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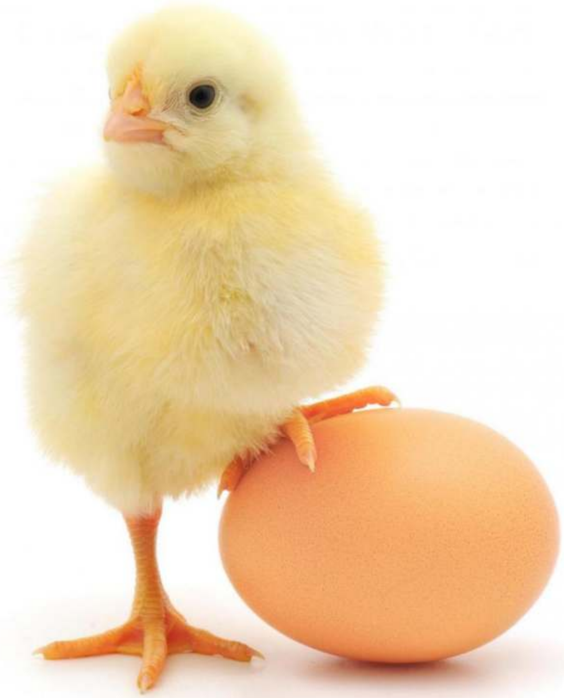

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Effects of Exposure Duration to Cottonseed Cake-Based Diets on Broiler Performance

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Abstract: Two experiments were separately conducted using cottonseed cake-based diets to feed table birds. In the first experiment (phase 1) broiler birds were fed from day old to 8 weeks of age, while in the second experiment (phase 2), the birds were fed cottonseed cake based diets from 4-8 weeks of age. Five dietary treatments were fed in both experiments formulated to be iso-caloric and iso-nitrogenous with Cottonseed Cake (CSC) replacing Soyabean Cake (SBC) at 0, 25, 50, 75 and 100% respectively. The live weight of broilers in the phases differed significantly ($p<0.05$) with broilers in phase 2 being better. The dressed weight was higher in phase 2 than phase 1. Broilers fed CSC based diets from 4 weeks had better feed conversion ratio than those fed from day old. Similar trend was observed in haematological and serum biochemistry parameters in the different treatments of the two phases. It can be concluded that feeding CSC protein as replacement for SBC protein was better from 4 weeks of age in respect of broiler performance though at a higher cost than the former.

Key words: Broiler's diet, cottonseed cake, serum biochemistry, performance

INTRODUCTION

The desire to proffer a specific answer to which is better, feeding Cottonseed-Cake (CSC) to broilers from day old or waiting until they are four weeks old led to comparing the results obtained in the following categories. Category 1, termed phase 1 broilers were fed from one day old through to eight weeks with diets containing CSC protein replacement for Soyabean Cake (SBC) at graded levels. Category 2, termed phase 2 broilers were fed only from four weeks old to finishing with diets containing CSC protein replacing that of SBC at graded levels.

Birds have been compared by various authors looking at different parameters of interest. Stappers (1969) and Grimbergen (1974) observed a remarkable difference in the feed intake of pullets in floor pens and cages. Dillon (1975) housed two birds whereas Mactnyre *et al.* (1975) caged the birds singly and their results were compared the birds output were different which was attributed to be as a result of social pressure. Nkanga and Egbunike (1990) observed no significant seasonal effect on semen quality, with two breeds of chicken at different seasons of the year.

Therefore, this work was carried out to compare the performance of broilers fed for four and eight weeks with graded levels of CSC on their growth rate, feed intake, feed conversion ratio, carcass characteristics and blood profile.

MATERIALS AND METHODS

A total of 180 day old mixed sexes Anak broiler chicks purchased from Avian Hatchery in Ibadan were used for category 1. The chicks were randomly assigned to five dietary treatment groups of 12 birds with three replicates per treatment in a Completely Randomized Design (CRD). The initial weight per bird was between 40-43 grammes.

Five isonitrogenous and isocaloric diets were formulated such that CSC protein replaced that of SBC in a maize-based broiler diet at 0, 25, 50, 75 and 100% level. The experimental starter diets contained 2980 kcal/kg ME and 23% crude protein as presented in Table 1 which was fed to the chicks for the first 4 weeks of life. The gross composition of the starter diet is shown on Table 1.

Two birds per replicate were bled by jugular vein puncture. Blood was collected in carefully labeled specimen bottles for haematological and serum metabolite studies. For haematological parameters, Packed Cell Volume (PCV) Haemoglobin (Hb) White Blood Cell (WBC) Red Blood Cell (RBC) Lymphocytes (Lym) Neutrophils (Neu) Eosinophil (EOS) and Monocytes (Mono) were assessed while for serum metabolites, albumin, globulin and total protein were assessed using the methods of Schalm (1971).

Proximate analysis was carried out according to the procedures described by AOAC (1995) for both the test ingredient, Cottonseed Cake (CSC) and the compounded diets, to analyze for dry matter, crude protein, crude fibre, ether extract and ash. Nitrogen free extract was calculated by difference. Free gossypol content of CSC was determined according to the procedure described by the AOCS (1979) and total gossypol was measured using the HPLC method of Hron *et al.* (1999).

Table 1: Composition of Cottonseed cake-based Experimental Starter Diets (kg)

	Diets				
Ingredients	1	2	3	4	5
Maize	47.20	45.75	44.20	41.10	44.00
Soyabean cake	32.30	24.22	16.15	8.10	0.00
Cottonseed cake	0.00	9.68	19.40	29.05	38.80
Wheat bran	13.46	13.31	12.21	13.71	9.16
Blood meal	1.00	1.00	2.00	2.00	2.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50	1.50
Methionine	0.04	0.04	0.04	0.04	0.04
*Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
CP (%)	22.89	22.77	22.78	22.88	22.74
ME (kcal/kg)	2,977	2,975	2,983	2,985	2,988

*Premix supplied per kg of diet: Vit A, 10,000 IU; Vit D, 2,800 IU; Vit E, 35,000 IU; Vit K, 1,900 mg; Vit B_{12} 19 mg; Riboflavin, 7,000 mg; Pyridoxine, 3,800 mg; Thiamine, 2,200 mg; D-Pantothenic acid, 11,000 mg; Nicotinic acid, 45,000 mg; Folic acid, 1,400 mg; Biotin, 113 mg; Cu, 8,000 mg; Mn, 64,000 mg; Zn, 40,000 mg Fe, 32,000 mg; Se, 160 mg; Iodine, 800 mg; Cobalt, 400 mg; Choline, 475,000 mg; Methionine, 50,000 mg; BHT, 5,000 mg; Spiramycin, 5,000 mg

In phase 2, five isonitrogenous and isocaloric diets were formulated such that CSC replaced SBC in the following order 0, 25, 50, 75 and 100% in maize based diets. The experimental finisher diets containing 2890 kcal ME/g and 20% crude protein were fed for the last four weeks of life.

A total of 90 day old Anak broiler chicks were obtained from Avian Hatchery in Ibadan were used for category 2. The chicks were randomly assigned to five dietary treatment groups of 6 birds replicated thrice with similar average weights in a completely randomized design.

Two birds per replicate were randomly selected and bled by the jugular vein using hypodermic needle with syringe from which blood was drained and collected into two carefully labeled specimen bottles for haematological and serum metabolite studies. One of the bottles contained EDTA an anti-coagulant, while the second bottle containing no anti-coagulant were kept in a refrigerator at 5 degree Celsius for about 4 h to aid sedimentation, after which they were spun in the centrifuge. The clearer portion was decanted into small sample tubes to assay for some serum metabolites for haematological parameters: Red Blood Cells (RBC) White Blood Cells (WBC) Packed Cell Volume (PCV) Haemoglobin (Hb) Lymphocytes (Lym) Neutrophils (Neu) Eosinophil (Eos) and Monocytes (Mono) were assessed using the methods of Schalm (1971).

Two birds per replicate were randomly selected for carcass analysis from the two categories. Selected birds were starved overnight and their live weights were taken. The birds were slaughtered by severing the jugular vein and were fully bled before scalding in hot water at 65°C. Feathers were removed after scalding the plucked weights recorded and were expressed as percentage of live weight. The birds were eviscerated and the eviscerated weight was recorded and expressed as percentage of live weight. The gizzard, crop, kidney, liver, neck, head and shanks were removed and dressed weights recorded and expressed as percentage of the live weight. The remaining dressed carcass was cut into different parts, weighed and recorded as percentage of dressed weight.

All the data collected from each treatment for all the parameters considered were subjected to analyses of variance using SAS (1999). The means were separated using Duncan's multiple range tests.

RESULTS

Feed intake: Feed Intake was significantly ($p<0.05$) higher in phase 2 than in phase 1. There was a significant CSC effect ($p<0.05$) in feed intake. Statistically there were significant differences with feed intake on the level of inclusion of CSC in the diets (irrespective of the phase) with lowered feed intake obtained at 100% level of inclusion than at lower levels.

Weight gain: There were no significant differences ($p>0.05$) between the weight gain of the two phases. Birds in phase 2 had higher weight gain than those in phase 1. Furthermore decline in weight gain were recorded with complete replacement of SBC with CSC than in lower levels of replacements.

Feed conversion ratio: Significant differences ($p<0.05$) were observed between the two phases. FCR values were significantly better ($p<0.05$) in phase 2 than in phase 1. Indicating that CSC based diets negatively affected performance and feed conversion of the birds in phase 1 than those of phase 2. In other words, feed were better utilized by birds in phase 2 than phase 1.

Live weight changes: Birds in phase 2 were significantly ($p<0.05$) better than birds in phase 1. Indicating that CSC based diets positively influenced growth and tissue development of birds in phase 2 than in phase 1.

Dressed weight: Differences between these phases were significant ($p<0.05$). Values from birds in phase 2 were significantly ($p<0.05$) higher than birds in phase 1. Indicating better muscle development in phase 2 than phase 1.

Liver and gizzard: No phase differences were observed for the two phases, numerically the liver and gizzard weight tended to be higher in birds raised from start to finish with cotton seed cake (phase 1) than those just raised with CSC in the finishing phase (phase 2).

Haematological characteristics: The PCV, Hb, RBC and WBC values showed that phase 2 was significantly

Table 2: A summary of comparison of performance traits of broilers fed cottonseed cake based diets in phase 1 (0-8 weeks) and phase 2 (4-8 weeks)

Performance traits	Phase 1	Phase 2	SEM±
Average weekly feed intake(g)	862.73^{b}	1027.55^{a}	16.83
Average weekly weight gain(g)	0.31	0.32	0.01
Average weekly feed conversion ratio	3.61^{b}	3.19^{a}	0.43
Live weight (kg)	1.89^{b}	2.15^{a}	0.06
Dressed weight (%)	69.8^{b}	72.0^{a}	1.80
Liver (%)	3.9	3.5	0.35
Gizzard (%)	4.1	3.9	0.20
Haematology			
Packed Cell Volume (PCV) %	29.00^{b}	32.33^{a}	0.50
Haemoglobin (Hb) g/100 ml	9.37^{b}	10.52^{a}	0.19
Red Blood Cell (RBC) $2.9\times10^{12}/mm^3$	3.14^{b}	3.59^{a}	0.26
White Blood Cell (WBC) $\times 10^6/mm^3$	2.05^{b}	2.93^{a}	0.10
Lymphocytes (Lym) %	45.73	46.57	1.94
Neutrophils (Neu) %	53.30	53.20	1.97
Serum Biochemistry			
Total protein g/100 ml	11.73	11.57	1.27
Albumin g/100 ml	5.23^{b}	7.06^{a}	0.96
Globulin g/100 ml	6.50^{b}	8.90^{a}	1.03
ALB : GLB Ratio	0.79	0.79	0.16

ab:Treatment means with different superscripts are significantly different ($p<0.05$)

higher ($p<0.05$) than those from phase 1. The lymphocytes and neutrophils values did not differ significantly in the two phases.

Serum biochemistry: Values obtained for total protein and ALB: GLB ratios were not significantly different ($p>0.05$) in the two phases. On the other hand albumin and globulin values were significantly different ($p<0.05$) in the two phases. Values observed were higher for birds in phase 2 than those in phase 1.

DISCUSSION

Feed intake: Feed intake was generally higher for broilers raised in phase 2 than those of phase 1. This is because during phase 2 the stringent requirement of a balanced ration and highly digestible nutrients as required by broiler starters for efficient growth and tissue development is absent in the finisher phase which was when the test ingredient (CSC) were introduced in graded levels to birds in phase 2. Thus they would require less digestible nutrients to take care of their need for growth and performance. Thus they are unlike birds raised in phase 1 that have to contend with a protein digestion inhibiting substance (gossypol) and the bulkiness of the diets formulated with CSC because of the high fibre nature of cottonseed cake in their diets from the starter to the finishing phase. The result of this study agrees with the work of Bamgbose (1988) as well as that of Gamboa *et al.* (2001).

Weight gain: The values of the average weight gain as shown in the table 29 indicate that there were no significant differences ($p>0.05$) between the phases. Though numerically phase 2 had a slightly higher value than birds in phase 1 showing that daily absorption of nutrients from digested feed were similar indicating the suitability of CSC as a worthy replacement for SBC despite its limitations of gossypol and high fibre content. This agrees with the work of Baber *et al.* (1995) and Bamgbose (1988) who reported that the inclusion of low gossypol CSC (0.03% free gossypol) up to 30 and 50% respectively had no adverse effect on body weight.

Feed conversion ratio: Significant differences between the phases on FCR were recorded. Generally, though significance was observed in FCR between the treatments, it did not follow a particular trend. This result does not agree with the submission of Watkins *et al.* (1993) and Baber *et al.* (1995) both of whom observed that values of FCR were not adversely affected by the inclusion of low gossypol CSC of up to 30% of the diet. The variance of this result with the above authors is due to the fact that the cottonseed cake used for this study were used in combination with soyabean cake and blood meal which supplemented the limiting lysine content in CSC and ensured that dietary lysine as an amino acid was not limiting.

These results agree with those of Fernandez *et al.* (1995) and Henry *et al.* (2001) though their values were relatively lower. These two authors attributed the differences in their FCR values to the addition of dietary supplemental lysine, which was recommended to overcome the deficiency of lysine in CSC.

Live weight changes: Live weight gain of animals is a function of not only its genetic potentials and environmental factors but also as a result of the amount of feed consumed and the efficiency of its utilization by the body. This investigation reveals that birds raised in the phase two had significantly better weight gain than those raised during phase one. The amount of nutrients released in the body for absorption and effective performance (growth/weight gain) depends on the quantity and quality of nutrients in feeds available in the body. When the nutrient intake is small or of low quality, the nutrients made available to the body for absorption will be impeded.

The quality of the feed in phase one was not as good as that of phase two because the chicks were exposed to the gritty fibre and gossypol content of CSC right from day old. This explains why birds raised during phase two had better weight gains than those raised in phase one. For both phases, the decrease in weight gain of the birds as the levels of inclusion of CSC exceeded 75% replacement for SBC could have been as a result of the increase in fibre and gossypol content which is known to dilute the nutrient in feed and also impede protein digestion in monogastrics. The results of this study agree with those of Bamgbose (1988) Fernandez *et al.* (1994;1995) as well as Henry *et al.* (2001).

Dressed weight: The dressed weights of the two phases were significantly different from each other. Birds raised in phase two had better dressed weight than those raised in phase one. Since birds raised in phase two had better performance in terms of feed intake and body weight gain, it is therefore not surprising that such birds will have higher dressed weight when compared with birds in phase one. These results agree with the submission of (McDonald, 1978; El-Boushy and Raterink, 1989; Fernandez *et al.*, 1995; Gamboa *et al.* (2001).

Liver and gizzard weights: The results on weights of organs revealed values that were different but were not significantly different. The liver and gizzard weights from phase one were higher which shows that the liver had more work of detoxification to do than those of birds in phase two, it also shows that the gizzard of bird in phase one was more muscular than those of phase two as they had more fibre to grabble with than birds of phase two, this agrees with the work of Aletor and Fetuga (1986) and also that of Ologhobo *et al.* (1993) who reported similar findings when diets containing jack bean were fed to broilers.

Haematological and Biochemical Indices: Haematological characteristics revealed that broiler chickens fed CSC based diets from day old to finishing gave significant reductions in PCV, Hb, RBC and WBC when compared with those fed CSC based diets from 4 weeks of age, this suggests a negative influence on blood haemopoesis. Apata (1990) suggested that the significant reductions in RBC, Hb, RBC and WBC may be results of factors acting together in an anti-nutrient containing dietary ingredient to induce inhibition of haemopoiesis or a combined toxic factor-induced RBC haemolysis leading to an increase in plasma volume.

This work is consistent with observations of Reddy and Salunkhe (1982) Apata and Ologhobo (1989) who stated that dietary antinutrients form a complex with dietary iron. The anti-nutrient-iron complex in turn reduces the amount of iron required for the functioning and regeneration of RBC, which is reflected in Hb. The decrease in white blood cells which act as a defense against infections, probably explains why the birds in phase one had reduced growth in line with the submission of Agrawal and Mahayan (1980).

The lymphocytes and neutrophils were not significantly different in the two phases. These granulocytes are responsible for providing the body with a defense against invading micro organisms. They are attracted in large numbers to any area of the body which has been invaded by micro organisms. This suggesting that the birds in the two phases were not at risk of microbial poisoning because of fed CSC. This is consistent with the findings of (Ikegwuonu and Bassir, 1977; Lis and Sharon, 1977) who attributed the production of these granulocytes to stimulation of the recticulo-endothelia system by the dietary endogenous toxic substances present.

Biochemical analysis revealed significant deceases in Albumin and Globulin of birds fed CSC based diets from day old to 8 weeks of age. This is attributable to the inhibition of protein utilization by the birds. According to Kakade *et al.* (1968) reduced serum protein and albumin levels manifest an alteration in normal systemic utilization.

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