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Effects of Cottonseed Cake Based Diets on Haematology and Serum Biochemistry of Egg-Type Chickens

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Abstract: The study evaluated the performance of layers fed on diets in which CSC replaced SBC in five experimental rations. The design of the experiments was Completely Randomized Design (CRD). There were 5 diets, in each experiment such that 0% (control), 15%, 30%, 45% and 60% of CSC replaced SBC. Chemical analysis was carried out to determine the Crude Protein (CP) and gossypol content of CSC. Seventy-five 23 week-old layers were fed with experimental layer diets for 12 weeks. Blood samples were collected and analyzed for differential white blood cell count (lymphocyte) and haemoglobin (Hb). All data were analyzed using descriptive statistics and analysis of variance. The determined CP of CSC was 35.11% and its gossypol content was 570g/ton, FCR ranged from 1.6 to 4.9. Values of lymphocyte and Hb ranged from 35.2% to 54.0% and 8.5g/dl to 11.1g/dl respectively. Birds on 60% CSC based diets had blood profile comparable to the control than those of other diets. CSC can replace up to 60% SBC without adverse effects on haematology and serum biochemistry of the Egg-type chickens.

Key words: Egg-type chickens, cottonseed cake, haematology and serum biochemistry

Introduction

In poultry production, diets are formulated to supply the nutrients needed by chickens to grow and lay eggs. These diets are composed of ingredients whose components can be digested and absorbed by chickens (Card and Nesheim, 1972).

Oilseed cakes have been reported to represent potential sources of protein and energy in poultry feeding. However, the cost of finished feeds containing the well known cakes like soyabean cake and groundnut cake has become prohibitive because of competition for the oilseeds by man. Therefore, it became necessary to find suitable plant protein alternatives less competed for by man. Cottonseed cake comes in as a useful alternative because of its relatively high crude protein content, cheapness and ready availability.

Cottonseed cake has not been extensively used in diets of egg-type chickens because of its potential deleterious effect on egg quality. Reid (1984) reported that the presence of gossypol in CSC fed to layers resulted in egg yolk discolouration during storage.

Feeding trials on the use of CSC in chicken diets shows that it is necessary to reduce the content of gossypol to fairly low levels in order to avoid the unfavourable physiological effect of this anti-nutrient (National Animal Production Research Institute Report, 1984).

Secondly the protein quality of CSC is usually lowered because of the heat processing methods which reduce lysine availability, especially in the presence of free gossypol which causes the formation of a protein-complex limiting the digestion of protein.

This study was designed to provide further information on the utilization of CSC in egg-type chickens when incorporated as a substitute for soyabean cake in layer diets. Effect on haematology and serum biochemistry were evaluated.

Materials and Methods

Experimental birds and diets: A total of 75 exotic ISA-Brown adult egg-type chickens of 23 weeks of age were randomly allotted to five dietary treatments each group having 15 layers. The experiment lasted 12 weeks. Cottonseed cake (CSC) was incorporated at 4.53, 9.10, 13.60 and 18.13% into a basal diet which served as control. The five diets were formulated to provide approximately 2.60 kcal ME.

Performance characteristics: Weekly records of feed intake were taken from which, the average weekly feed intake was calculated for each group. Feed conversion ratio was calculated using the following formula:

Feed Conversion Ratio = Average Feed Intake /Average Egg weight.

Blood sample collection and analysis: Blood samples were collected through the jugular vein into two well labelled sets of sample bottles at 27 and 31 weeks of age. One set contained ethylenediamine tetra acetate (EDTA) as an anti-coagulant while the other set contained nothing.

Hypodermic needles with syringe were used to withdraw the blood from the vein. Prior to the collection, the sample bottles were thoroughly washed dried and EDTA added to a set of the bottles. Blood samples in the set of bottles containing no anti-coagulant were kept in the

Table 1: Composition of Experimental CSC-based Diets fed to Layers

	% Replacement of SBC protein with CSC				
	0%	15%	30%	45%	60%
Ingredients	1	2	3	4	5
Maize	46.00	47.00	48.00	49.00	52.00
Soyabean cake	18.00	15.30	12.60	9.90	7.20
Cottonseed cake	-	3.23	6.48	9.71	12.97
Corn offal's	13.70	11.00	11.00	9.63	7.50
Wheat offal's	9.71	10.88	9.33	9.17	7.74
Fish meal	1.50	1.50	1.50	1.50	1.50
Bone meal	3.00	3.00	3.00	3.00	3.00
Oyster shell	7.50	7.50	7.50	7.50	7.50
Layers premix	0.30	0.30	0.30	0.30	0.30
Methionine	0.02	0.02	0.02	0.02	0.02
Salt	0.27	0.27	0.27	0.27	0.27
Total	100	100	100	100	100
Calculated					
Crude protein (%)	16.41	16.39	16.28	16.21	16.11
M.E.(kcal/g)	2.60	2.55	2.56	2.55	2.59
Crude fibre	4.30	4.45	4.65	4.82	5.09

*Premix supplied per kg of diet: Vit A, 20,000 IU; Vit D, 2,000 IU; Vit E, 5 IU; Vit K, 5mg; Vit B_{12} 7.5mg; Riboflavin, 4.2mg; Pantothenic acid, 25mg; Nicotinic acid, 45 mg; Folic acid, 0.5mg; Cu, 35mg; Mn, 250mg; Zn, 125mg Fe, 100mg; Iodine, 800mg; Cobalt, 1.25mg; Choline, 750mg

Table 2: Mean proximate composition of experimental diets and test ingredient

Diets	%DM	%CP	%EE	%CF	%ASH	%NFE
1	83.27	17.11	0.50	6.00	8.50	67.89
2	82.80	17.47	2.00	7.00	8.00	65.53
3	84.80	17.61	2.00	8.00	8.00	64.39
4	84.47	17.16	4.50	8.50	10.00	59.84
5	84.10	16.73	5.00	9.00	9.50	59.77
CSC	90.15	35.11	3.00	17.00	3.50	41.39

refrigerator at about 4°C for about 3 hours to aid sedimentation. The samples were later spun in a centrifuge at 3,000 rpm for 10 minutes and the serum separated, stored frozen at-10°C for analysis. The serum for the corresponding replicate groups was later used to assay the serum metabolites. The values for the haemoglobin were obtained using the whole blood.

Chemical analysis: The cottonseed cake and experimental diets were taken and analyzed according to A.O.A.C (1995) for their proximate composition. Serum albumin and globulin were assayed by the method Rodkey (1965).

Statistical analysis: The experiment was a completely randomized design. All the experimental data were subjected to the analysis of variance using SAS (1999) and where statistical significance was observed, the mean values were separated using the Duncan Multiple Range Test (Duncan, 1980).

Results

The determined proximate composition of the diets fed in the trial is presented in Table 2.

Nutrient composition: The determined crude protein ranged between 16.73% (diet 5) and 17.61% (diet 3). Crude fibre increased from 6.00 (diet 1) to 9.00% (diet 5), ether extract also increased for 0.50% (diet 1) to 5.00% (diet 5). Ash values also increased from 8.00% (diets 1 and 3) to 10% (diet 4).

Performance characteristics of layers fed CSC based diets

Feed intake: There were no significant differences ($p>0.05$) in the feed intake of layers fed CSC based diets. The feed intake increased from 138g/day/bird fed diet 1 (control) to 148g/day/bird fed diet 5.

Feed Conversion Ratio (FCR): The Feed Conversion Ratio did not follow any trend. Diet 2 had the best FCR of 2.46, even though this was not significantly different from diet 1 (control) with 2.56 or diet 5 with 2.63.

Haematological characteristics of layers fed CSC based diets: The results of the blood indices are presented in Table 3 and 4 showing measurement at 27 and 31 weeks of age respectively. Significant differences ($p<0.05$) were recorded for PCV and RBC as shown in Table 3 when the birds were 27 weeks of age. Significantly lower PCV and RBC were recorded for diet 5. In Table 4 only the WBC showed significant differences ($p<0.05$) between the treatment means. The value for diet 2 was significantly lower ($p>0.05$) when compared with the other diets.

Serum Metabolites of Layers Fed CSC based diets: The results of the serum biochemistry of treatment birds are presented in Table 5 (serum metabolites of layers measured at 27 weeks of age) and 6 (serum metabolites of layers measured at 31 weeks of age) respectively. Significant differences ($p<0.05$) were recorded for all the parameters measured (Table 5) when the birds were 27 weeks of age. Differences observed did not follow a particular trend. Surprisingly, the same birds did not show any significant difference ($p<0.05$) in the entire parameters measured when the birds were 31 weeks of age showing the adaptability of the birds to the treatment diets when fed long enough.

Discussion

Chemical composition: The test ingredient, cottonseed cake, has a proximate composition that is similar to those reported by Ryan *et al.* (1986); Reid *et al.* (1987); and Bamgbose and Niba (1998). Generally, cottonseed cake has about 24 to 42% crude protein and about 9 to 12% crude fibre (Balloun, 1980).

Table 3: Haematological parameters of layers fed CSC-based diets at 27 weeks of age

	Treatments					
Parameters	1	2	3	4	5	SEM
Packed cell volume (%)	26.17^{ab}	25.17^{ab}	27.00^{a}	25.00^{ab}	23.90^{b}	1.05
Haemoglobin(g/100ml)	8.32	8.18	8.72	7.90	7.83	0.64
RBC(2.9×10^{12}/mm^3)	2.10^{b}	4.40^{a}	3.07^{ab}	2.75^{ab}	2.12^{b}	0.87
WBC(1×10^{6}/mm^3)	9.03	8.27	11.32	9.08	7.92	2.71
Lymphocytes (%)	75.17	80.00	69.83	73.50	78.83	3.13
Neutrophils (%)	26.67	19.83	31.33	26.33	20.83	3.20

ab: Means in the same row with different superscripts are significantly different ($p<0.05$)

Table 4: Haematological parameter of layers fed CSC-based diets at 31 weeks of Age

	Treatments					
Parameters	1	2	4	3	5	SEM
Packed cell volume (%)	27.67	24.67	24.83	26.17	24.33	1.44
Haemoglobin (g/100ml)	9.08	7.97	7.98	8.45	7.97	0.87
RBC (2.9×10^{12}/mm^3)	5.41	5.81	5.26	5.49	5.54	0.90
WBC (1×10^{6}/mm^3)	10.70^{ab}	8.03^{b}	10.37^{ab}	11.30^{a}	10.18^{ab}	1.20
Lymphocytes (%)	59.33	56.50	77.00	66.67	55.17	3.21
Neutrophil (%)	42.00	33.50	23.00	33.67	41.50	2.94

ab: Means in the same row with different superscripts are significantly different ($p<0.05$)

Table 5: Serum metabolites in layers fed CSC based diets at 27 weeks of Age

	Treatments					
Parameters	1	2	3	4	5	SEM
Total Protein (g/dl)	4.55^{a}	3.32^{b}	4.18^{ab}	3.93^{ab}	4.57^{a}	0.71
Albumin (g/dl)	1.53^{a}	1.18^{b}	1.38^{ab}	1.35^{ab}	1.58^{a}	0.40
Globulin (g/dl)	2.80^{a}	2.13^{b}	2.80^{a}	2.58^{ab}	3.02^{a}	0.54
ALB:GLB ratio	0.55^{a}	0.55^{a}	0.49b	0.52^{ab}	0.52^{ab}	0.07

ab: Means in the same row with different superscripts are significantly different ($p<0.05$)

Table 6: Serum metabolites in layers fed CSC based diets at 31 weeks of age

	Treatments					
Parameters	1	2	3	4	5	SEM
Total Protein (g/dl)	3.52	3.50	3.67	3.63	3.97	0.58
Albumin (g/dl)	1.33	1.30	1.27	1.22	1.43	0.41
Globulin (g/dl)	2.19	2.18	2.40	2.42	2.53	0.47
ALB:GLB Ratio	0.61	0.60	0.53	0.50	0.57	0.09

One of the factors which are of concern in feeding CSC to monogastrics is the fibre content of CSC. The crude fibre content varies a great deal in CSC, depending on whether or not the CSC was delinted and/or dehulled before oil extraction.

Performance characteristics

Feed intake: Although the amount of feed consumed did not indicate any significant response to the treatment effects on the layers, a relatively higher consumption was recorded as the CSC level in the diet increased. The inclusion of CSC in the experimental diets correspondingly increased the fibre content as the level of CSC increases. Increased dietary fibre level is often associated with faster rate of passage which inhibits optimal benefit from feed intake through the gut filling effect with a consequential reduction in the feed consumption (Thorne *et al.*, 1992). The observed increase in feed intake as CSC level increases may be due to the natural instinct of the layers to eat to meet their energy needs. The increasing rate of inclusion of CSC inadvertently lowered available dietary energy. (Fetuga, 1984; Summers and Leeson, 1986; Gous *et al.*, 1990; Fahey *et al.*, 1992). Therefore, the propensity of birds to consume more at higher dietary fibre gave a clear indication of the natural reactions to events of lower energy.

Feed Conversion Ratio (FCR): FCR values increased in birds fed increasing amount of CSC in the experimental diets (Table 1). This could be explained by the higher feed intake in relation to the egg weights of the birds. Card and Nesheim (1972) reported that poor feed conversion in egg laying ventures can be an indicator of the poor quality of feed given to the birds. Mamputu and Buhr (1991) also observed high FCR in layers fed

varying amount of oil seed cakes. Dietary treatment did not influence the FCR significantly.

Haematological parameters: The haematological parameters particularly PCV and RBC were significantly affected by the CSC based diets in the first four weeks of feeding with the 60% CSC replacement for SBC being significantly lower than other inclusion levels. But after 8 weeks of feeding, the values obtained for RBC and PCV were no longer influenced significantly by dietary treatment except for WBC for diet 2 which was significantly different from other treatments. The significantly lower values obtained for diet 2 is indicative of the susceptibility of the birds to diseases and inferior health status which is not reflective of their nutrition as birds fed higher concentration of CSC than birds in this group did not show such low WBC counts. This perhaps can be explained as an isolated case of disease attack and reaction which cannot be ruled out because of the immune responses of birds to disease attack cannot be said be the same at all times. Physical signs of disease were not observed with birds in treatment 2. RBC counts were similar to the range reported for adult chicken by Mitruka and Rawnsley (1977) and Awotwi (1990) but were higher than the values reported by Aletor and Ogunyemi (1988).

The reduction in PCV and RBC values in the first four weeks of feeding trials indicate a low protein intake or mild anaemia as reported by Lindsay (1977) and Maxwell *et al.* (1990). The PCV values of layers in this study were similar to value recorded by Aletor and Ogunyemi (1988) but it was lower than the average value of 38.52% recorded by Awotwi (1990) for adult local domestic chicken. The difference in PCV value and that of Awotwi (1990) for local chickens may be due to breed and age difference. This seems to support the results of Kubena *et al.* (1972) and Oyewale (1987) who reported that birds in the tropics tend to have lower haemaglobin values than those reared in the temperates. The differential counts of values of Lymphocytes and Neutrophils obtained were not influenced by dietary treatments and were within the normal range for adult chickens as reported by Mitruka and Rawnsley (1977).

Serum metabolites of layers: The values of biochemical composition revealed significant differences in the total protein, albumin, globulin and albumin/globulin ratio in the first four weeks of feeding, but after 8 weeks of feeding it seemed the birds adjusted to the diets as differences observed were no longer significant. The lack of significance between the biochemical parameters particularly the total protein suggests that the protein quality was adequate at all levels of CSC inclusion considered.

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