ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 5 (4): 360-364, 2006
ISSN 1682-8356

Cottonseed Meal as Substitute for Soyabean Meal in Broiler Ration

G.S. Ojewola, S.N. Ukachukwu and E.I. Okulonye
Department of Non-Ruminant Animal Production, Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria

Abstract: In a 6 week feeding trial, cottonseed meal was substituted for soyabean meal at 0,25, 50, 75 and 100% and the diets were respectively designated as diets 1, 2, 3, 4 and 5 in a completely randomized design. Biologic and economic performance were investigated. Birds were fed and watered ad-libitum. The results showed that there were no significant differences (P>0.05) in the bird's mean daily weight gain and feed-to-gain ratio while the mean daily feed intake was significantly (P<0.05) influenced. Birds fed diets 3 and 4 respectively consumed 150.93g and 153.68g. This was closely followed by diets 5 and 2. Numerically, birds fed diet 3 gave the highest weight gain (2666.6g) while diet 1 was the least (2443.27g). The nutrient utilization analysis showed significant differences (P<0.05). Diet 5 had the highest percent mean values for nitrogen (81.45), crude fibre (60.81), ether extract (95.57), ash (66.79) and dry matter (85.72) retentions while birds fed diet 1 was least for same parameters. Mineral utilization followed the same trend; diet 5 was the highest (69.08), (84.72), (71.91), (79.39) for phosphorous, potassium, calcium and magnesium respectively while diet 1 gave least values for same parameters. Diet 5 was found to be the cheapest (N290.01) and savings were significantly (P<0.05) improved with the use of this diet while diets 1 and 3 had the least values of N285.94 and N302.67 respectively for marginal revenue. Though, the diets were comparable, diet 5 showed superior indices for nutrient utilization and economics of production. In conclusion, there is an indication that iron treated cotton seed meal can serve as a substitute for soyabean meal in broiler diet.

Key words: Cottonseed meal, substitute, soyabean meal, broiler ration

Introduction

The ever increasing cost of conventional protein feedstuffs for livestock has immensely contributed to the downward production and intake of animal protein. It has, therefore, become imperative for livestock producers to source for cheap alternative feedstuffs without compromising the quality of the feed, productive performance of the birds and the economics of production.

Several oil seeds have been investigated for this purpose (Njike, 1977; Nzekwe and Olomu, 1982; Bamgbose, 1995). Cottonseed meal has shown promises as a plant protein substitute to the conventional ones, especially, soyabean meal and groundnut cake. According to Njike (1977), cottonseed meal is the residue obtained after the extraction of oil from cottonseed and the product is ground resulting in flakes. It is produced in commercial quantities in Nigeria and its relatively cheap. Bamgbose (1995) observed that cottonseed cake contains 36.15% protein, 19.96% fibre, 14.42% fat, while biological value was 51.0% compared to 61.0 and 73.0% for defatted and full-fat extruded soyabean meals. The protein of cottonseed meal was found to be low in cystine, methionine and lysine (Nzekwe and Olomu, 1982). It is also a good, though, variable source of thiamine but a poor source of carotene (Obioha, 1992).

Cottonseed meal has successfully been used to replace at least between 50-75% of the desirable level of groundnut meal in broiler rations (Nzekwe and Olomu, 1982) and as much as between 30 and 40% protein of groundnut cake in chick feeds (Njike, 1975). Hermes *et al*. (1983) reported that with increasing increments of cottonseed meal in the diet of starting chicks, body weight gains were depressed and feed-to-gain ratios were increased. This has been associated with the presence of gossypol, a polyphenolic pigment usually found in most varieties of cottonseed meal. According to Jones (1981), cotton seed contains 0.03% to 0.2% gossypol. The issue of gossypol has constituted the greatest problem to the use of cottonseed meal in animal production. This is because the gossypol, a toxic phenolic compound has an inhibiting action on the enzymes pepsin and trypsin in the alimentary tract and this interferes with protein digestion (Tyani *et al*., 1986). Several attempts had been made to tackle this problem. Iron salts had been added to cottonseed meal based diets to bind the gossypol (Scott *et al*., 1982), while breeding of plant types with lower levels of gossypol content and physical extraction of gossypol had also been investigated (Tacon, 1997; Rhee, 1993). Some other workers have suggested other processing techniques such as toasting and cooking.

In the present communication, the potentials of factory treated cottonseed meal as a substitute for soyabean meal is reported using 5 graded levels inclusion to

evaluate the productive, nutrient utilization and economic parameters of broiler chickens. Such information could stimulate awareness and possible adoption of such cheaper plant protein source for performance and economic enhancement in broiler production.

Materials and Methods

Diet preparation, management of broiler chickens and data collection: Screw pressed cottonseed meal factory treated (with Iron (11) tetraoxo-sulphate (iv)) for the purpose of chelating the cotton seed gossypol was purchased from a local factory in Owerri, Imo State, Nigeria. Five diets were obtained by replacing soyabean meal (SBM) with cottonseed meal (CSM) at 0, 25, 50, 75 and 100% levels and were respectively designated as diets 1, 2, 3, 4 and 5 (Table. 2). Table 1 shows the proximate composition of the factory treated cotton seed meal used for this trial.

One hundred and thirty five- 3 weeks old broiler chickens were weighed and randomly allotted to five dietary treatments replicated three times with nine (9) birds per replicate in a completely randomized design (CRD). The feeding trial lasted 6 weeks. Feed and water were provided *ad libitum*. Health management was religiously carried out according to established and acceptable veterinary procedure.

Growth performance data of the chicks were obtained for the period between 21 and 63 days. Feed-to-gain ratio was evaluated by dividing feed intake by the weight gain. The nutrient retention trial was carried out at the 8th week of the trial. Three experimental birds per treatment (i.e one per replicate) were randomly selected and transferred into metabolism cages for four days acclimatization period, followed by three days of total collection of droppings. The droppings were sundried, bulked and representative samples taken for chemical analysis according to A.O.A.C. (1990). The costs of the different diets (N/kg) were noted. Feed intake per bird for the period was used to multiply the cost/kilogrammes of feed to obtain the cost of feed consumed by a bird for the period. The cost/kilogrammes weight gain was calculated according to the procedure of Sonaiya *et al.* (1986) and Ukachukwu and Anugwa (1995) which involves taking the product of cost/kilogrammes feed and feed-to-gain ratio of birds consuming such diets.

Chemical analysis: The proximate composition of the diets were determined according to the procedure of the Association of Official Analytical Chemists (A.O.A.C. 1990).

Statistical analysis: Data were subjected to analysis of variance of a completely randomized design. When analysis of variance indicated a significant treatment effect, Duncan's multiple range test was used to differentiate the means using procedures described by Duncan (1995).

Table 1: Proximate composition of the test ingredient (Percent DM)

Measurement	% Composition
Crude protein	39.86
Ether extract	6.57
Crude Fibre	17.38
Ash	6.79
Nitrogen Free Extract	29.40
Dry matter	89.38
Moisture	10.62

Results and Discussion

Oyenuga (1968) had stated that the nutrient composition of the cotton seed cake varies according to climate, soil and moisture. Other factors that could be responsible for the results obtained in this trial (Table 1) could be due to processing techniques, length of storage, variety, among others (Foley *et al.*, 1972; Bamgbose, 1995).

Birds fed diet 4 recorded the highest ($P<0.05$) mean daily feed intake, which is comparable with diets 3 and 5. The substitution of soybean meal with cotton seed cake might have lowered the actual energy content of the diets (Nzekwe and Olomu, 1984) which could have predisposed the birds to increasing their feed intake in order to satisfy their energy requirements (Hill and Dansky, 1954; Ojewola, 1993). There could also be a compensatory increase in feed intake in response to some deficient essential nutrients, which is not necessarily a craving for protein per se (Lipstein and Bronstein, 1975). The mean weight gain showed no significant difference ($P>0.05$) among the birds fed the treatment diets. Though, birds fed diets 3, 4 and 5 had their weights numerically improved with diet 3 showing superiority over others. This result showed consonance with earlier reports by NAPRI (1984) that feeding cottonseed cake up to 50% had no significant effect on performance of broiler chickens. However, this is at variance with the findings of Atuahene *et al.* (1986), Susbilla *et al.* (1994), Jones and Smith, (1977) and Hermes *et al.* (1983). This may not be unconnected with the chelation of the cotton seed gossypol by the iron (11) tetraoxosulphate (iv) used in the processing of the test ingredient. The low weight gain of the birds fed diet 1 could among others be due to unavailability of quality essential amino acids and impairment during processing of the intrinsic quality of the soyabean meal. Duration of storage and storage condition and the presence of anti-nutritional factors are also liable. The feed-to-gain did not differ significantly ($P>0.05$) among the dietary treatment. This shows that similar quantities of each of the diets are required to gain one unit of body weight by the birds.

The nutrient utilization of the different levels of dietary cottonseed meal to broiler chickens is presented in Table 4. There were significant differences ($P<0.05$) among treatment groups. Birds fed diet 1 had lower nitrogen retention than birds fed diets 2, 3, 4 and 5 but

Table 2: Percent composition of experimental diets

	Diets				
Ingredient	1	2	3	4	5
Yellow maize	58.30	58.30	58.30	58.30	58.30
Soyabean meal	29.00	27.75	14.50	7.25	0.00
Cottonseed meal	0.00	7.25	14.50	21.75	29.00
Fish meal(Danish)	7.00	7.00	7.00	7.00	7.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Oyster shell	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	20.25	0.25
Vit. Min. Promix*	0.25	0.25	0.25	20.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Llysine	0.10	0.10	0.10	0.10	0.10
Total	100.0	100.0	100.0	100.0	100.0
Calculated Composition					
Crude protein(%)	22.21	21.96	21.77	21.55	21.34
Metabolizable Energy (kcal/kg)	296.40	2925.23	2885.07	2844.90	2804.74
Determined Composition					
Crude protein (%)	20.34	20.62	19.74	21.04	19.96
Ether extract (%)	5.31	5.58	5.84	4.87	6.14
Crude fibre(%)	5.09	5.07	5.91	4.93	5.82
Ash (%)	7.81	7.94	8.01	7.96	8.11
Nitrogen Free Extract (%)	61.45	60.79	60.50	61.20	59.97
Dry matter %	90.12	90.25	90.42	90.31	90.14
Moisture (%)	9.88	9.75	9.58	9.69	9.86•

Each kg of Vitamin Mineral Premix Provided: Vit. A, 1500 IU, Vit. D_3, 1600IU, Riboflavin, 9.9mg, biotin, 0.25mg, Pantothenic acid, 11.0mg; Vit. B_{12}, 8.0mg; Nicotinic acid, 8.0mg; Iron, 5.0mg. Manganese, 10.0mg; zinc, 4.5mg, Cobalt, 0.02mg; selenium, 0.01mg.

statistically similar to birds fed diet 3. The nitrogen retention is an indication of the proportion of fed nitrogen that is retained for productive purposes. This is positively noticed in the rate of growth of the birds fed diets 2-5, showing that the levels of inclusion of cotton seed meal did not negatively influence utilization even at 100% replacement of soyabean meal. This is at variance with the findings of Tyani *et al.* (1986) probably because of the inactivation of the gossypol or chelation due to the treatment meted to the test ingredient using iron.

The percent crude fibre digestibility generally assumed an increasing order. Diets 2-5 had a significantly ($P<0.05$) higher crude fibre digestibility than that of diet 1. The nature and content of fibre in this cottonseed cake, associative dynamic dietary nutrient effect and the age of the birds could have contributed to an increasing fibre digestibility of the diets as the percent substitution of soyabean meal with cotton seed meal increased to 100%. In other words the dietary fibre imposed no limitation on the bird's performance nor the availability of other essential nutrients for the birds.

Ash retention values followed an increasing order (944.88%, 53.45%, 62.17% and 66.79%) respectively. An indication that as the level of cottonseed meal in the diets increased, more minerals were made available to the birds. The ether extract and dry matter retentions followed similar trend. This is a confirmation of the fact that, the nature and content of fibre in the test ingredient and the diet is a major determinant in the utilization of its nutrients.

The mineral utilization (Table 5) significantly ($P<0.05$) improved as the level of cottonseed meal substitution increased from 0 to 100%. The practical significance of this can be seen in the comparable rate of growth observed with the broiler chickens used for this trial.

Table 6 shows the cost analysis of the diets containing different levels of dietary cottonseed meal fed to broiler chickens. The cost per kilogramme feed (N) during the experimental period significantly ($P<0.05$) depressed as the percent substitutional levels of cottonseed meal increased from 0 to 100% level in the diets. Diet 1 was highest in cost per kilogramme (N62.00). This was followed by diets 2 (N57.80), 3 (N53.61), 4 (N50.21) and 5 (N49.00). The high cost of diet 1, whose plant protein source is soyabean meal could be traced to the high cost of soyabean compared with cottonseed meal, which is relatively cheaper in the market. The cost of total feed consumed by the birds was influenced by the cost per kilogramme of feed ($P<0.05$). Diet 1 was observed to be the costliest (N364.02). The cost for other diets were N347.93, N334.51, N331.93 and N290.01 for diets 3, 2, 4 and 5 respectively. The least cost observed in diet 5 could be due to the fact that the expensive soyabean meal was completely excluded. Also, the revenue realized from the sale of these birds was observed to be highest for those fed diet 5 (N359.97). Diets 4 (N318.07), 2 (N 315.49) 3 N302.07) and 1 (N285.98) in that order. The low cost of production and feed cost per kilogramme might have contributed greatly to diet 5 attracting the highest revenue.

Table 3: Performance characteristics of the broiler chickens fed graded levels of cottonseed meal

Performance	Diets					
	1	2	3	4	5	SEM
Mean initial body weight (g)	303.33	295.66	300.60	302.30	298.00	3.466
Mean final body eight(g)	2746.6	2796.60	2966.60	2933.30	2816.00	76.77
Mean daily feed intake(g)	136.50^{b}	134.54^{b}	150.93^{a}	153.93^{a}	142.42^{ab}	0.00
Mean body weight gain(g)	2443.27	2500.94	2666.00	2631.00	2518.60	74.65
Mean daily weight gain(g)	56.82	58.16	62.00	61.18	58.57	0.00
Feed-to-gain ratio	2.4	2.31	2.43	2.51	2.43	0.092

ab - Means within the same row with different superscripts are significantly different (P<0.05).

Table 4: Nutrient utilization of the diets containing different levels of cotton seed meal by broiler chickens (3-8 wks)

Paramenter (%)	Diets					
	1	2	3	4	5	SEM
Nitrogen retained	69.99^{b}	77.61^{a}	77.02^{ab}	80.71^{a}	81.45^{a}	2/22
Crude fibre digestibility	30.20^{d}	46.97^{c}	53.35^{b}	50.50^{b}	60.81^{a}	6.24
Fat digestibility	91.47^{b}	93.35^{ab}	94.51^{a}	94.47^{b}	95.57^{a}	0.70
Ash digestibility	44.88^{bc}	53.45^{ab}	59.56^{ab}	62.17^{ab}	66.79^{a}	3.97
Dry matter digestibility	81.98^{ab}	81.98^{ab}	82.75^{a}	84.47^{a}	85.72^{a}	1.75

abcd - means within a row with different superscripts are significantly different (P<0.05).

Table 5: Mineral (MACRO) utilization By broiler chickens fed varying levels of conttonseed meal (3.-8 wks)

Paramenter (%)	Diets					
	1	2	3	4	5	SEM
Phosphorous	49.09^{b}	57.40^{ab}	60.45^{ab}	66.27^{a}	69.08^{a}	5.01
Potassium	72.41^{a}	79.08^{ab}	81.24^{ab}	80.41^{ab}	84.72^{a}	4.37
Calcium	55.00^{b}	64.82^{ab}	66.32^{a}	67.60^{a}	71.91^{a}	4.59
Magnesium	62.61^{b}	71.13^{ab}	71.61^{ab}	73.07^{a}	79.36^{a}	4.20

ab - means within a row with different superscripts are significantly different (P<0.05).

Table 6: Cost analysis of diets containing different levels of dietary cottonseed meal fed to broiler chickens (3-8wks).

Measurement	Diets					
	1	2	3	4	5	SEM
Cost/kg feed (N)	62.02	57.82	53.61	50.21	49.00	0.00
Total feed consumed(g)	5869.49	5785.50	6490.00	6611.33	5919.26	147.2
Cost of feed consumed per bird (N)	364.02^{b}	334.51^{ab}	347.93^{ab}	331.93^{a}	290.00^{c}	8.58
Total body weight gain(g)	2443.27	2055.90	2666.00	2631.00	2518.60	74.65
Price/kg meat (N)	650	650.00	650.00	650.00	650.00	0
Marginal Revenue(N)	285.94^{b}	315.49^{ab}	302.07^{ab}	318.07^{c}	359.97	8.04

abc - means within the same row with different superscripts are significantly different.

In conclusion, it can be seen that treated cottonseed meal, was not in any way inferior to the costly soyabean meal. And since the basic requirement for the formulation of practical diets is knowledge in monetary terms of the output obtained by feeding nutrients of different protein and energy source, production and utilization of cottonseed meal in feed formulation for broiler chicken should be encouraged. This would in no small measure, reduce the price of poultry meat products and the competition between man and animals for soyabean as plant protein source, thereby, reducing the market price of soyabean.

References

A.O.A.C., 1990. Association of Official Analytical chemists. Official Methods of Analysis. 13th Edn. Washington. D.C.

Atuahene, C.C., A. Donkoh and P. Nkansah-Dako, 1986. Effect of raw cottonseed meal on the performance characteristics and certain blood parameters of broiler chickens. J. Anim. Prod. Res., 6: 107-114.

Bamgbose, A.M., 1995. Full-fat extruded soyabean meal in diet for laying hens performance and egg quality characteristics. Trop. Oil Seeds J. Vol., 3: 129-138.

Duncan, D.B., 1955. Multiple Range Biometrics. 11: 1-42.

Foley, R.C., D.L. Bath, F.N. Dickinson and H.A. Tucker, 1972. Dairy cattle: Principles, Problems and Profit. Leg and Febiger, Philade/Phia. U.S.A.

Hermes; I.H., N.E. Asker, M.T. Shulkamy and M. El-Sheikh, 1983. The effect of using different level of decorticated cottonseed meal on the performance of chicken. Ann. Agric. Sci. Ain Shams University Egypt, 28: 1415-1428 (Abstr.).

Hill, F.W. and L.M. Dansky, 1954. Studies on the Energy requirements of chickens. The effect of Dietary Energy level on Growth and feed consumption. Poult. Sci., 33: 112.

Jones, L.A., 1981. Special cottonseed products report. Foodstuffs, 53: 19-21.

Jones, L.A. and F.H. Smith, 1977. Effect of bound gossypol and amino acid supplementation of glandless cottonseed on the growth of weaning rats. J. Anim. Sci., 44: 401-409.

Lipstein, B. and S. Bronstein, 1975. The replacement of soybeen meal by the limiting amino acid in practical broiler diet 2 special additions of methionine and lysine as partial substitute for protein in finder diet. Brit. Poult. Sci.,16: 189-00.

NAPRI (National Animal Production Research Institute) (1984). Highlights of research achievements on animal feeds. Federal Min. Edu. Sci. Tec. Lagos, 12-14.

Njike, M.C., 1977. The effect of Cottonseed meal (CSM) Goundnut meal (Gnm) mixture and protein levels in practical broiler diets. Nig. J. Anim. Prod., 4: 81-84.

Njike, M.C., 1975. Cottonseed meal as substitute for GNC in the diet of baby chicks. In: Breeds and Nutrition of Poultry in Nigeria Published by the Nigerian Branch of World Poultry Sci. Association, PP: 59-69.

Nzekwe, N.M. and J.M. Olomu, 1982. The evaluation of cottonseed as a replacement for groundnut meal in broiler rations. J. Anim. Prod. Res., 2: 123-138.

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

Obioha, F.C., 1992. A guide to Poultry Production in the Tropics Acena Publishers Enugu; P: 3-7; 45-98.

Ojewola, G.S., 1993. Productive performance and body composition of broilers as influenced by dietary energy and protein in the humid tropics. Ph.D. Thesis. Faculty of Agriculture and Forestry, University of Ibadan. Nigeria.

Oyenuga, V.A., 1968. Nigerians feed and feeding stuff. Their chemistry and Nutritive values. Ibadan. University Press, 3rd Edn.

Rhee, K.C., 1993. Detoxification and de-allergenation of oil seed meals. Proceeding of the World Conference on oil seed Technology and Utilization campaign. Illinois U.S.A. American oil chemists Society. PP: 346-351.

Scott, M.L., M.C. Nesheim and R.J. Young, 1982. Nutrition of the chickens. M.L. Scoth Associates. Ithaca. New York.

Susbilla, J.P., T.L. Frand, G. Parkinson and C.B. Grow, 1994. WEIGHT OF internal organs and carcass yield of early feed restricted broilers. Br. J. Sci., 35: 677-685.

Sonaiya, E.B., A.R. Williams, S.A. Oni, 1986. A biological and economic appraisal of broiler production up to 16 weeks. J. Anim. Sci. Res., 6:115-125.

Tacon, A.G.J., 1997. Fishmeal replacers: Review of anti-nutrients within oilseeds and pulses – A limiting factor for the aqua feed green resvolution. Cahiers Options, Mediteriancennes, 22: 153-182.

Tyani, J.R., F.A. Kratzer, G.R. Grats and P. Vohrra, 1986. Gbudless cottonseed cake for laying and breeding hens and broiler chicks. Poult. Sci., 65: 549-955.

Ukachukwu, S.N. and F.O.I. Anugwa, 1995. Bio economics of feeding raw or heat-treated soyabeans to broiler chicken. Nig. J. Anim. Prod., 22: 137-140.