Response of Broiler Chicken to Different Levels of Boiled Cowpea seeds (*Vigna unguiculata*) as Replacer for Super-concentrate

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Response of Broiler Chicken to Different Levels of Boiled Cowpea seeds (*Vigna unguiculata*) as Replacer for Super-concentrate

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Abstract

The objective of the study was to assess the response of broiler chicken to different levels of boiled cowpea seeds (*Vigna unguiculata*) as replacer for super-concentrate. Growth performance, carcass characteristics, chemical and physical composition of broilers meat and economical appraisal were studied. Two hundred one-day-old un-sexed Ross (308) chicks were used in a complete randomized design. Cowpea seeds replaced super-concentrate at (0, 25, 50, 75 and 100%). Chicks were randomly allotted to five dietary treatments; each of them was further divided into 4 replicates of 10 birds each. The chicks were reared from one-day to six weeks of age in an open-sided poultry house. The chicks were placed in 20 pens (1×1m) with wood shavings litter. Five isonitrogenous starter and finisher diets were formulated according to National Research Council (NRC, 1994). Overall feed intake, body weight gain, feed conversion ratio (FCR) and protein efficiency ratio (PER) were significantly ($P \leq 0.05$) worsened for birds on total replacement of super-concentrate by boiled cowpea seeds. Replacement of super-concentrate by 0, 25 and 50% boiled cowpea seeds showed no significant (($P \geq 0.05$) effect on overall feed intake, body weight gain, FCR, PER, weight of half carcass, absolute weight of abdominal fat, thigh weight, drumstick weight, back weight, breast muscle weight, breast bone weight, drumstick muscle weight and drumstick fat weight. Moisture content, water holding capacity (WHC) and cooking loss of broiler meat were linearly increased with the increased level of replacement. However, CP, EE, and Ash were decreased as the level of replacement increased. The best economic efficiency index (EEI) and the least cost index (CI) were achieved by birds on 25% level of replacement. It could be concluded that boiled cowpea seeds could be used to replace super-concentrate in broiler chicken diets up to 50% without deleterious effect on performance.

Key words: boiled Cowpea, broiler, performance, carcass.

Introduction

Poultry production is currently increasing in developing countries through the usage of small-scale production facilities and increased poultry husbandry skills. There are many species and breeds of poultry. The domestic chicken (*Gallus domestic*) is the most important one. Poultry products are rich in protein, minerals and vitamins. Poultry industry has played an important role in meeting the demand to animal protein through the increased availability of eggs and meat in Sudan. Poultry production, particularly broiler production is the quickest way to increase the availability of high quality protein for human consumption. Since feed represents the major cost in poultry industry, economically poultry production is, therefore, possible only when the feed cost is reduced and efficiency of feed utilization is increased (Qureshi, 1991). Moreover, optimizing cost of poultry feed can be achieved by using alternative, locally available ingredients. However, the production of low quality feed has created many problems for the broiler industry resulting in poor performance and lower returns (Perves and Abdul, 2011).

Super-concentrate imported from abroad is very expensive and the prices are dramatically increased and continue to do so. The intensive poultry production is based on diets high in animal protein source. However, the need to reduce the impact of super-concentrate on poultry production has led to search for alternative local protein sources. Grain legumes are moderate to good sources of protein, containing 150 to 400 g/kg crude protein (Hedley, 2001). The seeds of these legumes contain moderately high levels of protein and their amino acid profiles are generally comparable to that of soybean meal, with the exception of sulphur containing amino acids. When processed into meal, soybean has about 44 to 48% crude protein, and is the major source of plant protein in poultry diets. However, the price of soybean meal was forecasted to increase higher on the international market due to the high demands in China and the emergent countries of Asia (Robinson and Singh, 2001). As a consequence, the risk will be this traditional source of protein for poultry would become too expensive and scarce in the coming years, particularly in low-income countries. It is therefore, necessary to search for good alternatives using readily available local feedstuffs. Among the potential sources of vegetable proteins are the cowpea grains (*Vigna unguiculata*) which serve as alternative to fat extracted soybean meal because they have similar amino acid profiles (Wiryawan and Dingle, 1999). Cowpea grains are cheap and readily available leguminous seeds that thrive well where others fail, due to their excellent adaptability to extreme climatic conditions (FAO, 1999). Cowpea yields about 633 and 727kg seeds per hectare with crude protein content of about 25% on dry matter basis (Dillon, 1987). However, the utilization of grain legumes in poultry diets remains limited, due to the variability in their nutritional composition and presence of a variable amount of anti-nutritional factors. It is well documented that feeding poultry with diets containing raw legumes can cause a number of nutritional disturbances (Farrell *et al*., 1999, lkowski *et al*., 2001, Rubio *et al*., 2003, Teguia and Beynen., 2005 and Wiryawan and Dingle, 1999). The presence of anti-nutritional factors such as trypsin and chymotrypsin inhibitors in legumes may lower digestibility of legume protein (Elegbede, 1998). It is known however, that treatments techniques like fermentation, roasting, germination and autoclaving can improve nutritional quality and bioavailability of nutrients present in legumes. Processing techniques are effective ways of making desirable changes, by removing of un-desirable components and effective utilization of the full potential of legumes as feed stuff (Gloria *et al*., 1985). Cowpea seed is considered among the highest protein-containing seeds. Hence the present study was designed to evaluate the effect of boiled cowpea seeds replacing super-concentrate on growth performance and carcass characteristics of broilers. As well as assessing the economical appraisal of different levels of cowpea seeds.

Materials and Methods

Chemical composition of cowpea seeds

Cowpea seeds were obtained from the local market. Cowpea seeds were cleaned and boiled at 100ºC in tap water for 25 minutes and sun dried. Chemical composition of raw and boiled cowpea seeds is shown in Table (1). The nutrients composition of raw and boiled cowpea seeds was determined according to the methods of the Association of Official Analytical Chemists (AOAC, 1990). Metabolizable energy, ME (kcal/kg) of cowpea seeds was calculated according to the equation suggested by Lodhi *et al*. (1976) as follow:

ME (Mjoule/Kg) = 1.549 ± 0.0102 (CP g/kg) ±0.0275 (EE g/kg) ± 0.0148 (NFE g/kg) – 0.0034 (CF g/kg).

Experimental birds and housing

One-day-old unsexed broiler chicks of a commercial strain (Ross 308) were purchased from a commercial hatchery. A total of 200 broiler chicks were selected according to uniform initial live body weight (43.5g ± 0.22). The chicks were randomly divided into five treatment groups; each of them was further Sub-divided into four replicates of 10 birds each. The chicks were reared from one-day to six weeks of age in an open-sided poultry house at the Poultry Unit of the Department of Animal Production, Faculty of Agricultural Technology and Fish Science, University of Al Neelain. The chicks were placed in 20 pens (1×1m) with wood shavings litter.

Experimental diets

In the present experiment, five isocaloric and isonitrogenous starter and finisher diets were formulated according to National Research Council (NRC, 1994). Boiled cowpea seeds replaced super-concentrate at 0, 25, 50, 75 and 100% in starter and finisher diets. The composition of starter and finisher diets is shown in Tables (2) and (3).

Management

The birds in each pen had continuous access to one metallic fountain drinker and feeder. Continuous light was provided throughout the experimental period by a combination of natural and artificial light. Broiler chicks were given mix vaccine (IB± Newcastle clone) at 5 days of age; also they were vaccinated against infections bursal disease (Gumboro) at 2 weeks of age. At fourth week, chicks were vaccinated via Newcastle (clone). Vitamins offered as a supportive doze before and after vaccination.

Experimental procedure

Feed intake, body weight and body weight gain were determined weekly on a pen basis. Mortality was recorded daily as it occurred to adjust feed intake. Based on the records of feed intake and body weight gain, feed conversion ratio (FCR) was calculated as feed intake per weight gain. Protein efficiency ratio (PER) was calculated as weight gain per protein consumed. At the end of the experiment, birds were fasted from feed for an overnight and then weighed and manually slaughtered. The carcasses were washed and allowed to drain and eviscerated by ventral cut. Different cuts, liver, heart, gizzard, intestine, abdominal fat were weighed. The dressing percentage on hot base was calculated as hot carcass weight to live weight.

Economical Appraisal

The change in total feed cost, total revenue and profit for dietary treatments diets containing boiled cowpea seeds were calculated comparatively with that of the control. The economic efficiency index (EEI) and the cost index (IC) were calculated according to (Fialho *et al*., 1985) as follows:

EEI = (MCe/CTei) ×100

CI = (CTei/MCe) ×100

Whereas, MCe is the lowest feed cost per kilogram of weight gain observed among treatments. CTei is the cost of the treatment one.

Statistical analysis

The experiment was arranged in a complete randomized design (CRD). Data were analyzed by one-way analysis of variance using the General Linear Model of SAS (SAS Institute, 2003). Significant differences between treatments means were tested by Duncan's multiple range tests (Steel and Torrie, 1980).

Table 1. Chemical composition of raw boiled and cowpea seeds

Item %	Raw cowpea seeds	Boiled cowpea seeds
ME* kcal/kg	3164	3203
Crude protein	23.88±0.38	24.38±0.39
Crude fat	1.80±0.03	2.00±0.04
Crude fiber	2.73±0.02	3.98±0.04
Moisture	8.35±0.20	6.43±0.15
Crude ash	3.42±0.03	2.70±0.02
Calcium	0.05%	0.05%
Total phosphorous	0.12%	0.12%
Tannin	0.49%	0.49%

* ME Calculated according to equation of Lodhi *et al*. (1976).

Table 2. Composition of experimental broiler starter diets containing graded replacement of super-concentrate by different levels of boiled cowpea seeds

	Replacement levels of cowpea seeds for super-concentrate, %				
Ingredients, %	**0 (A)**	**25 (B)**	**50 (C)**	**75 (D)**	**100 (E)**
Sorghum	64.40	63.05	62.00	60.00	58.00
Ground nut cake	23.5	24.40	25.00	25.20	25.70
Cowpea	0.00	1.25	2.50	3.75	5.00
Wheat bran	1.00	1.00	2.00	2.00	2.00
Super-concentrate*	5.00	3.75	2.50	1.25	0.00
Nacl	0.30	0.30	0.30	0.30	0.30
Limestone	1.26	1.22	1.19	1.14	1.10
Dical. Phosphate	0.14	0.55	0.99	1.40	1.85
L-Lysine	0.14	0.28	0.43	0.28	0.72
DL-Methionine	0.16	0.20	0.26	0.30	0.35
Choline chloride	0.20	0.20	0.20	0.20	0.20
Mycotoxin binder	0.20	0.20	0.20	0.20	0.20
Vegetable oil	3.50	3.40	3.60	3.70	3.75
Enzyme	0.20	0.20	0.20	0.20	0.20
Calculated analysis					
ME* *(kcal/kg)	3189	3185	3189	3186	3186
CP%	22.7	23.0	23.0	23.2	23.3
Crude fiber%	4.2	4.2	4.3	4.4	4.5
Ca%	1.0	1.0	1.0	1.0	1.0
Av. Phosphorous%	0.45	0.45	0.45	0.45	0.45
Lysine%	1.1	1.1	1.1	1.1	1.1
Methionine%	0.57	0.57	0.58	0.57	0.57
Meth. + Cysteine%	0.78	0.80	0.80	0.80	0.80
E.E.%	7.1	7.1	7.2	7.4	7.4
Determined analysis					
Moisture%	6.56	6.40	6.10	7.04	5.90
Ash%	6.36	6.57	6.40	6.95	7.32
CP%	21.55	23.94	22.34	23.94	24.14
E.E.%	6.53	6.05	7.55	6.76	7.81
Crude fiber%	3.47	6.96	4.81	4.58	4.63

* Cp 40%, ME 2000 kcal/kg, C.fiber 3%, EE 3%, Ash 34%, Ca 8%, Av. P 1.38%, Lysine 12%, Methionine 3%, Methionine+Cystine 3.5%. Vitamin A 250000 IU/Kg, Vitamin D3 50000 IU/Kg, Vitamin E 500Mg/Kg, Vitamin K3 60 Mg/Kg, Vitamin B1/ Thiamin 20 Mg/Kg, Vitamin B2/ Riboflavin 100 Mg/Kg, Niacin Vitamin PP 600 Mg/Kg, Pantothenic acid/ Vitamin B3 160 Mg/Kg, Vitamin B6/ Pyridoxine 40 Mg/Kg, Vitamin B12 300 Mcg/Kg, Biotin/ Vitamin H 2000 Mcg/Kg, Choline 10000 Mg/Kg, Vitamin C 4000 Mg/Kg, Folic Acid 30 Mg/Kg, Iron 800 Mg/Kg, Manganese 1400 Mg/Kg, Copper 120 Mg/Kg, Zinc 1000 Mg/Kg, Iodine 6 Mg/Kg, Cobalt 12 Mg/Kg, Selenium 3 Mg/Kg. ** ME Calculated according to equation of Lodhi *et al*. (1976).

Table 3. Composition of experimental broiler finisher diets containing graded replacement of super-concentrate by different levels of boiled cowpea seeds

	Replacement levels of Cowpea seeds for super-concentrate,%				
Ingredients, %	**0 (A)**	**25 (B)**	**50 (C)**	**75 (D)**	**100 (E)**
Sorghum	67.48	67.00	64.00	66.00	65.60
Ground nut cake	16.80	17.00	17.00	17.00	17.00
Cowpea	0.00	1.25	2.50	3.75	5.00
Wheat bran	4.21	4.21	6.00	4.00	4.00
Super-concentrate*	5.00	3.75	2.50	1.25	0.00
Nacl	0.30	0.30	0.30	0.30	0.30
Limestone	1.45	1.63	1.61	1.56	1.53
Dical. Phosphate	0.00	0.04	0.45	0.89	1.32
L-Lysine	0.09	0.24	0.38	0.55	0.70
DL-Methionine	0.12	0.18	0.22	0.27	0.32
Choline chloride	0.20	0.20	0.20	0.20	0.20
Mycotoxin binder	0.20	0.20	0.20	0.20	0.20
Vegetable oil	3.95	3.80	4.00	3.63	3.50
Enzyme	0.20	0.20	0.20	0.20	0.20
Calculated analysis					
ME (kcal/kg)	3198	3199	3198	3199	3197
CP%	20.1	20.2	20.2	20. 2	20.1
Crude fiber%	4.00	4.00	4.20	4.00	4.00
Ca%	1.0	1.0	1.0	1.0	1.0
Av. Phosphorous%	0.43	0.35	0.35	0.35	0.35
Lysine%	1.0	1.0	1.0	1.0	1.0
Methionine%	0.51	0.53	0.52	0.52	0.52
Meth. +Cysteine%	0.70	0.72	0.71	0.70	0.70
Fat%	7.2	7.1	7.5	6.9	6.7
Determined analysis					
Moisture%	6.25	6.12	6.19	5.77	5.96
Ash%	6.01	5.17	5.64	6.83	6.15
CP%	20.00	21.00	21.55	20.00	20.75
E.E.%	6.46	8.47	7.33	7.46	6.91
Crude fiber%	3.73	4.42	3.95	3.70	4.34

*As shown in Table 1.

Results and Discussion

The chemical composition of raw and boiled cowpea seeds (Table 1) showed that boiled one had higher metabolizable energy ME, DM, CP, EE and CF. Chakam *et al*. (2010) claimed that cooked cowpea had higher ME and DM and lower CP, ash, EE and CF. The result of chemical composition of cowpea seeds was comparable with the finding of Embaye *et al*. (2018) who found 25.76% CP, 6.22% CF, 1.65% EE, 4.6% ash and 3307 Kcal/Kg ME.

The effect of replacing super-concentrate by boiled cowpea seeds on broiler growth performance is presented in the Table 4. Feed intake and FCR during starter, finisher and the whole period were significantly ($P \leq 0.05$) deteriorated for birds fed on total replacement compared to the other dietary treatments. These results are agreed with (Akanji, 2016) who claimed that feed intake and FCR were significantly reduced in birds fed raw and de-hulled cowpea. In contrast to this result, Chakam *et al*. (2008) reported no significant difference in total feed consumption in broilers fed grower-finisher diet with graded levels of cooked cowpea seeds. On the other hand birds fed on total replacement had significantly ($P \leq 0.05$) the lowest body weight gain during starter, finisher and overall period. Similar finding was obtained by (Adino *et al*., 2018) who reported significant inferior daily weight gain in chicks fed 100% cowpea than the rest of dietary treatments. Moreover, total replacement of super-concentrate by boiled cowpea seeds resulted in a significantly ($P \leq 0.05$) poorest overall PER. This result is agreed with that obtained by (Akanji., 2016). However, no significant ($P \geq 0.05$) differences were observed in overall feed intake, body weight gain, FCR and PER for birds fed 0.0, 25 and 50% level of replacement. These results are coincided with Akanji. (2016), who found no significant difference in weight gain, feed conversion efficiency and PER of birds fed control diet and those fed dehulled cooked cowpea. The poor growth performance of birds on total replacement as compared to the control might be due to higher nutritive value of super-concentrate compared to cowpea seeds.

Carcass characteristics and internal organs as by replacement of super- concentrate by boiled cowpea seeds are shown in Table (5) and (6), respectively. Replacement at levels 0, 25 and 50% showed no significant ($P \geq 0.05$) effect on weights of half carcass, abdominal fat, thigh, drumstick, back, breast muscle, breast bone, drumstick muscle and drumstick fat. Noticeably poorest values were shown by birds fed on total replacement. Similarly, some carcass traits were negatively affected by inclusion of chickpeas in broiler diets (Christodoulou *et al*., 2006). On the other hand, different dietary treatments had an inconsistent effect on dressing% and weights of internal organs of broilers. No significant ($P \geq 0.05$) differences were shown in length of intestine among different dietary treatments. This finding in accordance with that obtained by (Nalle, 2009), who found similar length of small intestine of birds fed diets containing grain legume and those fed a maize-soy basal diet. Birds fed on total level of replacement revealed significantly ($P \leq 0.05$) the highest relative weight of intestine. Likewise, (Brenes *et al*., 2008) showed that relative weight of intestine increased with the increasing amount of chickpea seeds. This might be related to hypertrophy in chickens due to ANF contained in legume seeds (Huisman and Van der Poel, 1989).

Table (7) shows the effect of replacing super-concentrate by boiled cowpea seeds on chemical and physical composition of broiler meat. Moisture content, water holding capacity (WHC) and cooking loss meat were linearly increased as level of replacement of boiled cowpea seeds increased. However, CP, EE and ash were decreased with the increased level of replacement. These finding are agreed with (Hassan, 2021) who noticed decrease in CP, EE and ash of meat with the increased levels of boiled and roasted bambara seeds.

Economic appraisal of broiler as affected by replacement of super-concentrate by boiled cowpea seeds is given in Table (8). The cost (SDG) of one kg feed was decreased with increasing level of boiled cowpea seeds, this due to the low price of cowpea seeds versus super-concentrate. Total replacement of boiled cowpea seeds for super-concentrate induced the highest feeding cost to produce one kg live weight (Ekenyem and Obih., 2010). The result showed that the economic efficiency index EEI of birds fed control, 50, 75 and 100% was decreased by 0.1, 1.3, 10.8 and 50.9% versus those fed 25%. This result is finding agreed with (Ani *et al*., 2012), who found that feed cost per kg weight gain increased with increasing in cowpea legume levels.

Conclusion

Based on the current results, it could be concluded that boiled cowpea seeds can efficiently replace super-concentrate by up to 50% without negative effect on growth performance parameters. Nevertheless, at total replacement of super-concentrate with boiled cowpea seeds, there was a deleterious effect on growth performance, carcass traits and economic appraisal. The best economic efficiency index was achieved by birds fed 25% level of replacement.

Table 4. Effect of replacing super-concentrate by boiled cowpea seeds on broiler growth performance

	Replacement levels of cowpea seeds for super-concentrate					
Parameter	**0 % (A)**	**25% (B)**	**50% ©**	**75% (D)**	**100% (E)**	**±SEM**
0-3 wk						
Feed intake	1103.5^{a}±57.4	1087.8^{a}±42.9	1094.0^{a}±40.6	1048.9^{a}±64.8	924.6^{b}±56.9	26.7
Body weight gain	608.8^{a}±24.5	627.5^{a}±32.7	589.8^{a}±25.03	537.1^{b}±39.9	253^{c}±15.3	14.4
FCR	1.81^{b}±0.03	1.74^{b}±0.06	1.86^{b}±0.14	1.95^{b}±0.06	3.66^{a}±0.3	0.07
PER	2.43^{ab}±0.05	2.51^{a}±0.09	2.35^{bc}±0.17	2.21^{c}±0.07	1.75^{d}±0.09	0.05
4-6 wk						
Feed intake	1802.0^{a}±136.5	1887.7^{a}±78.5	1820.1^{a}±71.1	1726.1^{a}±128.3	965.2^{b}±87.5	51.9
Body weight gain	1096.4^{a}±168.0	1072.5^{a}±64.7	1035.7^{a}±25.0	829.9^{b}±71.1	271.0^{c}±85.5	1.59
FCR	1.66^{b}±0.15	1.76^{b}±0.05	1.76^{b}±0.03	2.10^{b}±0.32	3.83^{a}±1.14	0.27
PER	3.01^{a}±0.30	2.81^{ab}±0.08	2.82^{ab}±0.05	2.40^{b}±0.33	1.39^{c}±0.41	0.14
Overall period						
Overall FI	2905.6^{a}±167.6	2975.5^{a}±108.5	2914.2^{a}±92.7	2775.0^{a}±192.4	1889.8^{b}±99.6	69.1
Overall BWG	1705.2^{a}±174.9	1700.0^{a}±91.9	1625.4^{a}±38.9	1367.0^{b}±77.6	524.0^{c}±70.4	50.8
Overall FCR	1.71^{b}±0.10	1.75^{b}±0.05	1.79^{b}±0.05	2.04^{b}±0.19	3.65^{a}±0.47	0.12
Overall PER	2.78^{a}±0.17	2.69^{a}±0.08	2.63^{a}±0.08	2.32^{b}±0.20	1.28^{c}±0.17	0.07

Values are means of 4 replicates per treatment (10 birds/ replicate).
^{abcd} Means ± SD with different superscripts in the same row were significantly different ($P \leq 0.05$).
SEM: Standard error of the means from ANOVA d.f 15.

Table 5. Carcass characteristics of broilers as influenced by replacement of super-concentrate by boiled cowpea seeds

	Replacement levels of boiled cowpea seeds for super-concentrate,%					
Parameter	**0 (A)**	**25 (B)**	**50 ©**	**75 (D)**	**100 (E)**	**±SEM**
Dressing%	71.4^{a}±1.07	69.01^{ab}±3.0	62.8^{bc}±8.8	65.1^{abc}±2.5	59.3^{c}±3.8	2.3
Absolute abdominal fat wt.	46.7^{a}±6.3	55.1^{a}±39.9	35.5^{ab}±6.9	32.9^{ab}±6.9	9.9^{b}±3.0	9.3
	3.3±0.42	3.1±2.3	2.1±1.04	3.4±0.8	2.08±0.71	0.6
Relative abdominal fat wt.						
Half carcass wt.	686.6^{a}±125.9	645.6^{a}±45.9	658.5^{a}±81.4	401.4^{b}±63.2	206.2^{c}±60.9	40.1
Breast wt.	215.9^{a}±30.1	187.0^{ab}±27.8	185.1^{b}±25.1	105.3^{c}±33.8	55.3^{d}±25.1	14.3
Thigh wt.	116.0^{a}±24.2	112.2^{a}±10.3	100.6^{a}±25.6	79.4^{b}±8.3	37.4^{c}±10.6	8.7
Drumsticks wt.	102.6^{a}±16.7	94.0^{a}±5.4	92.2^{a}±12.7	67.8^{b}±10.1	37.4^{c}±8.4	5.7
Wing wt.	72.4^{a}±13.5	73.6^{a}±6.1	61.9^{b}±12.6	53.4^{b}±7.7	33.5^{c}±10.1	5.2
back wt.	155.9^{a}±53.5	148.3^{a}±26.3	170.0^{a}±22.7	97.2^{b}±37.1	43.5^{c}±20.0	17.1
Breast muscle wt.	143.3^{a}±29.6	138.4^{a}±22.9	129.6^{a}±19.4	70.4^{b}±27.5	29.9^{c}±15.3	11.8
Breast bone wt.	34.4^{a}±3.9	28.3^{a}±10.4	28.6^{a}±5.2	21.3^{b}±5.0	14.8^{b}±7.0	3.3
Should Breast fat wt.	19.8^{a}±6.2	13.3^{b}±4.3	12.4^{b}±3.5	6.7^{c}±4.0	4.0^{c}±1.1	2.07
Thigh muscle wt.	76.4^{a}±20.5	68.4^{ab}±8.9	57.4^{bc}±8.7	47.6^{c}±7.4	19.8^{b}±7.5	5.9
Thigh bone wt.	11.3^{c}±6.4	18.0^{a}±3.1	16.5^{ab}±4.5	12.8^{bc}±1.8	6.9^{d}±2.4	1.1
Thigh fat wt.	13.6^{b}±4.1	18.9^{a}±3.9	11.3^{bc}±3.5	9.0^{c}±4.3	3.4^{d}±1.8	1.8
Drum. muscle wt.	56.6^{a}±11.7	48.8^{a}±8.9	51.4^{a}±9.7	35.9^{b}±10.3	15.3^{c}±4.1	4.7
Drum. bone wt.	25.4^{a}±6.0	21.8^{ab}±1.6	20.9^{b}±3.1	14.9^{c}±3.3	9.1^{d}±2.1	1.8
Drum. fat wt.	9.3^{a}±1.6	8.3^{ab}±1.4	9.4^{a}±1.6	7.0^{b}±1.1	2.5^{c}±1.1	0.7

Values are means of 4 replicates per treatment. ^{abcde} Means ± SD with different superscripts in the same row were significantly different ($P \leq 0.05$). SEM: Standard error of the means from ANOVA d.f 15.

Table 6. Internal organs of broilers as influenced by replacement of super-concentrate by boiled cowpea seeds

	Replacement levels of cowpea seeds for super-concentrate					
Parameter	**0 %(A)**	**25% (B)**	**50% (C)**	**75% (D)**	**100% (E)**	**±SEM**
Absolute wt. of heart (g)	$7.9^{ab}±2.3$	$9.6^{a}±3.7$	$7.8^{ab}±1.6$	$6.6^{ab}±1.2$	$4.5^{b}±0.9$	1.1
Relative wt. of heart	$0.54^{b}±0.06$	$0.70^{ab}±0.18$	$0.68^{ab}±0.36$	$0.67^{ab}±0.12$	$0.93^{a}±0.16$	0.1
Absolute wt. of liver (g)	$35.2^{ab}±10.8$	$41.7^{a}±6.3$	$44.50^{a}±5.3$	$30.7^{b}±3.1$	$16.1^{c}±1.5$	3.2
Relative wt. of liver	$2.5^{b}±0.7$	$3.1^{ab}±0.4$	$3.6^{a}±0.8$	$3.1^{ab}±0.2$	$3.3^{ab}±0.5$	0.3
Absolute wt. of gizzard (g)	$34.4^{a}±7.1$	$37.1^{a}±15.3$	$28.3^{ab}±7.2$	$23.2^{ab}±4.3$	$17.9^{b}±6.1$	4.5
Relative wt. of gizzard	2.4±0.3	2.7±0.8	2.3±0.9	2.4±0.8	3.7 ±1.4	0.5
Intestine length	190.3±25.1	188.8±12.7	193.5±11.9	183.5±36.4	160±25.6	12.1
Absolute wt of Intestine (g)	$91.2^{a}±30.6$	$80.1^{a}±4.2$	$94.3^{a}±18.3$	$83.9^{a}±21.2$	$50.2^{b}±4.4$	9.4
Relative wt of intestine	$6.2^{c}±1.1$	$6.1^{c}±0.8$	$7.5^{bc}±0.3$	$8.5^{b}±2.1$	$10.3^{a}±0.3$	0.6

Values are means of 4 replicates per treatment. [abc] Means ± SD with different superscripts in the same row were significantly different (P≤ 0.05). SEM: Standard error of the means from ANOVA d.f 15.

Table 7. Chemical and physical composition of broilers meat as influenced by replacement of Super-concentrate for boiled cowpea seeds

	Replacement levels of boiled cowpea seds for super-concentrate, %					
Parameter	**0 (A)**	**25 (B)**	**50 (C)**	**75 (D)**	**100% (E)**	**±SEM**
Moisture	$72.7^{d}±0.8$	$73.4^{c}±0.5$	$74.2^{b}±0.5$	$74.7^{b}±0.5$	$75.6^{a}±0.5$	0.3
Ash	$1.02^{a}±0.05$	$0.95^{b}±0.04$	$0.91^{c}±0.03$	$0.85^{d}±0.03$	$0.77^{e}±0.04$	0.02
EE	$2.05^{a}±0.25$	$1.82^{b}±0.07$	$1.73^{b}±0.10$	$1.50^{c}±0.13$	$1.29^{d}±0.31$	0.01
CP	$20.04^{a}±0.25$	$19.8^{ab}±0.10$	$19.7^{b}±0.12$	$19.5^{c}±0.17$	$18.3^{d}±0.37$	0.11
WHC	$1.7^{d}±0.11$	$1.8^{d}±0.12$	$2.01^{c}±0.12$	$2.8^{b}±0.21$	$3.53^{a}±0.21$	0.08
Cooking loss	$27.1^{e}±0.7$	$28.5^{d}±0.7$	$30.06^{c}±0.6$	$31.6^{b}±0.5$	$33.9^{a}±0.4$	0.30

Values are means of 4 replicates per treatment. [abcd] Means ± SD with different superscripts in the same row were significantly different (P≤ 0.05). SEM: Standard error of the means from ANOVA d.f 15

Table 8. Economic appraisal of broilers as influenced by replacement of Super-concentrate for boiled Cowpea seeds

	Replacement levels of boiled cowpea seedsfor super concentrate %				
Parameter	**0 (A)**	**25 (B)**	**50 (C)**	**75 (D)**	**100 (E)**
cost (SDG) of 1 kg starter feed	23.8	23.2	22.9	22.4	21.9
cost (%) of 1 kg starter feed	100	97.6	96.1	94.1	92.1
cost (SDG) of 1 kg finisher feed	23.5	22.7	22.4	21.6	21.0
cost (%) of 1 kg finisher feed	100	96.9	95.5	92.0	89.5
cost of consumed starter	23.9	22.9	22.7	21.3	18.1
cost of consumed finisher	42.3	42.9	40.8	37.3	20.3
total cost of feed consumed	74.0	73.8	71.5	66.5	46.3
Cost (SDG) of feed/1kg meat	43.4	43.4	44.0	48.6	88.3
Economic efficiency index (EEI)	99.9	100	98.7	89.2	49.1
Cost index (CI)	100.1	100	101.3	112.1	203.5

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