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Original Research Article

The effect of different levels of dietary cottonseed oil on broiler chickens production

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The study was conducted to evaluate the effect of dietary cottonseed oil at different levels on broiler chickens,. Dietary Cottonseed oil (CSO) was tested for energy supplementation values in poultry at levels 0, 3, 6 and 9% utilizing isonitrgenous (22.5% CP), semi-isocaloric (3100Kcal/kg) rations and run in experiment. Ninety six (96) seven days-old unsexed Ross-308 broiler chicks with initial weight of 75g were used for each experiment in a completely randomized design (4×4×6). Chicks were fed for 50 days. Different levels of CSO were incorporated into the broiler diet for performance (with energy retention values determined by the comparative slaughter technique), on blood haemogram, serum metabolites, enzyme activities and electrolytes, slaughter and carcass data and economic appraisal. Supplementation with the oils improved performance ($p>0.05$) but CSO gave significant ($p<0.05$) values in final, weight gain and feed conversion ratio. Results of energy retention showed similar values in initial energy, but final and gained energy revealed significant ($p<0.05$) differences among treatment groups. Hematological values, serum metabolites, serum enzyme activities and serum electrolytes were not seen significantly ($p>0.05$) different. The effect of adding CSO on absolute slaughter weights showed no significant ($p<0.05$) differences except in heart and liver which were highest in the diet with CSO level of 6% (22.80±03.50 and 53.80±04.80, respectively) and with percent slaughter values, no significant ($p>0.05$) differences were recorded except for liver of group C (02.12±00.25) which was the highest, but CSO affected significantly ($p<0.05$) the drum and drum muscle absolute weight values, being highest in group C (260.00±21.60 and 192.50±25.00 respectively). The CSO treatment effect on all meat subjective values was not significant ($p>0.05$). Economically appraised values were profitability ratio (01.39) of group C (6% cottonseed oil) was the highest of the test groups.

Key words: cottonseed, dietary fat, broiler, economic profile, metabolizable energy

INTRODUCTION

There is growing interest within the feed industry to use full-fat oilseeds in poultry diets. The major oilseeds grown in Sudan are cotton seed, groundnut and sunflower. Cottonseed oil has a 2:1 ratio of polyunsaturated to saturated fatty acids. Its fatty acid profile generally consists of 70% unsaturated fatty acids including 18% monounsaturated (Oleic) and 52% polyunsaturated (Linoleic) and 26% saturated (primarily palmitic and stearic). Cottonseed oil is rich in tocopherols, therefore, a valuable source of energy and protein for poultry diets.

Digestibility of dietary fats is affected by the fatty acid profile. Oils of plant origin, such as soybean oil (SO), contain high levels of unsaturated fatty acids and are more completely digested by fowl than animal fats such as lard and tallow (T), which contain higher proportions of saturated fatty acids. Ketels and DeGroote, (1989) digestibility and AME_n of fats from different sources was improved with the increase of unsaturation of the dietary fat up to a maximal value achieved when the ratio of unsaturated to saturated fatty acid was 2. Smink et al. (2008) concluded that randomized palm oil may be used as vegetable oil in broiler nutrition with positive effect on saturated fatty acid digestibility when compared with native palm oil and positive effect on firmness of meat when compared with vegetable oils rich in unsaturated fatty acids. Bartov and Bar-Zur, (1995) broilers from 8 to 21 days consuming diets with HOC developed showed no differences in feed intake or weight gain, but feed efficiency was better when compared with a conventional corn. Han et al. (1987) reported that weight gain, gain-to-feed ratio, and skin and plasma pigmentation were improved in chicks fed HOC compared to those fed conventional yellow dent corn. Song et al.(2003) reported that availability of amino acid in Chinese oil corn is equal or superior to that in conventional corn and that the available energy for poultry is higher in Chinese oil corn than in conventional corn. Daghir et al. (2003) indicated that the extra calories derived from high-oil corn could have been funneled primarily toward abdominal fat pad deposition rather than increased growth. Cherian (2007) values reported as percentages (weight of total fatty acids) and subject to change due to differences in batch, cultivars, or processing methods used. Adams et al. (1994) such diets can result in improved body weight gain and feed utilization as compared to diets containing yellow dent corn with similar energy utilization.

The objective of the present experiment was to study the effect of oils cottonseed (CSO) was tested for energy supplementation values in poultry to dietary with different levels of the approximate requirement in a common feeding regimen for broilers reared to compare responses to those receiving the level at the same Crude Protein (CP) and Metabolizable Energy (ME).

MATERIALS AND METHODS

Birds and Housing

Ninety six commercial broilers Ross-308 were obtained at hatch (trial d) from a commercial Coral hatchery and transported to Student Poultry Premises, Faculty of Agricultural Studies, Sudan University of Sciences and Technology, Shambat, in December 2009. Broilers were evaluated upon receipt for signs of disease or other complications that may have affected the outcome of the study. Following examination, broilers were weighed, identified with a wing band, and placed randomly in 0.914 m × 1.219 m (3 ft × 4 ft) floor pens at a density of approximately 0.305 m2 (1.0 ft2) of available floor space per broiler; new pine shavings with a minimal amount of saw dust was provided as litter. Pens were separated by a wire partition and did not touch other pens from any side to minimize potential for cross-contamination. A continuous 24-h lighting program was followed. Birds were observed 3 times daily for overall health, behavior and evidence of toxicity, and environmental conditions. No type of medication was administered during the entire feeding period. Mortalities were recorded, drinking water was provided for *ad libitum* consumption.

Experimental design

The experimental design for this study was a completely randomized design with 4 dietary treatments (control, and 3 commercial references). There were 6 broilers per pen and 4 pens (replicates) 4 per treatment for a total of 96 broilers per treatment. Broilers were fed with their respective dietary treatments from time of (trial seven day) to 50 d of age.

Diets

Diet was fed in one phase (d 1 to 50) to minimize the possibility of cross-contamination between diet was offered as a mash feed for *ad libitum* consumption, and formulated to meet the nutrient requirements of a typical commercial broiler diet using the NRC Nutrient Requirements for Poultry (1999) as a guideline of Central animal nutrition research laboratory animal production research centre, Kuku, Khartoum North Sudan. Diets were prepared at the mill of animal department. Control, test, or reference CSO was added to the indicated diets in equal amounts; requirements for protein, lysine, methionine, cystine, calcium, and phosphorus were met recommendation ingredients. Also diet was formulated to the same ME level 3,100 kcal of ME/kg. Tables 1, 2 and 3 show the composition of diets. All feeds were subjected to analysis for crude protein (N x6.25) and found to be in agreement with calculated values. Diets were fed in mash form. The diets were divided into four groups A un supplemented with cotton oil (0%) reference diet; B supplemented with (3%) cotton oil; C supplemented with (6%) cotton oil and D supplemented with (9%) cotton oil.

Fatty acids composition was determined by Gas Liquid Chromatography (GLC) using a Pye–Unicam – GCD model according to A.O.C.S. (2000).

Data collected on performance

Data on average body weight, weight gain and feed consumption (g) for each group were determined weekly throughout the experimental period. Health of the

Table 1. Percent inclusion rates (as fed basis) and calculated analyses (dry-matter basis) of experimental diets fed to broiler chicks for 50 days.

Ingredients	Ration %
Fetarita	50.00
Groundnut cake	14.00
Sesame cake	14.00
Wheat bran	12.00
Cottonseed oil	03.00
Salt	00.50
*Concentrate	05.00
Limestone	01.50
Total	100.00
Calculated analysis	
Dry matter	95.91
Crude protein	22.50
Ether extract	03.50
Crude fiber	11.80
N-free extract	53.91
Ash	04.20
M E, Kcal/Kg	3100

*crudeprotein:40.00;crudefat:4.00;crudefiber:2.00;Calcium:4.00;Phosphorus(avail):4.00;Lysine:12.00;Methionine:3.00;Meth+Cyst.:3.20;Met.Energy:2100Kcal/Kg;Sodium:2.60, product: vit. A: 200.000 I.U/Kg; vit. D3: 40.000 I.U/Kg; vit.E : 500mg/Kg; vit. B1 : 15mg/Kg;vit.B2:100mg/kg;vit.B6 :20vit.B12:300mcg/Kg; Biotin :1.000mcg/Kg ;Nicotinic acid :600mg/Kg ;Folic acid :10mg/Kg ;vit.K3 :30 mg/Kg ;pantothenic acid: 150 mg/Kg ; choline chloride: 5.000 mg/Kg ; copper: 100 mg/Kg ; iodine: 15 mg/Kg ;Cobalt :3 mg/Kg ; selenium:2 mg/Kg ; manganese: 1.200mg; zinc: 800 mg/Kg ; iron: 1.000 mg/Kg ; B.H.T. :900 mg/Kg ;Salinomycin-Na :1.200.

Table 2. Analysis of experimental oils

Oil	Palmatic %	Oleic %	Linoleic %	Peroxide value (mille equivalents /kg)	Free fatty acids %	Viscosity (centipoises)
Cottonseed	30.00	13.50	56.50	08.00	00.30	50.20
Olein	42.13	44.64	13.23	06.00	00.30	60.40
Frying olein	43.80	41.20	15.00	08.00	01.13	48.00

Table 3. Fatty acid composition of the oil sources used in poultry rations[1]

		Polyunsaturated fatty acids		
Fat source	Saturated fatty acids	n-6	n-3	Monounsaturated fatty acids
Restaurant grease	21.4	23.3	2.6	52.4
Sunflower oil	12	71	1	16
Cottonseed oil	27	54	Trace	19
Palm oil	51	10	Trace	39

experimental stock and mortalities were closely observed.

Blood and serum profiles

Blood samples drawn from the heart, wing or jugular veins were analyzed for a complete hemogram, Hemoglobin (Hb) concentration, Packed Cell Volume (PCV), a Red Blood Cell (RBC) count RBC and White Blood Cell (WBC) count. Serum prepared from the same sample withdrawn was analyzed for concentrations of metabolites total protein, cholesterol, urea, glucose, enzyme activities Alkaline phosphatase (ALP), Glutamyl oxaloacetic transaminase (Aspartate amino

Table 4. Analysis of variance and average (mean ± st.dev) performance values of broiler chicks fed different levels of cotton seed oil for 50 days

Items	cottonseed oil levels			
	A (0%)	B (3%)	C (6%)	D (9%)
Initial weight	74.60±08.40	76.70±04.70	72.30±08.50	76.04±12.90
Final weight	2327.60a ±41.90	2370.90a±133.60	2475.90a±141.90	2052.50b ±229.70
Weight gain	2253.02a±40.00	2294.30a±134.30	2403.60a±145.60	1970.20b±227.50
Daily feed intake	90.93±06.98	100.64±10.40	93.10±05.27	90.20±09.86
Daily energy intake (kcal/g)	276.42±21.21	311.98±32.27	293.31±16.59	287.76±31.47
Feed conversion ratio	02.03b±00.20	02.20ab±00.14	02.00b±00.10	02.30a±00.20
Mortality %	04.20±08.35	08.33±16.65	04.20±08.35	00.00±00.00

†At (3, 12) d.f.
NS = not significantly different (p>o.05).
Means in a row bearing the same letter or no letter superscript do not differ significantly (p>0.05).

transferase, L. Aspartate; 2- oxoglutarate amino-transferase, E. C. 6.1.1.; G.O.T, A.S.T) AST and minerals Phosphorous and Calcium.

Slaughtering and processing

At the end of the feeding period, broilers were processed under simulated commercial conditions. Feed was withdrawn for 8 h, and then the birds were transported to the pilot processing plant for slaughter. The birds were slaughtered by cutting the jugular and carotid veins, bled for 3 min, scalded at approximately 62°C for 45 s, defeathered in a rotary drum picker, and manually eviscerated. Carcasses were prechilled for 15 min at 45°C, and then chilled for 45 min in ice water at approximately 0°C. Afterward, they were aged for 5 h at 4°C, hot carcass and each organs, heart, liver, gizzard, intestines with the abdominal fat were separately weighed were collected for preparation of meat. The left side was divided into three commercial cuts, thigh, drumstick and breast according to Mohammed (1996). Each cut was weighed separately. The breast, drumstick and thigh cuts of the right side were skinned and deboned. The meat and bone were weighed separately. The meat was frozen and stored for further analysis.

Statistical analysis

Statistical examination of the data was performed using the analysis of variance, to Snedecor and Cochran (1980) the means were compared using least significant difference (LSD) procedure as out lined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Response of broiler chicks to dietary cottonseed oil performance

The effect of feeding different levels of dietary cottonseed oil on performance of broiler chicks is shown in Table 4. Treatment effect is only significant (p<0.05) on weight gain and feed conversion ratio. Initially all groups started and finished at similar (p>0.05) body weights. Mean values of body final and weight gain were similar (p>0.05) except for group D, where the mean value (2052.50±229.70 and 1970.2±227.5 respectively) was lowest than in the other treatment groups.

Mean values of both daily feed and energy intake are highest (p>0.05) in group B that reflected on weight gain. Best feed conversion ratio was recorded by group C (2.00±0.10), and zero (p>0.05) mortality is that of group D. therefore the supplemented diet with CSO high dose record decrease in weight gain. This was agreeing by earlier reports of (Hill and Dansky 1954; Sklan, 1979; Corino et al., 1980; Leeson and Atteh, 1995) observed that the most practical method for increasing the energy density of diets is through the addition of fats and oils. Also Vila` and Esteve (1996) found that sunflower acid oil produced less abdominal fat deposition in broilers than tallow acid oil at different levels of fat inclusion, although the ME of tallow was lower than that of sunflower. Fats and oils such as lard, choice white grease, beef tallow, corn oil, and soybean oil contain about 2.25 times as much metabolizable energy as most of the cereal grains. Renner and Hill (1961) the main factor affecting the ME value of fat is its digestibility. The digestibility of fats is dependent on factors such as length of the carbon chain and degree of saturation of the fat acids. This result was similar to those reported by Stilborn et al., (2000) reviewed that the benefits of high-oil corn as follows: 1) reduced fat supplementation, 2) better feed mixing efficacy, and 3) ration formulation flexibility. They also stressed that the added value of high-oil corn is mainly determined by the price of supplemental fat source in relation to that of yellow dent corn. Similarly Vanschoubroek et al. (1971) reported that the addition of animal fat or vegetable oil at 4.5% to chick ration had no effect on mortality Energy balances of broiler chicks fed at different levels of cottonseed oil for 50 days are shown

Table 5. Analysis of variance and average (mean ± st.dev) energy (kcal) balance of broiler chicks fed different levels of cottonseed oil for 50 days.

Items	F† - value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Initial	30.32NS	465.06±07.70	465.06±07.70	465.06±07.70	465.06±07.70
Final	793.19*	1078.65d±01.91	1223.36a±04.28	1133.47b±04.75	1096.99c±04.25
Gain	793.19*	613.59d±01.91	758.30a±04.28	668.41b±04.75	631.93c±04.25

†At (3, 12) d.f. Means in a row bearing the same letter or no letter superscript do not differ significantly (p>0.05).
NS = not significantly different (p>o.05).
*Denotes f-value significant at p<0.05.

Table 6. Analysis of variance and average (mean ± st.dev) hematological values of broiler chicks fed different levels of cottonseed oil for 50 days

Items	F† - value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
PCV%	00.50NS	22.70±03.20	23.70±01.20	24.70±01.90	23.80±00.90
Hb%	00.60NS	08.90±01.70	09.30±01.10	10.20±01.40	09.40±00.60
RBC(×106)	00.20NS	02.30±00.40	02.10±00.20	02.10±00.60	02.00±00.40
WBC(×103)	00.60NS	07.58±01.37	07.24±00.64	06.79±00.55	07.70±01.00

†At (3 , 12) d.f. NS = not significantly different (p>o.05). Means in a row do not differ significantly (p>0.05).

in Table 5.

The performance parameters showed significant difference (p>o.05), throughout the experimental period. However, the increase in weight in grams per bird per day was higher (P < 0.05) in chickens fed the diet with the lowest CSO content (3%, Cottonseed oil) during the whole trial period than in chickens fed the diet that included (6%, 9% and control diet). Treatments effect in final and body energy gain were significant (p<0.05). Highest and lowest energy retentions were recorded by groups B and A respectively.

Hematological values the hematological values of broiler chicks fed different levels of cottonseed oil for 50 days are shown in Table 6. Treatment effect in all hematological values is not significant (p>0.05).

Mean hematological values are similar (p>0.05) in all groups with group C showing higher (p>0.05) values in PCV% and Hb %. Mean values of RBCs showed similar values in groups B and C (02.10±0.20, 02.10±00.60) with group D showing the lowest value (02.00±0.40). Mean value of WBCs is higher (p>0.05) in group D (07.70±01.00).

Serum metabolites

The serum metabolites values of broiler chicks fed different levels of cottonseed oil for 50 days are shown in Table 7. Treatment effect in all serum metabolites showed no significant (p>0.05) difference between groups.

Mean values of cholesterol in all groups are similar (p>0.05) but group B recorded the highest value (147.20±18.10). Mean values of glucose, total protein and Urea are similar (p>0.05) in all groups with group D having the highest values (239.20±152.30, 3.30±0.90 and 16.70±02.70 respectively), these results was agreed with Özdogan and Aksit (2003) investigated that the groups fed with the diets containing plant oil has highest values of cholesterol.

Serum electrolytes and enzyme activities

The serum electrolytes and enzymes values of broiler chicks fed different levels of cottonseed oil for 50 days are shown in Table 8. Treatment effect in serum electrolytes and enzymes is not significant (p>0.05). Mean values of ALP and AST activities are highest in group C (299.40±228.50 and 24.60±07.90 respectively). Mean values of calcium and inorganic phosphorus are highest (p>0.05) in group C (08.80±01.04 and 01.40±00.40 respectively).

Slaughter values

The slaughter values of broiler chicks fed with different levels of cottonseed oil for 50 days are shown in Table 9. The treatment effect in slaughter values is not significant except for the heart and liver (p<0.05).

Mean values of slaughter weight, empty body weight, hot carcass weight, heart and liver recorded highest (p<o.05) values in group C. Mean values of gizzard showed the highest value in group B (42.50±13.20), whilst intestine and abdominal fat means (89.20±09.82and 41.30±20.20 respectively) are the highest in group D. The percent slaughter values out of empty body weight of broiler chicks

Table 7. Analysis of variance and average (mean ± st.dev) serum metabolites values of broiler chicks fed different levels of cottonseed oil for 50 days

Items	F†- value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Cholesterol(mg/dl)	00.20NS	141.80±12.50	147.20±18.10	145.70±09.80	137.40±19.40
Glucose (mg/dl)	00.10NS	192.90±105.80	210.40±87.20	215±125.60	239.20±152.30
Total protein(g/dl)	00.10NS	03.20±00.80	03.20±00.90	03.00±00.60	03.30±00.90
Urea (mg/dl)	01.90NS	14.30±05.00	10.70±01.20	16.10±03.50	16.70±02.70

†At (3 , 12) d.f.
NS = not significantly different (p>o.05). Means in a row are similar (p>0.05).

Table 8. Analysis of variance and average (mean ± st.dev) serum enzymes and electrolytes values of broiler chicks fed different levels of cottonseed oil for 50 days

Items	F† - value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Calcium (mg/dl)	00.30NS	09.40±01.60	08.80±01.04	08.30±01.90	7.90±02.70
Phosphorus(mg/dl)	00.20NS	01.20±00.50	01.40±00.40	01.30±00.20	01.30±00.20
ALP (IU/l)	00.40NS	180.20±61.80	205.10±89.90	299.40±228.50	198.80±13.00
AST (IU/l)	01.00NS	18.30±02.30	22.40±04.50	24.60±07.90	19.30±03.40

†At (3 , 12) d.f. Means in a row do not differ significantly (p>0.05).
NS = not significantly different (p>o.05).

Table 9. Analysis of variance and average (mean ± st.dev) slaughter values (g) of broiler chicks fed different levels of cottonseed oil for 50 days.

Items	F†- value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Slaughter weight	02.58NS	2155.oo±214.10	2147.50±345.02	2568.80±231.60	2185.00±196.70
Empty body weight	02.58 NS	2141.28±214.94	2132.65±344.88	2553.73±231.27	2169.20±195.92
Hot carcass weight	02.40NS	1649.60±257.90	1688.10±289.oo	2031.00±180.30	1676.70±177.60
Heart	08.30*	16.60b±01.90	15.60b±01.50	22.80a±03.50	18.20b±01.02
Liver	18.50*	40.00b±04.10	35.00b±04.10	53.80a±04.80	40.00b±00.00
Gizzard	00.30NS	40.00±04.10	42.50±13.20	38.80±04.80	37.50±02.90
Intestine	01.96 NS	77.53±06.40	83.90±04.07	84.98±06.03	89.20±09.82
Abdominal fat	01.20NS	31.30±10.30	20±16.80	36.30±18.00	41.30±20.20

†At (3 ,12) d.f. Means in a row bearing the same letter or no letter superscript do not differ significantly (p>0.05).
NS = not significantly different (p>o.05).
* Denotes f-value significant at p<0.05.

fed different levels of cottonseed oil for 50 days are shown in Table 10. Treatment effect in percent slaughter values is only significant (p<0.05) for the liver.

Mean values were highest for hot carcass and heart (p>0.05) and liver (p<0.05) in group C. Gizzard mean percent value (02.01±00.58) was highest (p>0.05) in group B. Intestine and abdominal fat values (04.12±00.45 and 01.90±00.95 respectively) were highest (p>0.05) in group D compared to other groups. the decreased of polyunsaturated fatty acids in the diet resulted in a increase of performance this finding was agreeing with Pinchasov and Nir (1992) showed that in broiler chickens was increased of polyunsaturated fatty acids in the diet resulted in a decrease of myristic and oleic acids and an increase in the linoleic acid content of the adipose tissue. Also Saleh et al., (1997)when compared in isocaloric, nutritionally balanced diets, live performance of chicks fed high oil corn equaled that of chicks fed yellow dent corn with no adverse effects on dressing percentage, abdominal fat, or parts yield. Earlier reported Adams et al., (1994) founded that feeding diets based on high oil corn had no adverse effect on dressing percentage, abdominal fat content, or weight loss during cooking.

Carcass yield

The carcass cuts and tissue weight values of broiler chicks fed different levels of cottonseed oil for 50 days is shown in

Table 10. Analysis of variance and average (mean ± st.dev) percent slaughter values out of EBW of broiler chicks fed different levels of cottonseed oil for 50 days

Items	F† - value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Hot carcass	00.51NS	76.84±06.38	79.07±00.97	79.55±00.56	77.29±03.54
Heart	01.13NS	00.78±00.12	00.75±00.16	00.89±00.11	00.85±09.54
Liver	03.72*	01.88b±00.20	01.66c±00.16	02.12a±00.25	01.88bc±00.24
Gizzard	01.64NS	01.88±00.10	02.01±00.58	01.53±00.21	01.74±00.15
Intestine	01.76NS	03.67±00.63	04.01±00.66	03.35±00.32	04.12±00.45
Abdominal fat	01.29NS	01.49±00.54	00.91±00.54	01.42±00.66	01.90±00.95

†At (3, 12) d.f. Means in a row bearing the same letter or no letter superscript do not differ significantly (p>0.05).
NS = not significantly different (p>o.05).
* Denotes f-value significant at p<0.05.

Table 11. Analysis of variance and average (mean ± st.dev) carcass cuts and tissue values (g) of broiler chicks fed different levels of cottonseed oil for 50 days

Items	F† - value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Thigh	02.02NS	255.00±33.20	245.00±49.30	295.00±40.40	235.00±17.30
Thigh bone	01.60NS	42.50±05.00	42.50±09.60	47.50±05.00	37.50±05.00
Thigh muscle	01.70NS	212.50±33.00	202.50±40.30	247.50±42.70	197.50±15.00
Drum	07.20*	205.00b±17.30	207.50b±26.30	260.00a±21.60	205.00b±12.90
Drum bone	00.90NS	55.00±12.90	60.00±00.00	67.50±17.10	62.50±05.00
Drum muscle	06.00*	150.00b±08.20	145.00b±23.80	192.50a±25.00	142.50b±15.00
Breast	00.20NS	487.50±108.70	477.50±129.70	530.00±101.00	482.50±76.30
Breast bone	01.40NS	60.00±21.60	87.50±12.60	77.50±22.20	77.50±20.60
Breast muscle	00.30NS	427.50±92.50	390.00±135.90	452.50±83.40	405.00±83.50

†At (3, 12) d.f. Means in a row bearing the same letter or no letter superscript do not differ significantly (p>0.05).
NS = not significantly different (p>o.05).
* Denotes f-value significant at p<0.05.

Table 11. The results showed treatment effect significant (p<0.05) in drum cut and drum muscle. There is no significant (p>o.05) difference between groups in mean cuts weights or tissues, which recorded highest values in group C, except mean value of breast bone which was highest in group B (87.50±12.60).

Treatments effect is not significant (p>0.05) in all carcass cuts and tissue percentages. Mean values of thigh, thigh bone, thigh muscle, breast and breast muscle showed highest (p>0.05) values in group A. Mean values of drum and drum muscle recorded highest (p>0.05) values in group C (12.90±01.50 and 09.60±01.80 respectively). Mean values of breast and drum bone showed highest (p>0.05) values in groups B and D respectively. Özdogan and Aksit (2003) the effect of fat sources in the feed on the moisture, ash, and fat content of thigh and breast of broilers was different. The different fat sources did not have any statistical significant effect on protein content of thigh or breast meat. Song et al., (2004) indicated that true amino acid availability is equal to or superior to that in Chinese high-oil corn varieties compared with conventional corn.

Bird type has an important effect on results and should be considered when developing true amino acid availability.

Meat quality attributes

The percent meat chemical values of broiler chicks fed different levels of cottonseed oil for 50 days are shown in Table 12. Treatment effect in all meat chemical components assayed is not significant (p>0.05).

Mean values of moisture recorded higher (p>0.05) values in group C (71.30±0.80). Mean values of CP and ash gave highest (p>0.05) values in group B. Mean values of EE and cholesterol gave highest values in group D (07.70±02.10 and 10.38±06.84 respectively). Cholesterol in this study agrees with the normal values reported by Sturkie et al., (2000) 100-150 mg/dl. They noted a consequent increase in the cholesterol level of the blood when feed cholesterol intake was increased. The values of cholesterol reported by Aderemi (2004) (100.3-108.21 mg/dl) and Nworgu (2004) (93.33-116.67 mg/dl) were lower than those reported in this study. Variations in cholesterol could be attributed to breed of chicken, nutritional pattern, type of feed and

Table 12. Analysis of variance and average (mean ± st.dev) percent meat chemical values of broiler chicks fed different levels of cottonseed oil for 50 days

Items	F† - value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Moisture	00.90NS	69.80±03.20	68.70±01.70	71.30±00.80	68.60±03.80
C.P	00.90NS	19.90±01.80	20.30±01.30	18.70±00.90	19.90±01.70
E.E	00.50NS	06.40±03.10	07.60±00.80	06.70±00.60	07.70±02.10
Ash	00.40NS	00.70±00.40	01.00±00.30	00.70±00.50	00.80±00.50
Cholesterol (mg)	00.70NS	07.83±01.86	06.63±01.58	08.98±02.26	10.38±06.84

†At (3 , 12) d.f. Means in a row do not differ significantly (p>0.05).
NS = not significantly different (p>o.05).

Table 13. Analysis of variance and average (mean± st.dev) percent meat subjective values of broiler chicks fed different levels of cottonseed oil for 50 days

Items	F† - value	cottonseed oil levels			
		A (0%)	B (3%)	C (6%)	D (9%)
Tenderness	02.30NS	05.70±00.30	04.40±01.10	05.50±00.60	05.00±00.80
Flavor	00.20NS	05.30±00.20	05.20±00.50	05.30±00.80	05.50±00.60
Color	01.50NS	05.50±00.50	04.50±00.50	05.50±01.10	04.80±01.00
Juiciness	01.00NS	05.30±00.10	04.20±01.05	04.90±01.10	04.50±01.00

†At (3 , 12) d.f.
NS = not significantly different (p>o.05).
Means in a row do not differ significantly (p>0.05).

Table 14. Major inputs and margin over major inputs per head of broiler chicks fed different levels of cottonseed oil for 50 days

Items	cottonseed oil levels			
	A (0%)	B (3%)	C (6%)	D (9%)
Meat sales (SDG)*	11.50	11.80	14.20	11.70
Chick purchase (SDG)	02.250	02.250	02.250	02.250
Feed cost (SDG)**	03.10	03.80	03.90	04.10
Major cost of production	07.45	07.15	07.25	08.45
Margin over major inputs	04.05	04.65	06.95	03.25
Profitability (%)	35.20	39.40	48.90	27.80
Profitability ratio	01.00	01.10	01.39	00.79

*At current (March' 2007) prices of meat 7.00 SDG/ kg.
**At current (March' 2007) price of mash 900 SDG/ kg.

environmental factors (Nworgu et al., 2007).

The percent meat subjective values of broiler chicks fed different levels of cottonseed oil for 50 days are shown in Table 13.

Treatment effects in sensory values show non-significant (p>0.05) differences between groups. Mean values of all sensory attributes are closely similar (p>0.05). Eltazi (2000) in a panel test, agreed to significant differences in tenderness and juiciness when feeding broilers corn oil at 2, 4 and 6%. The deposition of inter and intramuscular fat with other intracellular components in broiler carcasses would bring differences in organoleptic values (Lawrie, 1979). According to Grashorn (1995), the most important criteria for meat quality are juiciness and tenderness. These two attributes are closely related. For more tender meat, juices are released more quickly on chewing, and the juicy sensation of the meat is greater. The appraisal of major inputs and margin over major inputs per head of broiler chicks fed at different levels of cottonseed oil for 50 days is shown in Table 14.

Chick purchase and Feed cost values (SDG) were the major inputs considered. The total selling values of meat is the total income obtained. Profitability ratio (01.39) of group C (6% cottonseed oil) was the highest of the test. This resulted was agreeing with many workers Adams et al. (1994) economic considerations of high oil corn should include its potential to improved performance, also Saleh et al, (1997) improve live weight gain and reduce feed

conversion ratios concomitant with increased nutrient density, and also LÓpez-Ferrer et al. (2001) improve meat quality parameters of the breast, no differences between treatments or sexes were detected.

Conclusion

- Supplementation with the oils improved performance ($p>0.05$) but CSO gave significant ($p<0.05$) values in final, weight gain and feed conversion ratio.
- Adding CSO, oils were promoting to the performance of broiler chicks with a positive energy balance.
- Using plant oils imposed no changes in hematological, metabolic, enzymatic or electrolytes normal values, referring to normal health.
- Supplementing plant oils resulted in similar percent slaughter and carcass cuts values except when adding CSO on non- carcass values.
- Adding plant oils resulted in economic benefits.

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