Quality of eggs produced by laying chickens fed low-gossypol cottonseed meal

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ABSTRACT

The study investigated the effects of feeding low-gossypol cottonseed meal (CSM) on the quality of eggs produced by laying chickens. A total of 288 Shaver Starcross 579 pullets of 30 weeks of age were randomly allotted to six dietary treatment groups of 48 birds each. Graded levels of CSM, 0, 2.5, 5.0, 7.5, 10.0 and 12.5 per cent were incorporated into their diets. All the diets were isonitrogenous and isocaloric. Results indicated an increase in egg production with increasing levels of CSM in the diet up to 10 per cent level of inclusion. The addition of CSM to the diets had no significant effects on egg weight, Haugh unit values (HUV), yolk index, and yolk colour scores. However, egg yolk colour tended to improve with increasing levels of CSM in the diet. Irrespective of dietary treatments, egg weight, Haugh unit values, and yolk index scores deteriorated with storage at room temperature. However, no yolk or albumen discolouration were observed in stored eggs, even after 3 weeks of storage. On the basis of market quality of eggs produced, the low-gossypol CSM used in this study was satisfactory for incorporating into layer diets as a protein source.

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RÉSUMÉ

NELSON, F. S.: *Qualité d 'oeufs produits par les poules pondeuses.* Une expérience se déroulait pour déterminer les effets d'alimentation avec farine de graine de coton (FGC) de faible gossypol sur la qualité d'œufs produits par les poules pondeuses. Un total de 288 poulettes de Shaver Starcross 579 ayant l'âge de 30 semaines étaient assignées au hasard aux six groupes de traitements diététiques de 48 volailles par chacun. Des niveaux calibrés de FGC, 0, 2.5, 5.0, 7.5,10.0 et 12.5 pour cent étaient incorporées dans leur régimes. Tous les régimes étaint isoazoté et isocalorifique. Les résultats indiquaient une augmentation en production d'œuf avec l'augmentation du niveau de FGC dans le régime jusqu' à 10 pour cent de niveau d'inclusion. L'addition de FGC aux régimes n'avait pas d'effets considérables sur poids d'œuf, unité de valeurs de la noue, indice de la jaune et les scores de couleur de jaune. Toutefois, la couleur de jaune d'œuf avait la tendance d'améliorer avec l'augmentation des niveaux de FGC dans le régime. Sans tenir compte de traitements diététiques, poids d'œuf, unité de valeurs de la noue, et les notes d'indice de jaune détérioraient avec stockage à une température ambiante. Aucune décoloration d'albumen ou de jaune n'était observée dans les œufs stockés, même après 3 semaines de stockage. Par suite de qualité marchange d'œufs produits, la FGC de faible gossypol utilisée dans cette étude était satisfaisante pour incorporation aux régimes des pondeuses comme source de protéine.

Introduction

Malnutrition is endemic in Africa. The food deficit situation is indeed more serious with the intake of animal proteins in Africa. Ghanaians are among the lowest meat-consuming people in the world (Alhassan & Barnes, 1993). Meat and animal products are not enough to meet protein requirements in Ghana. It is estimated that in Africa, on the average, 10 g of animal protein is consumed per day, compared to a recommended daily intake of 35 g (FAO, 1986). The World Health Organisation (WHO) recommended minimum of 70 g protein per day has not been achieved in Ghana. This trend can be changed because Ghana has the capacity of improving the production of livestock and poultry to meet the needs of the people. Poultry production offers one of the fastest and most efficient means of providing meat and eggs for correcting the shortage of animal protein in Africa in general and Ghana in particular.

Animal protein can, thus, be produced from chicken at a cheaper cost if the price of feed could be regulated (if feed could be produced at a reasonably lower cost). Feed is the greatest single cost factor in poultry production, accounting for over 70 per cent of the cost of production (Inkumsah, 1971; Ademosum, 1976). The conventional protein sources used in formulating diets, especially fishmeal, are very expensive and not always available in amounts adequate to ensure constant supply. It has, therefore, become necessary to find alternative ingredients which are locally available in large quantities and relatively inexpensive. This need has brought cottonseed meal into focus as a potential source of dietary protein in poultry diets.

Although cottonseed meal has been found to be an important protein supplement, it is not usually recommended for use in diets of laying chickens, due to earlier views expressed on the development of egg yolk and albumen discolouration with storage.

This study was, therefore, designed to determine the effects of low-gossypol CSM on the quality of eggs produced by laying chickens.

Materials and methods

The eggs used in this study were obtained from a population of 288 Shaver Starcross 579 pullets of 30 weeks of age which was originally supplied by the Pomadze Poultry Enterprises Limited, Accra. The birds were wing-banded, weighed, and randomly allotted to six treatment groups. Cottonseed meal was included in the diets at various levels of 0, 2.5, 5.0, 7.5, 10.0 and 12.5 per cent. Each experimental diet (Table 1) was offered

TABLE 1

Composition and Calculated Analysis of Layer Experimental Diets Used

Ingredient g kg⁻¹	*Dietary treatment (g CSM kg⁻¹)*					
	0	25	50	75	100	125
Maize	538.0	530.0	520.0	512.0	509.0	500.0
Wheatbran	200.0	200.0	200.0	200.0	200.0	200.0
Fishmeal	77.0	60.0	45.0	28.0	26.0	9.5
Cottonseed meal	-	25.0	50.0	75.0	100.0	125.0
Soyabean meal	100.0	100.0	100.0	100.0	80.0	80.0
Oyster shell	70.0	70.0	70.0	70.0	70.0	70.0
Dicalcium phosphate	10.0	10.0	10.0	10.0	10.0	10.0
Premix*	2.5	2.5	2.5	2.5	2.5	2.5
Common salt	2.5	2.5	2.5	2.5	2.5	2.5
Total	1000	1000	1000	1000	1000	1000
Calculated analysis (g kg⁻¹)						
CP	170.5	170.0	170.6	170.2	170.4	170.2
Fibre	39.6	47.4	49.9	52.3	55.1	57.6
Ether extract	36.11	36.15	36.18	36.22	35.79	35.81
Ca	29.8	28.9	28.5	28.0	27.9	23.5
P (available)	8.1	8.0	7.9	7.7	7.8	7.7
Lysine	9.3	8.8	8.4	7.9	7.6	7.2
Methionine	3.6	3.4	3.2	3.0	2.9	2.7
Energy ME (MJ KG g⁻¹)	10.86	10.59	10.51	10.44	10.60	10.53

*Vitamin-mineral premix provided per kg diet: vitamins A, 2 million IU; D, 400,000 IU; E, 3,000 IU; K, 2,000 IU; B1, 2000 IU; B1, 200 mg; B2 900 mg; B12, 2,400 mg; niacin, 5,000 mg; minerals Fe, 9,000 mg; Cu, 500 mg; MMMn, 12,000 mg; Co, 100 mg; Zn, 10,000 mg; 1,40 mg; Se, 4.

to four replicate groups of 12 birds per group for a period of 336 days, divided equally into 12 28-day periods. Diet 1 (Control) contained fishmeal with no CSM. Feed and water were supplied *ad libitum*.

Parameters studied during the experimental period were feed intake, egg production, feed conversion efficiency, egg weight, Haugh unit, and yolk indices. However, only egg production for the 12-month period is shown in this study in addition to interior quality of egg indices. All eggs collected in a day from each group were stored to determine the effects of storage on albumen quality and egg yolk discolouration after breaking the eggs open at 0, 4, 7, 14 and 21 days of storage under normal room temperature. After weighing, each egg was broken out unto a smooth level surface. The height of the albumen was measured, away from the chalazae, at a point midway between the inner and outer edges of the thick white. The height and diameter of the yolk were also measured.

Yolk index values as a measure of yolk quality were calculated as the ratio of yolk height to yolk diameter. Haugh unit values, as measurement of albumen quality, were calculated using the following equation as outlined by Card & Nesheim (1976).

$$HUV = 100 \log (H + 7.57 - 1.7W^{0.37})$$

where H is height of albumen in millimeters and W is weight of egg in grams

Shell thickness of individual eggs was also measured using a micrometer screw gauge.

The data collected were analysed using the analysis of variance technique described by Steel & Torrie (1980). Differences among treatment means were determined using Duncan's New Multiple Range Test (1955).

Results and discussion

Tables 2 and 3 present summaries of the results. Average egg production increased significantly ($P< 0.05$) with increasing levels of CSM in the diet up to 10 per cent level of inclusion. The addition of CSM to the diets had no significant effect on egg weight, Haugh unit values, yolk index, and yolk colour scores. However, egg yolk colour tended to improve with increasing levels of CSM in the diet. Haugh unit values also tended to increase with increasing levels of CSM.

Mean egg shell thickness was significantly ($P< 0.05$) affected by dietary treatments, even though no visible trend was observed. Regression analysis between the level of CSM and egg shell thickness was low and showed no significant relationship (b = - 0.0009). However, egg shell thickness tended to deteriorate at the 12.5 per cent level of inclusion of CSM. Shell strength (egg

TABLE 2

Effects of Low-gossypol Cottonseed Meal (CSM) on Performance and Egg Quality Characteristics

Parameter	*Dietary treatment, % cottonseed meal*						
	0	2.5	5.0	7.5	10.0	12.5	SEM
Hen-day production (%)	68.03[b]	72.75a	70.51ab	70.15ab	71.47ab	67.39b	2.17
Mean egg weight (g)	60.79	61.52	62.47	61.29	60.70	60.12	0.62
Haugh unit value	82.55	84.02	83.61	84.67	84.57	84.85	1.02
Yolk index (%)	42.68	43.57	44.06	43.67	43.14	43.12	0.41
Yolk colour [1]	1.00	1.00	1.15	1.19	1.19	1.25	0.04
Mean shell thickness (mm)	0.36[ab]	0.36[ab]	0.37[a]	0.36[ab]	0.37[a]	0.34[b]	0.01

[a,b] Means in row with different letters are significantly different ($P< 0.05$)

SEM = standard error of means

[1]Roche colour fan units. Lower number indicates a paler colour.

TABLE 3

Effects of Dietary CSM on the Storage Quality of Eggs[1]

Dietary	*Fresh eggs*			*1-week storage*			*2-week storage*			*3-week storage*		
treatment	*Egg wt*	*HUV*	*YI(%)*	*Egg wt*	*HUV*	*YI(%)*	*Egg wt*	*HUV*	*YI(%)*	*Egg wt*	*HUV*	*YI(%)*
0 % CSM	65.5a	80.6	45.4	60.1a	65.0ab	35.2b	56.8	53.1b	25.0b	56.8ab	44.07b	20.8ab
2.5 % CSM	63.1ab	84.0	46.2	57.4	63.7ab	34.7b	58.8	56.9ab	28.6ab	57.4ab	53.0ab	22.5ab
5.0 % CSM	62.4ab	82.8	46.1	60.6	63.0ab	34.20b	61.1	53.4	26.2ab	60.4a	48.0b	19.5b
7.5 % CSM	61.9ab	83.4	46.4	58.1ab	68.6ab	37.5ab	58.7	60.9ab	27.8ab	56.1ab	60.5a	19.6b
10.0 % CSM	60.7b	88.0	45.9	59.4ab	71.1a	39.3a	54.1	67.8a	29.2a	52.1b	64.0a	24.8a
12.5 % CSM	62.1ab	80.2	45.7	61.0a	64.8ab	34.8b	61.2	55.0b	26.2ab	58.8a	49.4b	21.4ab
SEM	0.66	1.46	0.33	0.56	1.31	0.73	1.29	1.86	0.64	1.02	2.04	0.77

[1]Column values with same letters are not significantly different ($P<0.05$)

HUV = Haugh unit value = 100 log ($H + 7.57 - 1.7W^{0.37}$)

W is weight of egg in grams and H is height of albumen in millimetres

Yolk index (YI) = $\frac{\text{Yolk height}}{\text{Yolk width}}$

shell thickness) is very important, if a high incidence of cracked eggs is to be avoided. The poultry industry loses a lot of revenue from cracked eggs. This could be attributed partly to inadequate shell thickness.

Irrespective of dietary treatments, egg weight, Haugh unit values, and yolk index scores deteriorated with storage at room temperature (Table 2). Also, no yolk or albumen discolouration were observed in stored eggs, even after 3 weeks (21 days) of storage. Similar findings have been reported by Nzekwe & Olomu (1984) and Stephenson & Smith (1952) who fed screw-pressed CSM to laying chickens. Screw-pressed CSM is known to be low in free gossypol (Jones, 1981). Thus, like the earlier reports of Waldroup & Goodner (1973) and Reid (1972), the results confirm that the use of certain types of CSM in diets of laying chickens may not have any detrimental effects on egg production and egg quality.

Conclusion

This study indicates that, on the basis of market quality of eggs produced, the low-gossypol CSM used was satisfactory for incorporating into layer diets as a protein source.

REFERENCES

Ademosum, A. A. (1976) *Livestock production in Nigeria: Our commissions and omissions.* Inaugural Lec. Ser. 17, University of Ife, Nigeria.

Alhassan, W. S. & Barnes, N. (1993) Meat consumption patterns in Ghana – A tentative survey report. *Proceedings of Sixth Annual Conference, Ghana Society of Animal Production, Univ. of Cape Coast, August, 1993,* pp. 23-29.

Card, L. E. & Nesheim, M. C. (1972) *Poultry production*, 11th ed. Philadelphia: Lea and Febiger.

FAO (1986) *African agriculture, the next 25 years.* Food and Agriculture Organisation of the United Nations, Rome, Italy.

Inkumsah, J. C. E. (1971) *The percentage of feed in relation to total cost of production of poultry* (BSc Thesis). University of Science and Technology, Kumasi, Ghana.

Jones, L. A. (1981) Nutritional values for cottonseed meal. *Feedstuffs* **53**(52), 19-21.

Nzekwe, N. M. & Olomu, J. M. (1984) Cottonseed meal as a substitute for groundnut meal in the laying chickens and growing turkeys. *J. Anim. Prod. Res.* **4**, 57-71.

Reid, R. L. (1972) Ammoniated cottonseed meal in poultry diets. *Feedingstuffs* **44**, 42.

Steel, R. G. D. & Torrie, J. H. (1980) *Principles and procedures of statistics: A biometrical approach.* New York, McGraw-Hill.

Stephenson, E. L. & Smith, R. M. (1952) The storage quality of eggs produced by hens fed screw-pressed cottonseed meal. *Poultry Sci.* **31**, 98-100.

Waldroup, P. W. & Goodner, T. O. (1973) Tolerance levels of free gossypol in layer diets as influenced by iron: gossypol ratios. *Poultry Sci.* **52**, 20-28.