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Effect of Inclusion of Cotton Seed Cake on the laying Performance and Egg Quality of layers

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Target Audience: Poultry scientists, poultry farmers, feed millers.

Abstract

A total of 104 pullets were used to investigate the effect of different levels of cotton seed cake (CSC) on the laying performance and correlation of egg weight with other egg quality traits . Four different diets designated T1, T2, T3 and T4 were formulated containing 0, 23.80, 27.35, and 30.0 % CSC for the chicks (0-8 weeks), while the diets for the growers and the laying pullets contained 0, 4.75, 7.75, and 10.0 % CSC respectively. The experimental diets were fed from 8 weeks to 32 weeks of age. The results indicated a significant reduction (P<0.05) in the body weight of the pullets at 32 weeks of age due to CSC inclusion compared to the control. No significant differences (P>0.05) were observed in the body weights of the pullets fed different CSC levels. All the external egg (egg length, width, shape index, shell thickness, weight and percent shell) and internal egg (egg yolk, height, diameter, albumen weight, height, pH, yolk/ albumen ratio and Haugh unit) egg quality traits measured showed no significant differences (P>0.05). Egg weight was positively correlated with egg width and yolk. The highest CSC level (10.0 %) in T4 resulted in a negative correlation indicating an inverse relationship between egg weight and yolk weight in a high CSC diets. The correlation of egg weight with egg albumen weight and height was positively high except in T2 indicating that high CSC may not be detrimental to albumen formation and development.

Keywords: Laying performance, egg weight, egg quality, pullets, cotton seed cake.

Description of Problem

There are many factors that could affect the performance of pullets and egg quality traits. Among such factors is nutrition. Feed consumption itself is a function of dietary energy content(1). Closely related to this is dietary composition. Many workers have reported significantly reduced feed consumption in birds fed cotton seed cake (2, 3, 4). They reported depressed feed intake and feed conversion efficiency (FCE) and attributed it to high gossypol component of cotton seed cake (CSC). It was reported by (3) that one kilogramme of feed per dozen egg was poorer in 22.5 % cotton seed cake inclusion compared to none cotton seed cake diets. They reported better hen-day production in 30.0 % cotton seed cake pullets than those fed 0.0 % cotton seed cake. However, 37.5 % cotton seed cake reduced hen-day production compared to 0.0 % but the difference was not significant (P>0.05). They observed that the levels of cotton seed cake used did not significantly (P>0.05) affect egg weight, Haugh unit score, yolk index and egg shell thickness. These authors did not relate the egg weights to the egg quality traits of the pullets.

Several other scientists who have reported works on egg quality characteristics did not find the interrelationships between egg weights and quality traits. The work of (5) was on age of the laying hens and egg quality traits while (6) measured the effect of different protein levels and micro-nutrients in commercial diets on egg quality traits and (7) only reported the interrelationship of laying hens body weight and egg quality parameters. All these necessitate the need to relate

the egg weight to the other quality traits. Certainly egg shell, yolk and albumen are essential components of egg that determine egg weight and quality. A defect in any of these components will, no doubt, affect the egg quality. For instance thinness of egg shell affects its tensile strength. Already losses from cracked eggs are a major problem on commercial farms. Knowing the relationship between egg weight and its component parts will assist in no small measure to ameliorate some of these observed problems. The challenge facing animal scientists therefore is to develop the desired egg quality traits. This will mean developing production traits that are highly and positively correlated. In this effort differences in performance due to non- genetic factors, mainly, feeding can not be ignored.

This work was therefore designed to evaluate the laying performance of pullets and examine the interrelationships of egg quality traits in cotton seed cake based diets.

Materials and Methods

A total of one hundred and four pullets were used for this work. They were purchased at day - old and were fed on chicks' mash and experimental diets. The chicks' diets contained 0, 23.80, 27.35 and 30.0 % cotton seed cake respectively and were fed for 8 weeks. The experimental layers' diets contained 0, 4.75, 7.75 and 10.0 % cotton seed cake and were fed from 18 to 32 weeks of age. The cotton seed cake and the fish meal levels were adjusted to make the diets at each of these phases (chicks' versus grower/ layers' phases) isonitrogenous and also to account for the differences in the protein requirements of the chicks and the pullets as recommended by(16). The composition of the experimental diets is shown in Table 1. The supplementation with lysine and methionine was necessary because of the cereal and ground nut components which are widely known to be deficient in these amino acids. Feed and water were given *ad lilbitum*. At 18th week of age each pen was provided a pair of wooden laying hutches (nest boxes).The birds were raised on deep litter system. The floor of the laying nests was lined with a layer of litter materials to serve as a cushion to the laid eggs. This measure was taken to reduce the number of eggs cracked and broken.

Routine vaccination and drug administration were used against Coccidiosis, Gumboro and Newcastle diseases. Worms were expelled using piperazing while antistress (*Vitalyte*) was given at the end of each weighing exercise.

Egg collection: All the eggs that were laid in each pen were collected. Collections were made 3 times a day. The daily collections were carefully placed in egg trays, counted, weighed and recorded for each replicate. The number of cracked and broken eggs were recorded daily.

Egg quality analysis: Egg quality analysis was carried out fortnightly. Five percent of the total eggs were randomly picked from each replicate and analysed. Individual egg was labeled and weighed using electronic weighing balance. Egg quality measurements of width, length, shell thickness, shell weight, percent shell, egg shape index, yolk weight, yolk height, yolk diameter, yolk index, yolk: albumen ratio, albumen weight and pH were measured as described by (5) and (6). Haugh unit score was determined according to (8) and percent hen-day production was estimated as the number of eggs produced per bird per day in percentage. Percent cracked egg was expressed as the number of cracked eggs of the total number of eggs produced.

Chemical analysis: The proximate analysis of the chicks' mash, growers' and layers' mash and the experimental cotton seed cake was conducted according to (9) standard methods.

Statistical analysis: The data obtained were subjected to statistical analysis using analysis of variance(ANOVA) technique according to (10). Mean separation was done using Duncan multiple range test (11) where there were significant differences. Correlation analysis between egg weight and other egg quality measurements was carried out using a computer package (12) and Quattro-Pro version 5 (13).

Table 1: Composition of experimental diets

Feed Ingredient	Chixks' mash (0-8 weeks)				Growers mash (8-18) weeks				Layer's mash (18-32) weeks			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Maize	62.00	62.45	60.90	60.25	68.00	69.75	70.00	70.00	60.65	60.90	59.90	59.15
Ground Nut cake	26.25	0.00	0.00	0.00	18.05	8.55	6.55	3.80	20.00	13.50	12.00	11.50
cotton seed cake	0.00	23.80	27.35	30.00	0.00	4.75	7.75	10.00	0.00	475	7.75	10.00
fish meal	3.00	5.00	3.00	1.00	1.00	1.00	1.00	1.00	0.00	5.00	5.00	5.00
Corn offal	5.00	2.00	5.00	5.00	10.00	13.00	11.75	12.25	5.00	5.50	5.00	4.00
Bone meal	2.00	1.00	2.00	2.00	1.20	1.20	1.20	1.20	6.00	6.00	6.00	6.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	3.00	3.00	3.00
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.30	0.30	0.30	0.30
Methione	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.50	0.50	0.50	0.50
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Results and Discussion

The values obtained for cotton seed cake composition, ether extract, and crude fibre were higher than the values reported by (14) but compared well with those reported by (15). The high fibre values in the diets were attributed to the high level of fibre in the cotton seed cake resulting from an attempt to meet up with the required protein levels. The chicks' mash was formulated on a higher protein than the layers' diets to be in line with the recommendation of (16). It was observed that diet T_1 consistently had higher crude protein and ether extract than other diets while diet T_2 had high crude fibre (Table 2).

The indices of performance of the pullets are indicated Table 3. Non-significant differences ($P>0.05$) were observed in the values for mean weekly feed intake, feed conversion ratio and percent hen-day production. However, inclusion of cotton seed cake in diets T_2, T_3 and T_4 depressed ($P< 0.05$) the body weight compared to the control diet at 32 weeks of age. A similar observation was attributed to high gossypol by (4) and (20). In a report by (2) even addition of 0.2 % lysine and 0 .1 % methionine did not significantly improve the body weight gain of birds fed high cotton seed cake diets. Inclusion of cotton seed cake in the diets significantly ($P< 0.05$) reduced the percent cracked eggs (Table 3). This could be attributed to the difference in the amounts of Ca and P furnished by ground nut cake and cotton seed cake used in the diets as (17) reported that the quality of egg shell was primarily a function of the nutrition of birds. Thinner shells were associated with increasing egg size and lower Ca availability (18, 19).

Table 4 shows that the different levels of cotton seed cake fed did not have significant effect ($P > 0.05$) on both the external and the internal egg quality traits measured. The values reported in Table 4 compare well values obtained by 3, 5, 6.

Table 5 shows the correlation coefficient between egg weight and quality traits of the pullets. There was a highly positive correlation of egg weight with egg width and yolk weight except in T_4 where negative correlation was observed between egg and yolk weights. These results indicate that there is an inverse relationship between egg weight or egg width in a high cotton seed cake diet. The observed effect could be attributed to the effect of high gossypol level in the high cotton seed cake diets as (4) reported that chickens tolerate levels below 0.04 % of free gossypol. The correlation of yolk height, yolk diameter, yolk index and yolk: albumen ratio with egg weight did not show any consistency but the values were mostly negatively correlated with egg weight in high cotton seed cake diets. The correlation of egg weight with albumen weight, albumen height and pH were high and positive

Table 2: Proximate composition of the cotton seed cake, and the experimental diets.

Parameters	Ether extract	Crude fibre	Crude protein	Ash	Nitrogen free extract
Cotton seed cake	**11.69**	**21.20**	**28.42**	**4.46**	**30.23**
Chicks' mash					
T_1	18.52	10.33	22.74	7.23	36.28
T_2	20.00	19.13	22.73	5.67	32.45
T_3	5.75	12.60	19.80	6.82	45.03
T_4	6.92	13.08	21.25	5.33	43.42
Growers' diet					
T_1	18.03	8.20	22.02	4.88	42.87
T_2	15.09	24.52	19.07	6.03	32.29
T_3	14.52	13.71	19.19	7.33	45.25
T_4	14.72	11.04	19.58	5.19	49.47
Layers' diets					
T_1	16.10	9.47	21.23	12.54	40.66
T_2	15.27	14.52	17.90	13.03	39.28
T_3	14.91	12.01	18.14	14.60	40.34
T_4	15.07	11.56	17.86	12.92	42.59

Table 3. Performance of pullets fed different levels of cotton seed cake

Parameters	T_1	T_2	T_3	T_4	SEM
Weekly feed intake (g)	958.18	917.42	932.16	950.45	± 3.97 NS
Feed conversion ration	4.77	5.42	4.78	4.98	± 0.26 NS
Mean weights of birds at 32 weeks of age (g)	1457.23^{b}	1347.68^{a}	1384.74^{a}	1350.50^{a}	± 11.04
Percent hen day production (%)	32.37	29.00	31.22	31.69	±1.2 NS
Percent cracked eggs (g)	11.16^{b}	10.16^{b}	4.49^{a}	7.92^{ab}	± 2.56

Values with different superscripts in the row are significantly different ($P< 0.05$).

except in T_2 where negative correlation was observed for albumen weight and pH at the last cotton seed cake level. The results obtained agreed with the (19) and (21) that egg weight was more strongly correlated with albumen weight than any other component of the egg and that albumen is the main bulk of egg weight. It is possible that the gossypol of cotton seed cake might have depressed the egg yolk component according to (4). The results indicate that high cotton seed cake may not be detrimental to albumen formation and development (9) in an egg.

Table 4. Egg quality traits of pullets fed different levels of cotton seed cake.

Parameters	T_1	T_2	T_3	T_4	
External egg quality traits					
Mean egg weight (g)	54.97±1.155	54.84±0.76	53.51±0.98	53.26±0.80	NS
Egg length (cm)	5.58±0.05	5.59±0.07	5.60±0.03	5.53±0.65	NS
Egg width (cm)	3.96±0.05	4.02±0.06	3.99±0.03	3.94±0.05	NS
Shell thickness (mm)	0.34±0.03	0.32±0.01	0.32±0.01	0.32±0.01	NS
Shell weight (g)	4.88±0.08	4.79±0.18	4.70±0.11	4.61±0.18	NS
Percent shell (%)	8.90±0.25	8.76±0.31	8.91±0.22	8.71±0.36	NS
Egg shape index	0.17±0.01	0.72±0.02	0.71±0.01	0.71±0.01	NS
Internal egg quality traits					
Yolk weight (g)	15.55±2.05	17.58±2.58	15.25±2.31	14.46±1.84	NS
Yolk height (cm)	1.54±0.07	1.52±0.05	1.55±0.07	1.59±0.06	NS
Yolk diameter (cm)	4.03±0.06	3.80±0.17	3.86±0.15	4.01±0.01	NS
Yolk index	0.38±0.02	0.41±0.02	0.41±0.03	0.40±0.02	NS
Yolk/Albumen ratio	0.51±0.08	0.66±0.13	0.52±0.09	0.50±0.08	NS
Albumen weight (g)	32.66±2.44	28.90±2.31	31.57±2.48	31.27±2.71	NS
Albumen height (cm)	0.67±0.05	0.67±0.03	0.70±0.03	0.66±0.05	NS
Albumen pH	6.83±0.15	7.19±0.18	7.12±0.15	6.69±0.15	NS
Haugh unit score	82.25±3.06	82.27±1.73	84.84±1.73	81.69±2.13	NS

NS indicates means in the same row that are not significantly different ($P < 0.05$)

Table 5: Correlation between egg weight and egg quality traits of pullets fed diets with different levels of cotton seed cake.

Eggs quality traits	T_1	T_2	T_3	T_4
Egg weight	1.000	1.000	1.000	1.000
Egg width	0.854	0.884	0.737	0.365
Yolk weight	0.448	0.724	0.296	-0.518
Yolk height	-0.169	0.394	0.190	-0.218
Yolk index	0.749	-0.746	0.379	0.976
Yolk diameter	-0.443	0.942	-0.154	-0.707
Yolk/albumen ratio	-0.168	0.713	0.117	-0.637
Albumen weight	0.940	-0.813	0.093	0.757
Albumen height	0.919	0.457	0.117	0.783
Albumen pH	0.593	-0.585	0.824	0.513
Haugh unit score	0.904	0.125	0.045	0.784

T1= 0.00; T2 = 4.75; T3 = 7.75; T4 = 10.00 % respectively.

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