African Journal of Biotechnology Vol. 7 (9), pp. 1351-1356, 2 May, 2008
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2008 Academic Journals

Full Length Research Paper

Performance and carcass characteristics of broilers fed boiled cowpea (*Vigna unguiculata L Walp*) and or black common bean (*Phaseolus vulgaris*) meal diets

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Accepted 29 February, 2008

A total of 256 broiler chicks were used to evaluate the effect of replacing meat meal with boiled cowpea and/or black common bean on the performance and carcass characteristics of broilers. At the starter phase, boiled cowpea and or black common bean meal constituted 11% of S1, S2 and a 1:1 ratio of boiled cowpea and black common (S3) diets replacing 100% of meat meal and 25% of fish meal. For the finisher phase, 14% boiled cowpea (F1), 14% boiled black common bean (F2) and an equal proportion (1:1) of boiled cowpea and black common bean meals (F3) were used to replace 100% meat meal and 25% fish meal. During the starter period, feed intake and weight gain were significantly ($P < 0.05$) higher for broilers fed the control diet compared to those in the treatment diets. No significant ($P > 0.05$) difference was observed between treatment groups for feed conversion ratio and feed cost for the production of 1 kg live body weight. At finisher, broilers started with the control starter diet and finished with any of the test diets significantly ($P < 0.05$) consumed more feed and acquired heavier weights compared to the other dietary combinations. Feed cost was significantly ($P < 0.05$) lower for birds started the control starter diet and finished with either the control finisher diet or boiled cowpea diets. Carcass yield was significantly ($P < 0.05$) higher for birds finished with boiled cowpea diet compared to the other treatments. Cowpea and black common bean boiled for 30 min under uncontrolled temperature and pressure could not be recommended for broiler's diet formulation.

Key words: Heat treatment, *Vigna unguiculata* L Walp, *Phaseolus Vulgaris*, growth performance, broiler.

INTRODUCTION

Meat meal is a source of protein with high biological value for monogastric animals (Robinson and Singh, 2001). However, the current restrain on livestock trade and use of animal meal in livestock feed worldwide including states of the Central African sub-region have added additional constrains to poultry production in this region (Teguia et al., 2002; Teguia and Beynen, 2005). Soya bean meal, which is traditionally the stable vegetable protein source for poultry feed in Cameroon and other countries of the sub region (Teguia and Beynen, 2005; Robinson and Singh, 2001), is mainly imported and it is predicted that soybean will be scarce and expensive (Leeson and Summer, 1997) due to the expanding economies in China and emerging Asian countries. It is therefore imperative to search for unconventional vegetable protein sources to replace animal meal concentrate during period of soybean shortage (Leeson and Summer, 1997; Robinson and Singh, 2001). Among the potential sources of vegetable proteins, leguminous grains such as *Vigna unguiculata* L. Walp (cowpea or niebe) and *Phaseolus vulguris* (black common bean) serve as alternatives to fat-extracted soybean meal because they have similar amino acid profiles (Wiryanwan, 1997).

Cowpea and black common bean have high potentials (Westphal et al., 1985) and desirable agronomic and nutritive characteristics as feedstuffs (Universite de Nia-

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mey, 1987; Borget, 1989). Cowpea and black common bean 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 and black common bean yield about 633 and 729 kg seeds per hectare with crude protein content of about 25 and 23% on dry matter basis, respectively (Borget, 1998; Dillon, 1987). One of the major problems with legume utilization is the presence of anti-nutritional factors (Teguia and Beynen., 2005; Miega, 1987; Duc, 1998; Wiryawan and Dingle, 1999). Cowpea and black common bean have been reported to contain ant-nutritional factors particularly trypsin inhibitors (Buget, 1989; Tacon, 1995; Duc, 1996; Teguia and Beynen, 2005; Amaefuil et al., 2005) which limit their utilization in animal feeding. Wiryawan and Dinlge (1999), Bressani (2002), Teguia et al. (2003) reported poor performance of birds when fed raw cowpea and black common bean. Cooking is a conventional method of detoxification among the rural dwellers.

The objective of the present study was to investigate the effect of replacing meat meal by boiled cowpea (*V. unguiculata* L Walp) and/or black common bean (*P. vulgaris* L) meal on the performance of broiler chickens.

MATERIALS AND METHODS

Grains of cowpea and black common bean where purchased from local markets in Dschang, Western Province of Cameroon with other feed ingredients. The raw cowpea and black common bean grains were cooked separately with firewood and kept boiling for 30 min. The grains were sieved, spread thin in a tapeline sheet, frequently stirred and allowed to dry on the sun for seven days, milled and incorporated in the diets. At the starter phase (1 – 28 days), four experimental diets (S0, S1, S2 and S3) were formulated. Diet S0 (control) was purely meat meal (CAMV10) base diet while the test feedstuffs (boiled cowpea and/or boiled black common bean) quantitatively replaced 10% meat meal and 25% fish meal by 11% boiled cowpea (S1), 11% boiled black common bean (S2) and 1:1% mixture of boiled cowpea and boiled black common bean at 5.5% each (S3). In the finisher phase (29 – 49 days), in addition to the control diet containing no legume grain, three experimental diets were formulated to contain 14% boiled cowpea (F1), 14% black common bean (F2) and or equal proportion of both grains (7% boiled cowpea and 7% boiled black common bean) F3 replacing 100% meat meal and 25% fish meal respectively. In additional to the meat meal, fish meal and/or legume grains, the starter and finisher diets contained maize, wheat meddling, soybean meal, cotton seed cake, ground cake, palm oil, salt and oyster shell. Both the starter and finisher diets were formulated to meet the requirements for broiler birds as recommended (AOAC. 1990). The composition and determined analysis of the experimental diets are given in Tables 1 and 2.

A total of 272 unsexed day-old Arbor acres chicks weighing about 41.03 g each were used for the starter period. The day-old chicks were brooded using electric heaters and bulb as source of light in a deep-litter house. The birds were vaccinated against Newcastle, infection bronchitis and Gumboro diseases. Anti coccidia agents were administered for 3 consecutive days from day 15 and every week thereafter. The birds were administered antistress (Aliseryl®: 1 g per 5 L of water) before and after each vaccination and during transfer of birds from the brooding to the finisher house. At the starter phase (1-28 days) the chickens were randomly distributed over 16 experimental units with a floor area of 1.2 m^2 each in a completely randomised design comprising 4 treatments (S0, S1, S2 and S3) with 68 chickens per treatment, each treatment had 4 replicates and 17 birds per replicate. Each treatment was fed on one of the experimental starter diets. The birds were fed in groups of 17 and records of feed intake were used to compute average weekly feed consumption per bird. The chickens were given feed and water *ad libitum.*

At the end of the starter period, all the birds of each treatment group were weighed brought together sexed and redistributed randomly into 4 groups with equal sex. 16 treatment combinations were obtained (S0, S1, S2, S3) X (F0, F2, F3, F4) with 16 birds allotted to each treatment in a completely randomised design (CRD). Each combination was replicacted 4 times (2 cocks and 2 hens). The couples were housed in California type cages and fed *ad libitum.* Mortality cases from day old and then daily were recorded during the experiment while two birds (one cock and one hen) selected randomly per replicate were used for carcass evaluation at the end of the experiment according to Jourdan (1980) following a 24-h fasting period. Data were collected at days 1, 7, 14, 21 and 28 for the starter period and at day 35, 42 and 49 for the finisher period on body weight and feed consumption. Feed conversion ratio (FCR) and feed cost for the production of 1 kg body weight were calculated (cost/kg body weight = FCR X cost of 1 kg of feed). Animal weight, feed served and leftover were measured with a top loading (20 kg capacity Stude® with sensitivity of 5 g) weighing scale. All the data collected or calculated were subjected to ANOVA. Chi-Square (χ^2) was used to test the effect of the experimental diet on the mortality rate. Where significant differences exist, treatment means were compared using the Least Significant Difference (LSD) test at 5% probability level. All statistical analysis was performed using JMPIN (2001).

RESULTS

The crude fibre content of boiled black common bean was higher (4.55%) than that of boiled cowpea (2.65%). The crude protein, crude fat and ash content of the treated grains were comparable (Table 3). The average data on feed consumption, weight gain, feed conversion ratio (g feed: g gain) and feed cost for the production of 1 kg live body weight of chickens fed meat meal, boiled cowpea and/or boiled black common bean during the starter period are presented in Table 4. The replacement of meat meal in the starter diet of broiler chickens by boiled cowpea and/or boiled black bean induced effect on growth rate. Feed intake and body weight gain for S0 birds was significantly ($P < 0.05$) higher compared to the other treatment groups. Birds fed S1 and S2 diets respectively recorded the lowest feed intake and weight gain. Feed intake and body weight gain for S1, S2 and S3 birds were comparable ($P > 0.05$). No significant ($P < 0.05$) difference was observed between treatment groups for feed conversion ratio (FCR) and the cost of feed for the production of 1kg live weight. No significant ($P > 0.05$) difference was observed as for mortality in the treatment groups.

During the finisher period, feed consumption was significantly ($P < 0.05$) influenced by the starter diets. Birds starter with S0 diet containing meat meal and finished with any of the finisher diets significantly ($P < 0.05$)

Table 1. Characteristics and composition of starter diets.

Ingredients	Diets			
	S0	S1	S2	S2
Maize	540.0	500.0	500.0	500.0
Wheat middling	60.0	27.5	27.5	27.5
$CMAV_{10}$[1]	100.0	-	-	-
Fish meal	60.0	45.0	45.0	45.0
Soya bean meal	110.0	180.0	180.0	180.0
Cotton seed cake	50.0	30.0	30.0	30.0
Ground nut cake	50.0	60.0	60.0	60.0
Palm oil	20.0	25.0	25.0	25.0
Cowpea	-	110.0	-	55.0
Black bean	-	-	110.0	55.0
NaCl	5.0	7.5	7.5	7.5
Oyster shell	5.0	15.0	15.0	15.0
Chemical analysis (%)				
Crude protein	22.032	22.0445	22.0248	22.0346
Crude fibre	4.154	4.3358	4.5448	4.4403
Calcium	0.9864	0.93175	0.93175	0.93175
Phosphorus	0.4946	0.332175	0.332175	0.332175
Lysine	0.946	1.024	1.024	1.024
Methionine	0.333	0.33075	0.33075	0.33075
Energy: Protein	138.23	138.38	138.40	138.39
M.E (kcal/kg)2	3045.42	3050.58	3048.33	3049.43

[1]CMAV10 composition (g kg^{-1}): Protein (520), fat (40), fibre (20), Ca (90), P (37.5), lysine (28), methionine (23), methionine + cystine (28), M.E. (2300 kcal kg^{-1}), vitamin (per 100 kg), A (15 x 10^6 IU), D3 (3 x 10^6 IU), E (3 x 10^4 IU), vitamin (mg kg^{-1}): K3 (26), B1 (25), B2 (60), B6 (25), B12 (0.3), folic acid (120), trace minerals (mg kg^{-1}): Fe (1650), Cu (200), Ze (1300), Mg (850), Se (3).
[2]Metabolizable energy was calculated according to Sibbald (1980) quoted by INRA[16].

sumed more feed and acquired heavier weights compared to the other groups. Feed intake was lowest for birds started with S1 and S3 diets and finished with F3 and F2 finisher diets, respectively. Birds started with S3 diet and finished with F2 diet recorded the lowest body weight gain (624.80 g) whereas birds fed the control diet (S0F0) recorded the highest (1688.41 g) weight gain during. The starter diets significantly ($P < 0.05$) influenced FCR during the finisher period. Birds started with S3 diet and finished with F0 diet recorded the best FCR compared with birds started with S1 and S2 diets and finished with any of the finisher diets $P < 0.05$. Feed conversion ratio was significantly ($P < 0.05$) lower for birds fed S0F0 diet compared to the other groups. The cost of feed for the production of I kg live weight was significantly ($P < 0.05$) higher for birds fed the S2S3 diet whereas the control birds (S0F0) and S0F1 birds had the least cost of production ($P < 0.05$). There was a significant ($P < 0.05$) interaction between the starter (S1 and S2) and the finisher diet for the cost of production of 1 kg body weight. Carcass yield was significantly ($P < 0.05$) affected by the test diets, with the F1 birds recording the highest yield and the F2 birds fed with boiled black common bean the lowest carcass yield. Carcass yield for F2 and F3 birds was comparable (Table 6). The heart, liver and gizzard were significantly ($P < 0.05$) bigger for birds fed diet F2 containing boiled black common bean compared to the others.

DISCUSSION

The decrease observed in the crude protein content of boiled cowpea and boiled black common bean could be attributed to protein denaturation under high temperature and pressure as explained by Wiryawan and Dingle (1999). Feed consumption was significantly ($P < 0.05$) higher for the control birds during the starter and finisher periods suggesting that ant-nutritional factors (ANFs) in the test diets were not completely eliminated through boiling. The poor feed consumption in the starter and finisher periods observed in the present study agrees with the findings of Borget (1989), Tacon (1995), Amaefule and Osuagwu (2005) and Teguia and Beynen

Table 2. Characteristics and composition of the finisher diets.

Ingredients	Diet			
	F0	F1	F2	F2
Maize	565.0	520.0	520.0	520.0
Wheat middling	60.0	32.5	32.5	32.5
CMAV101	100.0	-	-	-
Fish meal	60.0	45.0	45.0	45.0
Soya bean meal	100.0	145.0	145.0	145.0
Cotton seed cake	30.0	30.0	30.0	30.0
Ground nut cake	30.0	30.0	30.0	30.0
Palm oil	40.0	37.5	37.5	37.5
Cowpea	-	140.0	-	70
Black bean	-	-	140.0	70
NaCl	7.5	7.5	7.5	7.5
Oyster shell	7.5	12.5	12.5	12.5
Chemical analysis (%)				
Crude protein	20.047	20.0655	20.0403	20.0529
Crude fibre	3.6065	3.8967	4.1492	4.0162
Calcium	1.07215	0.8227	0.8227	0.8227
Phosphorus	0.47885	0.317475	0.317475	0.317475
Lysine	0.856	0.8815	0.8815	0.8815
Methionine	0.314	0.30225	0.30225	0.30225
Energy: Protein	158.06	158.04	158.10	158.07
M.E (kcal/kg)2	3168.635	3171.175	3168.375	3169.775

[1]CMAV10 composition (g kg^{-1}): Protein (520), fat (40), fibre (20), Ca (90), P (37.5), lysine (28), methionine (23), methionine + cystine (28), M.E. (2300 kcal kg^{-1}), vitamin (per 100 kg), A (15 x 10^6 IU), D3 (3 x 10^6 IU), E (3 x 10^4 IU), vitamin (mg kg^{-1}): K3 (26), B1 (25), B2 (60), B6 (25), B12 (0.3), folic acid (120), trace minerals (mg kg^{-1}): Fe (1650), Cu (200), Ze (1300), Mg (850), Se (3).
[2]Metabolizable energy was calculated according to Sibbald (1980) quoted by INRA[16]

Table 3. Proximate chemical composition of cowpea and black common bean as affected by treatment.

Nutrient	Raw cowpea	Boiled cowpea	Raw black common bean	Boiled black common bean
Crude protein (%)	24.57	23.60	23.40	22.25
Crude fibre (%)	2.70	2.65	4.60	4.55
Crude fat (%)	1.30	2.70	1.20	1.46
Ash (%)	3.60	3.20	3.70	3.40

Table 4. Feed consumption (g), body weight gain (g), feed conversion ratio (g feed : g gain) and feed cost of producing 1 kg live body weight (FCFA) of broilers fed diets containing meat meal, boiled cowpea, and /or black bean during the starter period (1 - 4 weeks).

Diets[1]	Feed consumption	Weight gain ± SEM (g)	Feed conversion ratio (g) feed g^{-1} gain)	Feed cost/kg body weight (FCFA)[2]
S0 (Control)	1303.83[a]	653.69[a]	0.9238[a]	237.45[a]
S1	801.37[b]	351.44[b]	0.8669[a]	213.69[a]
S2	900.51[b]	325.97[b]	0.9400[a]	233.76[a]
S3	875.75[b]	342.11[b]	0.9486[a]	235.06[a]
±SEM (g)	40.33	26.84	0.16	5.52

[1]S0 = Meat meal, S1 = boiled cowpea, S2 = boiled black bean and S3 = 1:1 Mixture of S2 and S3.
[2]1 Euro = 655.95 FCFA
ab: Means in a column with same letter are not significantly different (P>0.05).

Table 5. Feed consumption (g), weight gain (g), feed conversion ratio (g feed : g gain) and feed cost of producing 1kg live body weight (FCFA) of broilers fed boiled cowpea, and /or black common bean during the finisher period (5 - 7 weeks).

Diets[1]	Feed consumption	Weight gain	Feed conversion (ratio (g) feed g^{-1} gain)	Feed cost / kg body weight (FCFA) [2]
SOF0	3383.33±[a]	1688.41[a]	0.654[f]	171.155[f]
S0F1	3308.33[a]	1398.93[c]	0.7207[e]	177.386[f]
S0F2	3291.67[a]	1215.08[c]	0.8131[c]	198.144[de]
S0F3	3364.58[a]	1290.81[bc]	0.7880[d]	195.053[e]
S1F0	2129.58[bc]	936.23[d]	0.7843[d]	205.106[cd]
S1F1	2225.00[b]	866.89[d]	0.8387[b]	206.432[cd]
S1F2	2023.33[cd]	722.06[e]	0.8332[bc]	206.656[cd]
S1F3	1891.67[d]	656.33[e]	0.8096[cd]	200.411[d]
S2F0	2366.67[b]	1032.47[d]	0.8528[b]	218.321[ab]
S2F1	2002.08[cd]	905.68[d]	0.7674[d]	190.650[e]
S2F2	2041.67[bcd]	754.43[e]	0.8645[b]	216.928[ab]
S2F3	2177.08[bcd]	769.22[e]	0.9266[a]	226.100[a]
S3F0	2135.42[bcd]	1022.61[d]	0.7335[e]	191.817[e]
S3F1	2214.58[bcd]	925.85[d]	0.8116[c]	199.765[de]
S3F2	1879.17[d]	624.80[e]	0.8556[b]	212.227[bc]
S3F3	1958.33[cd]	716.40[e]	0.8503[b]	210.459[bc]
SEM (g)	91.75	50.09	0.01	6.16

[a,b,c,d,e,f]: Means in the same column with the same superscript are not significantly different (P>0.05).

Table 6. Effect of heat-treated cowpea (Vigna unguiculata L Walp) and or common black bean (Phaseolus Vulgaris) on carcass characteristics (% body weight).

Characteristics (% BW)	Diet			
	F0	F1	F2	F3
CY_1	63.30±2.08[ab]	65.60±2.85[a]	62.46±3.323[c]	63.92±2.27[bc]
Heart	0.41±14[b]	0.44±0.15[b]	0.50±0.166[a]	0.43±0.12[b]
Liver	2.28±0.39[b]	2.27±0.24 [b]	2.67±0.38[a]	2.40±0.31[a]
Gizzard	2.75±0.37[b]	3.02±0.32[a]	3.07±0.37[a]	2.92±0.24[ab]

[a,b,c]: Means in a row with same letter are not significantly different (P>0.05).

(2005). These authors observed poor feed intake of broiler birds fed raw Bambarra groundnut (*Vigna subterr-anean* (L) Verdc), cowpea and black common bean and attributed the poor feed intake to the presence of ANFs in the legume grains (Table 5). Weight gain was lower and feed conversion ratio was poorer in all the treatment groups during the starter period including the control compared to suggestion by the Societé de Provenderies du Cameroun (SPC) hatechery (1997). The low weight gain and FCR obtained could be attributed to the poor accessibility of nutrients in the diets by enzymes and the treatment method used in detoxifying the test grains as explained by Kracht et al. (1999). However, the results obtained for FCR during the starter period were the best compared to the results obtained by Teguia et al. (2003) who fed broiler birds with raw cowpea and raw black common bean. The replacement of meat meal in the starter diet of broiler chickens by meals of boiled cowpea and/or boiled black common bean induced a deteriorating effect on the growth performance at finish-ing, feed consumption values obtained for birds started with S0 diet and finished with any of the finisher diets were within the range considered normal for broiler birds (Duc, 1998) but higher than the recommended value SPC (1997). The higher feed consumption recorded with birds started with meat meal diet (S0) and finished with any of the finisher diets, confirmed that older birds can tolerate ANFs better than young chicks. The depressive effect on weight gain induced by boiled black common bean observed with chicks fed S1F3 and S3F2 diets could be due to the inability of the treatment method to properly deactivate the ANFs (protease and lectins inhibitors) present in the black common bean that are responsible for weight depression The results obtained for weight gain in the present study are better for birds fed with diet F1 containing boiled cowpea compared with the work of Amaefule and Osuagwu (2005) when raw bambara groundnut were used to replace maize in broiler starter and finisher diets. Generally, birds fed the test diets during the finisher period improved on their body weight gain compared to the control birds. This is due to the beneficial influence of the animal age on the nutritional value of black common bean as explained by Jaffe (1973) and the compensatory growth effect of chick (Leeson and Summer, 1997). However, at finishing, the results obtained for FCR and feed cost for the production of 1 kg body weight in all the groups were far lower compared to values indicated by the hatchery SPC (1997). This is probably due to poor feed consumption associated with poor weight gain. The replacement of meat meal by leguminous grains resulted in a cheaper feed but the benefits in feed cost due to the inclusion of leguminous grains were undermined by poor FCR

The carcass yield recorded for all the treatment groups were lower than the range suggested by Jourdain (1980). However, the proportion of the heart, liver and gizzard were higher for birds fed with the test diets. Similar results were previously reported by Teguia et al. (2003) when birds of same strain were fed raw cowpea and Bambara groundnut and the low carcass yield was attributed to the presence of ANFs in the diet. The increase in the size of liver and gizzard was related to increased activity to overcome the effect of toxic anti-nutritive compounds in the diets not totally destroyed by boiling. Cowpea and black common bean boiled for 30 min under uncontrolled temperature and pressure could not be recommended for broiler's diet formulation.

ACKNOWLEDGEMENT

The authors are grateful to Mr. Fonge Philip for assistance during the publication of this article.

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