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Effect of Cowpea (*Vigna unguiculata*) Grain on Carcass Characteristics of Cobb 500 Broiler Chickens

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Introduction: There is a need to search for locally available alternative sources of protein to use as feed for poultry. The possible sources of protein for poultry are the grains of legume plants. Grains of legume plants are characterized by protein that contains high level of lysine and low level of methionine. Cowpea as well as other peas can be excellent sources of dietary protein in animal nutrition.

The highest source of protein which is soybean does not produce in Tigray National Regional State. On the other side, the small scale poultry production has increased from time to time. In this case, feed source is the major challenging in the small scale poultry production in our region especial in the Central Zone of Tigray. Hence this study is designed to evaluate the recently introduced cowpea (*Vigna unguiculata*) variety in the region as a source of protein for poultry and evaluate its effect on carcass characteristics of Cobb 500 chickens with the following specific objectives:

Objective:

- To evaluate the effect of feeding different inclusion levels of cowpea grain on carcass characteristics of Cobb 500 Broiler chickens.

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- To evaluate the effect of different inclusion levels of cowpea grain on lameness of Cobb 500 broiler chickens.

Methodology: 300 day old Cobb 500 broiler chicks were used for the experiment. They were distributed randomly in to 20 pens with 15 chicks per replication. Five different feed treatments were used to evaluate the carcass characteristics of Cobb 500 broiler chickens fed different inclusion levels of cowpea grain for the life time of 49 days. The research was conducted using completely randomized design (CRD). Inclusion levels of cowpea grain in the treatments were 0% (T_1), 5% (T_2), 10% (T_3), 15% (T_4) and 20% (T_5). At the end of the experiment four birds 2 male and 2 female from each replication were taken to evaluate carcass characteristics of Cobb 500 broiler chickens.

Results: The result of the study revealed that, there was no significant difference on carcass yield, and gut parts of male and female Cobb 500 broiler chickens except for drumstick weight and drumstick percentage greater in male, whereas, abdominal fat percentage was significantly ($P<0.05$) higher for female than male broiler chickens. Lameness was occurred in all treatment, T_1, T_2, T_3, T_4 and T_5 which was 15%, 11.67%, 10%, 13.33%, 15%, respectively.

Conclusion and Recommendation: This study indicated that inclusion of cowpea from 5-20% in the diet of broiler chickens have no adverse effect on carcass characteristics of Cobb 500 broiler chickens. Whereas, effect of cowpea inclusion on layer's and dual purpose chickens performance needs further investigation.

Keywords: Broiler; carcass characteristics; cowpea grain; lameness.

1. INTRODUCTION

Domestic chicken plays a significant role in capital build up, food security attainment, malnutrition, poverty, and hunger reduction [1]. They also have social, cultural and religious importance, and improve growth, mental development, school performances and labor productivity, and reduce the likelihood of illness among the small-scale farmers' children through diversification of consumable foods [2]. In addition, poultry production plays a major role in bridging the protein gap in developing countries where average daily consumption is far below recommended standards [3].

The productivity of poultry in tropics has been limited by scarcity and consequent high prices of the conventional protein and energy sources. Protein sources are especially limiting factors in poultry feed production in the tropics [4].

There is a need to search for locally available alternative sources of protein to use as feed for poultry. The possible sources of protein for poultry are the grains of legume plants. Grains of legume plants are characterized by protein that contains high level of lysine and low level of methionine [5]. Many locally available source of protein and energy like grains of legume plants, contribute in the supply of poultry industry in Africa [5]. Cowpea varieties are temperature and drought tolerant crop and requiring low input costs and are well adapted to the arid and semi-arid agro-ecologies. Cowpea as well as other peas can be excellent sources of dietary protein in animal nutrition [6], especially where animal proteins are in short supply and expensive [7].

Intercropping of cowpea has practiced in the Tigray National Regional State since long time, which was used as sources of feed for animals and for soil fertility improvement. Intercropping this legume with maize and sorghum used to improve soil fertility as well as increase productivity and striga control [8]. An indicator of its suitability in the region, recently, a new variety has been released from Humera Agricultural Research Center. The herbage parameters were evaluated in detail and the result showed that, except dry matter, neutral detergent fiber and acid detergent fiber all the other parameters were significant and the mean grain yield of this genotype were 30.6 quintals per ha in three consecutive years [9]. This variety also tried to adapt in the central zone of Tigray and its performance was very promising.

Therefore, this variety can be used as a potential alternative source of feed that can be incorporated into the diets of poultry as a means of reducing high cost of conventional protein sources [10]. This cultivar (Temesgen) is better in its performance as compared with the local legumes as well as than pigeon pea which are produced in our region. The highest source of protein which is soybean does not produce in Tigray National Regional State. On the other side, the small scale poultry production has increased from time to time. In this case feed source is the major challenging in the small scale poultry production in our region especial in the

Central Zone of Tigray. Hence this study was designed to evaluate the recently introduced cowpea (*Vigna unguiculata*) variety in the region as a source of protein for poultry and evaluate its effect on carcass characteristics of Cobb 500 chickens with the following specific objectives:

- To evaluate the effect of feeding different inclusion levels of cowpea grain on carcass characteristics of Cobb 500 Broiler chickens
- To evaluate the effect of different inclusion levels of cowpea grain on lameness of Cobb 500 broiler chickens

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was carried out in Axum town central zone of Tigray National Region State, Northern Ethiopia. Central Zone of Tigray is one of the six zones in the Tigray National Regional State 1024 km far away from Addis Abeba and 241 km far from Mekelle capital city of Tigray. The altitude of the zone mainly falls within the category of 2000 to 3000 m.a.s.l. The larger part of the zone receives mean annual rainfall ranging from 400 to 800 mm. The mean monthly maximum and minimum temperatures of the zone are 30^{o}C and 10^{o}C, respectively.

2.2 Experimental Feed Ingredients and Treatments

The feed ingredients used in the formulation of the different experimental rations for the study were corn grain, wheat middling, noug seed cake (NSC), soybean meal (SBM), cowpea grain (CSM), vitamin premix, salt, lime stone, di-calcium phosphate, L-lysine and D-methionine. All the ingredients except SBM, wheat middling, vitamin premix, salt, limestone, dicalcium phosphate, L-lysine and d-methionine were also milled in a 5 mm sieve size.

Treatments were: Treatment one (T1), 0% CG; Treatment two (T2), 5% CG; Treatment three (T3), 10% CG; Treatment four (T4), 15% CG and treatment five (T5), 20% CG.

The rations were formulated to be iso-caloric and iso-nitrogenous with recommended metabolizable energy (ME) content 3000 kcal ME per kg DM and 22% CP for the starter phase (0-21 days of age) and 3200 kcal per kg DM and 20% CP for the finisher phase (22 to 49 days of age) by using feed win software.

2.3 Management of Experimental Birds and Design

Three hundred unsexed Cobb 500 broiler chickens were randomly divided into five dietary treatments and four replications per treatment in a completely randomized design with 15 chicks per replicate or pen. The pens were prepared by using a Eucalyptus (local material) and wire mesh (industrial material) 3m by 1.5m with the assumption of required space for finisher. The birds were vaccinated against Newcastle (HB1 at day 7 with an eye drop, Lasota at day 21 with drinking water) and Infectious Bursal Disease (Gumboro) at the age of 14 and 28 days all were given with drinking water. Before the commencement of the actual experiment, the experimental pens were cleaned and disinfected 14 days before the arrival of the chicks by using disinfectants and fumigated by using formaldehyde solution and calcium phosphate powder. Watering and feeding troughs were thoroughly prepared and cleaned 24 hours before the arrival of the chicks. The temperature of the house was made desirable 12 hours before the arrival of the chicks. Its desirability was estimated by using thermo-hydrometer and digital room temperature measurement. Immediately after arrival, the chicks were brooded using 250 watt infrared electric bulbs with gradual height adjustment as sources of heat and light in a deep litter house covered with Tef straw mixed with the sawdust litter material. Clean water and feed were offered ad libitum all the time throughout the experiment.

2.4 Measurements and Data Collection

The experimental time was taken 49 days, because they were broiler chicken breeds. The amount of feed offered and refused per pen was recorded daily. The amount of feed consumed was calculated as the difference of feed offered and refused. Feed offered and refused were sampled daily per pen and was pooled per treatment for the entire experimental period for chemical analysis. Lameness was recorded by assessing the condition of the chickens every morning. In general, health status was monitored throughout the experiment with the help of veterinarian professionals. At the end of the experiment, four randomly selected birds two male and two female from each replication were deprived for 12 hours, and they were weighed immediately before slaughter and they were exsanguinated by severing the neck. After slaughtering, the birds were dry de-feathered by

hand plucking. Birds were eviscerated and carcass cuts and non-edible offal components were determined according to the procedure described by Kubena et al. [11]. Dressed carcass weight was measured after the removal of blood and feather and the dressing percentage was calculated as the proportion of dressed carcass weight to Pre- slaughter weight multiplied by 100. Eviscerated carcass weight was determined after removing blood, feather, lower leg (shank), head, kidney, lungs, pancreas, crop, proventriculus, small intestine, large intestine, caeca and urogenital tracts from dressed carcass. The eviscerated percentage was then determined as the proportion of the eviscerated weight to pre-slaughter weight multiplied by 100. From eviscerated carcass weight drumstick, thigh and breast meat were separated and weighed. Then, their weight were divided by pre-slaughter weight and multiplied by 100 to determine percentage weights of each component. Sex difference were compared based on the slaughter weight, dressing percentage, eviscerated weight, abdominal fat percentage and gut parts of male and female.

2.5 Laboratory Analysis

Feed ingredients and samples of feed offered and refusal of the formulated diets from the respective treatments were analyzed for Dry Matter (DM), Crude protein, Crude Fiber (CF), Ether Extract (EE) and Total Ash [12]. Calcium and total phosphorus content were also determined by atomic absorption and vanado-molybdate method, respectively [13]. Metabolizable energy (ME) content of the experimental diets were determined according to Wiseman [14] as: ME (kcal/kg DM) = 3951+54.4EE-88.7CF-40.80Ash. Chemical analyses were conducted at Jije laboclass and Ethiopian public health institute Addis Ababa.

2.6 Data Analysis

Data was analyzed using the general linear model (GLM) procedures of Statistical Analysis Systems software [15] with the model containing treatments for data other than carcass characteristics. One-way Analysis of variance (ANOVA) was used to compare the treatment means of the group and for the existence of significant differences among treatments, the differences between treatment means was separated using the Tukey Kramer test at $P < 0.05$ was used.

The following model was used for the experiment [16]

a) $Yij = \mu + Si + eij$

Where,

Yij = Overall Responses
μ = overall mean
Si = i^{th} effect of sex difference
eij = random error effect

3. RESULTS AND DISCUSSION

3.1 Chemical Composition of Feed Ingredients

The results of laboratory analysis for the different feed ingredients and formulated experimental rations are shown in Table 2. In this experiment, the laboratory result showed that, Cowpea grain was contained 25.76% CP and 89.94 % DM, 6.22% CF, 1.65% EE, 4.6% ash, 3307.37 kcal/kg DM ME, Tannin content 0.75 g/kg DM and Phytate 1.5 g/kg DM respectively. This makes the cowpea grain is a good sources of protein and energy for poultry production, which can contribute towards overcoming the predicted protein content. Chemical composition of cowpea seed might differ mainly due to variety, treatments and environmental factor. The result of the chemical analysis of cowpea in the current experiment was in line with the finding of Tshovhote [17] that protein content was ranged from 25.35 % to 26.43% CP for the three cultivars (Glenda, Agrinawa and Indigenous cowpea) respectively and 90.7, 90.2 and 90.15% DM were found respectively in the three cultivars. The same researcher reported that, the CF content of the three cultivars ranged from 5.15 to 5.81%. Muamer et al. [18] also reported that the raw cowpea contain 24.78%, 93.66%, 0.91%, 3.46%, 3.33%, 3153 for CP, DM, EE, CF, Ash and ME kcal/kg DM respectively. Except DM content, all the other chemical compositions were below the current results. In addition to this, the current proximate composition result was within the range of other authors' result who worked on different varieties of cowpea seed [19] whereas greater than reported by Abdelatief and El-Jasser [20] in all parameters tested in the current experiment. Generally cowpea genotypes are highly variable for seed protein and its soluble fraction contents [21]. The same researcher reported that, a variation of CP from 20.79 to 31.78% among different varieties of cowpea seeds. The similarities and the differences of chemical composition between cowpea in this experiment and other reports might be due to variety differences.

Table 1. Chemical composition of feed ingredients used to formulate the experimental ration

Nutrients	Feed Ingredients				
	Maize grain	Noug seed cake	Wheat middling	Cowpea grain	Soybean meal
DM (%)	90.69	92.86	91.15	89.94	94.17
CP (% DM)	8.46	32.26	16.89	25.76	40.04
CF (% DM)	3.45	17.51	8.15	6.22	6.14
EE (% DM)	3.9	7.14	4.77	1.65	10.8
Ash (% DM)	3.28	9	4.36	4.6	5.5
ME(Kcal/kg DM	3223.65	2419.08	3309.7	3307.37	3769.5
Ca (% DM)	0.04	0.33	0.27	0.15	0.61
P (% DM)	0.46	0.67	1	0.5	0.68
Tannin(g/kg DM)				0.75	
Phytate (g/kg DM)				1.5	

DM= Dry Matter, CP= Crude Protein, CF= Crude Fiber, EE= Ether Extract, ME= Metabolizable Energy, Ca= Calcium and P= Phosphorus

Table 2. Proportion of ingredients used in formulation of broiler starter and finisher rations

Ingredients	Treatments									
	Starter					Finisher				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
Maize	33	31	29.5	29	29	46	43.2	42.3	41	40
Noug seed cake	28.1	27	26.5	26.5	26.2	22.6	22.4	21.6	20	18.6
Wheat middling	21.5	21.5	20.7	18.1	15	14.4	14	13	11.6	10.6
Cowpea grain	0	5	10	15	20	0	5	10	15	20
Soybean meal	13	11.2	9	7	5.5	13	11.4	9.2	8.5	7
Di calcium phosphate	1	0.9	0.9	1	0.9	0.8	1	1	1	1
Limestone	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5
Vitamin premix	1	1	1	1	1	1	1	1	1	1
Lysine	1	1	1	1	1	0.8	0.7	0.6	0.6	0.5
Methionine	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Treatment1= 0% inclusion of cowpea grain, Treatment2= 5% inclusion of cowpea grain, Treatment3= 10% inclusion of cowpea grain, Treatment4= 15% inclusion of cowpea grain, Treatment5= 20% inclusion of cowpea grain

Table 3. Chemical composition of the starter and finisher rations of Cobb 500 broiler chicken

Chemical composition	Treatments									
	Starter					Finisher				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
DM	92.21	92.07	91.94	91.83	91.71	92.02	91.92	91.78	91.67	91.54
CP	21.87	21.91	21.9	21.9	21.97	19.75	19.93	19.74	19.89	19.78
CF	8.61	8.55	8.52	8.48	8.39	7.52	7.56	7.49	7.32	7.17
EE	5.72	5.45	5.16	4.89	4.64	5.5	5.26	4.97	4.74	4.75
Ash	5.26	5.23	5.21	5.2	5.19	4.89	4.9	4.86	4.81	4.75
ME(Kcal/kg DM)	3070	3072	3061	3046	3045	3195	3174	3169	3179	3184
Ca	1.05	1.02	1.01	1.02	0.99	1.01	1.02	1	1	0.99
P	0.82	0.8	0.79	0.79	0.76	0.74	0.77	0.76	0.75	0.74

DM= Dry Matter, CP= Crude Protein, CF= Crude Fiber, EE= Ether Extract, ME= Metabolizable Energy, Ca= Calcium and P= Phosphorus, Treatment1= 0% inclusion of cowpea grain, Treatment2= 5% inclusion of cowpea grain, Treatment3= 10% inclusion of cowpea grain, Ttreatment4= 15% inclusion of cowpea grain, Treatment5= 20% inclusion of cowpea grain

Table 4. Carcass yield characteristics of Cobb 500 broilers chickens fed different inclusion levels of cowpea grain 1-49 days of the trail period

Parameters	Treatments					
	T1	T2	T3	T4	T5	SEM
Slaughter weight (g)	1727.75	1719.63	1816.25	1753.75	1702	16.4
Dressed carcass weight	1562.88	1549.13	1554.5	1570.63	1532.63	17.1
Dressed percentage	90.5	90.1	85.6	89.5	90.2	0.84
Eviscerated weight (g)	1120.5	1098.13	1123.25	1136	1073.38	13.5
Eviscerated percentage	64.9	63.8	61.8	64.7	63.4	0.65
Breast meat (g)	406.63	413.63	418.38	425.13	399.5	6.9
Breast percentage	23.5	24	23	24.2	23.5	0.31
Thigh weight (g)	185	184	183.25	195.13	183.38	3.04
Thigh percentage	10.7	10.7	10.1	11.1	10.8	0.15
Drumstick weight (g)	152.3	148	151.3	154.5	145.3	2.4
Drumstick percentage	8.8	8.6	8.3	8.8	8.5	0.1
Fat percentage	1.53	1.66	1.27	1.31	1.89	0.11

g=gram; Treatment1= 0% inclusion of cowpea grain; Treatment2= 5% inclusion of cowpea grain; Treatment3= 10% inclusion of cowpea grain; Ttreatment4= 15% inclusion of cowpea grain; Treatment5= 20% inclusion of cowpea grain, SEM= Standard Error of Mean

Table 5. Weight of the gut parts of Cobb 500 broiler chickens fed ration containing different levels of cowpea grain

Parameters	Treatments					
	T1	T2	T3	T4	T5	SEM
Esophagus weight (g)	3.0	2.88	3.13	3.3	2.75	0.26
Crop weight(g)	6.6	7.5	6.9	8.1	7.8	0.3
Proventriculus weight (g)	8.9	8.9	8	8.3	7.5	0.31
Gizzard weight (g)	28.38	27.88	25.75	28.25	28.25	0.54
Small intestine weight(g)	54.1	42.8	45.3	45.3	54.1	1.36
Large intestine weight(g)	2.0	2.4	2.1	2.0	2.4	0.104
Caeca weight (g)	6.4	5.8	5.1	6	5.8	0.24

g=gram; Treatment1= 0% inclusion of cowpea grain; Treatment2= 5% inclusion of cowpea grain; Treatment3= 10% inclusion of cowpea grain; Treatment4= 15% inclusion of cowpea grain; Treatment5= 20% inclusion of cowpea grain, SEM= Standard Error of Mean

3.2 Carcass Parameters

The characteristics of carcass yield of Cobb 500 broiler chickens fed different inclusion levels of cowpea grain is shown below on Table 4. No significant (P>0.05) difference was found among carcass parameters, gut parts and abdominal fat percentage between broilers fed different levels of cowpea grain and the control ($Treatment_1$).

The current finding was in agreement with Chakam et al. [22] who found that no significant difference was detected on carcass characteristics of male finisher Hubbard broiler chickens fed different inclusion levels (0, 15, 20, 25 and 30%) of cooked cowpea grain. In addition to this, an experiment conducted on socked pigeon pea seed and cooked mucuna utilis grain for substitution of soybean meal at different level were no significant influence between treatments on slaughter weight, dressing percentage and organs weight [23]. However, the current results contradicted with report of Fakolade et al. [24] who found a significant (P<0.05) difference in the percentage weight of breast and drumstick which fed graded levels (0, 15, 30 and 50%) of cowpea testa meal to the substitution of soybean for broiler chickens diet. The similarities and differences might be depends on the nutritional content of the diet, management of birds, environmental factors in relation to temperature and humidity and sex composition of birds in treatment groups.

3.3 Gut Parts

Weight of gut parts of Cobb 500 broiler chickens fed ration containing different levels of cowpea grain presented on Table 5. There were no significant (P>0.05) difference on the weight of

gut parts across broiler fed different levels of cowpea and the control (T_1). This result is contradict with the report of Fakolade et al. [24] who found that as inclusion level of cowpea testa meal increased weight of intestine and gizzard were also increased. The author concluded that this might be due to the bulkiness of fiber in the cowpea testa. In the current study as inclusion level increased fiber content almost similar across treatment groups. Therefore, the difference between current results and previous results might be due to diet formulation uniformity across treatment groups.

3.4 Sex

Effect of sex on slaughter weight, carcass characteristics and weight of gut parts of Cobb 500 broiler chickens fed different inclusion levels of cowpea grain is shown on Table 6. There were no significant (P>0.05) difference between male and female on response to the different inclusion levels of cowpea grain in all carcass parameters and gut parts except for drumstick weight, drumstick percentage and abdominal fat percentage. The present study was in line with the finding of Etalem et al. [25] who found that there was no significant difference in the primal carcass cuts in female and male broiler chickens. The current result contradict with the result of Radu-Rusu et al. [26] who found that significant difference at 42 days old, male and female Cobb 500 broiler chickens reach live weight of 2295.75 g 2168.57g respectively, which was greater than the current finding. Drumstick weight, drumstick percentage and fat percentage were significantly ($p<0.05$) different between male and female in this study. Similarly, drumstick weight and drumstick percentage were significant different in Hubbard broiler chickens fed different levels of Moringa olifera leaf meal [25] which was in agreement with the current finding. In the current study abdominal fat percentage was also significantly higher in female than in male Cobb 500 broiler chickens agreed with the report of Beg et al. [27] who observed a significant difference in abdominal fat percentage greater in female than male Cobb 500 broiler chickens. On the other hand, Etalem et al. [25] was not found a significant difference in abdominal fat percentage between male and female broiler chickens. Generally sex of birds influenced the deposition fat tissues between depots which male broiler chickens tended to deposit more of their fat to carcass fat depots than female broiler chickens which tended to deposit more of their fats to non-carcass fat depots [28].

Table 6. Effect of sex on slaughter and carcass characteristics of Cobb 500 broiler chickens fed different inclusion levels of cowpea grain

Parameters	sex		
	M	F	SEM
Slaughter weight	1749.2	1738.55	16.43
Dressing weight	1556	1551.9	15.8
Dressing percentage	89.6	88.8	0.72
Eviscerated weight	1115.35	1105.20	13.33
Eviscerated percentage	63.80	63.61	0.61
Breast weight	421.10	404.30	6.94
Breast percentage	24.1	23.25	0.31
Thigh weight	187.85	184.45	3.11
Thigh percentage	10.81	10.54	0.16
Drumstick weight	155.65[a]	144.85[b]	2.2
Drumstick percentage	8.96[a]	8.29[b]	0.12
Fat percentage	1.30[b]	1.76[a]	0.11
Esophagus weight	3.15	2.7	0.24
Crop weight	7.25	7.5	0.3
Proventriculus weight	8.1	8.5	0.27
Gizzard weight	27.95	27.45	0.60
Small intestine weight	46.95	45.5	1.3
Large intestine weight	2.15	2.2	0.14
Caeca weight	5.85	5.75	0.2

[a-b] Means within a row and within treatment or sex with different superscripts differ significantly (P<0.05), M= Male, F= Female and SEM=Standard Error of Mean

3.5 Lameness

There was occurred a phenomenon of lameness in all treatment, T_1, T_2, T_3, T_4 and T_5 which was 15%, 11.67%, 10%, 13.33% and 15%, respectively starting from week three. It was increased as the age of the birds increase. Lameness in broiler chickens occurred in relation to lack of the micro mineral (Na^+, K^+ and Cl^-) in the diet, due to unbalanced growth of muscle and bone. In this case due to genetic selection meat chickens are fast grower, as a result they deposit large amount of muscle which is above the capacity of the bone. Finally lameness has been occurred as a major problem in broiler production. In the most recent large-scale broiler production studied in the United Kingdom found that 27.7 percent of the birds assessed closed to slaughter age (40 days) showed poor locomotion, and 3.3% were also unable to walk [29]. Other authors also reported that, selection for faster and short fattening period results in increased in skeletal disorder which related to transient difficulty during the phase of fast growth of long bones, especially the tibia, since the proximal tibia is the site of the most fast growing growth plate [30].

4. CONCLUSION

Based on the current study, it is possible to conclude that inclusion of cowpea grain up to 20% on the diet of Cobb 500 broiler chickens did not have an adverse effect on carcass characteristics of broiler chickens. It can be replace expensive protein feed source such as soybean without adversely affecting carcass characteristics of Cobb 500 broiler chickens up to 20% inclusion level. Therefore, levels of inclusion from 5-20% can be used as an alternative protein sources in broiler diet.

5. RECOMMENDATIONS

- To fully exploit the use of cowpea feed for broilers, different methods of reducing anti-nutritional factors in the seed needs to be investigated.
- Effect of cowpea inclusion on layer's and dual purpose chickens performance needs further investigation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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