Gliricidia leaf meal in Broiler Chickens Diet: Effects on Performance, Carcass, and Haemato-biochemical Parameters

ABSTRACT

Aims: This study seeks to access the influence of Gliricidia leaf meal on broiler chickens' growth performance, carcass traits, and haemato-biochemical parameters.
Study design: Completely randomized design.
Place and Duration of Study: The 56-day feeding trial was carried out at the Teaching and Research Farm of Agricultural Technology Department, The Federal Polytechnic, Ado Ekiti, Nigeria.
Methodology: Fresh *Gliricidia sepium* leaves were harvested, shade dried and milled to produce leaf meal. Three diets were formulated to contain *Gliricidia sepium* leaf meal (GLM) at 0 (control), 5 and 10 % level. A total number of 144 day-old chicks of arbor acre were assigned to 3 dietary treatments of 3 replicates of 16 chicks per replicate in a completely randomized design experiment.
Results:
The total weight gain and total feed intake was lower (P<0.05) in broiler chicken fed 10% GLM inclusive diet (1890.48 g/b and 5188.90 g/b) compare to the total weight gain and total feed intake of those fed the control (2188.04 g/b and 5754.14 g/b) and 5% GLM inclusive diet (2154.31 g/b and 5579.04 g/b). The slaughter weight, dressed weight and dressed percentage of birds fed 10% GLM inclusive diet were lower (P<0.05) than those fed the control and 5% GLM inclusive diets. The liver, kidney and gizzard relative weights were higher (P<0.05) in the birds fed 10% GLM inclusive diet compared to those fed rest diets. The white blood cell count of birds fed control diet and 5% GLM inclusive diet were similar (P>0.05) but significantly (P<0.05) lower than white blood cell counts of birds fed 10% GLM inclusive diet. The cholesterol levels of birds fed GLM inclusive diets (5 and 10%) were lower (P<0.05) compare to those birds fed the control diet.
Conclusion: The dietary gliricidia leaf meal at 5% inclusion level supports normal body weight gain, feed intake, carcass traits and normal health status of the rabbits.

Keywords: Gliricidia sepium; leaf meal; broiler; growth; carcass; cost.

1. INTRODUCTION

Poultry production has the good potential to bridge the protein gap in Nigerian diets because the high yielding exotic poultry breeds are easily adaptable to our environment, the relatively simple production technology required for their production is available and the return on investment is appreciably high [1]. However, feeding which accounts for 70 to 85 percent of the production cost of poultry [2] is an important aspect of livestock production. Therefore, judicious use of feed can enhance animal productivity and also reduce the cost of production [3,4].
The poultry production in Nigeria is experiencing declination and on the brink of collapse [5]. According to Esonu *et al* [6], about 30% of poultry farms in Nigeria are forced to reduce their production capacity while more than 50% have closed down due to shortage and a high price of feed [4]. This has also resulted in the reduction in the affordability of the poultry products by the average Nigerians. The price of concentrates like groundnut cake, fish meal and soybean meal which are the major conventional protein sources have soared so high that it is becoming uneconomical to use then in livestock feeds [6, 7]. It is therefore imperative to use unconventional or locally available and cheap feed resources that do not attract competition in consumption between humans and livestock in place of the more expensive conventional feed resources.
Leaf meal of some tropical legumes and browse plants could be a cheap source of protein [1, 7, 8]. Leafy vegetables have been found to be the rich source of protein/amino acids, vitamins and minerals [9, 10]. Earlier reports have established that leafy vegetables are cheapest and most abundant source of proteins because of their ability to synthesize amino acids from a wide range of available primary materials such as water, carbon dioxide and atmospheric nitrogen [11].
Gliricidia has the potential of producing large quantities of high-quality forage matter all- year round [12]. Leaf meal from *Gliricidia sepium* has high feeding value with crude protein of 20-30% of dry matter, the crude fibre of 15% and in-vitro digestibility of 60-65% [13]. The high quality of calcium and

adequate concentration of other mineral elements of Gliricidia leaf also makes it a potential feedstuff for poultry [14].
In a study conducted by Kagya-Agyemang *et al* [15], carcass dressing percentage of the birds fed control diet was comparable with those birds fed 10% Gliricidia leaf meal inclusive diet. Odunsi *et al* [14] in their report recommended 5% Gliricidia leaf meal inclusion for the laying hen while Oloruntola et al., [8] recommended 5% Gliricidia leaf meal for broiler chicken starter. The physiological life stage of the birds has an effect on their response to feed and there is dirt of information on the effect of dietary Gliricidia leaf meal on performance, carcass, haematological and serum biochemical indices of broiler chicken [8]. This study, therefore, seeks to evaluate the effects of Gliricidia leaf meal on broiler chicken using growth performance, carcass traits, haematological and serum biochemical indices as response criteria.

2. MATERIAL AND METHODS

2.1 Experimental Site

This feeding trial was carried out at the Poultry Unit of the Teaching and Research Farm, Agricultural Technology Department, The Federal Polytechnic Ado Ekiti. Nigeria. The study area is located between latitudes 7°37´N and 7°12´N and longitudes 5°11´E and 5°31´E. The mean annual rainfall is 1247 mm with relative humidity from between 70 to 85%. The location is situated at about 437 mm above sea level with a mean annual temperature of 26.2°C.

2.2 Experimental Diets

The *Gliricidia sepium* leaves were harvested fresh from Teaching and Research Farm of the Agricultural Technology Department, The Federal Polytechnic Ado Ekiti. Nigeria and spread lightly on clean tarpaulin under the shed. The shade-dried leaves were milled using hammer mill to produce gliricidia leaf meal (GLM) and stored in sacks under room temperature prior to laboratory analysis and usage.
Thereafter, a basal diet (diet 1) was formulated for each phase (starter and finisher) to meet the NRC [16] minimum requirement broiler chicken. Two other diets (diets 1 and 2) were formulated to contain *Gliricidia sepium* leaf meal at 5 and 10% level, respectively. All the diets were isocaloric and isonitrogenous (Table 1 and 2). The compositions of GLM were determined according to AOAC [17] methods. The cyanide content was determined by the silver nitrate method [18], while tannin was determined as described by Makkar and Goodchild [19].

Table 1. Gross composition of the starter phase diets

Ingredients (%)	Diet 1	Diet 2	Diet 3
Maize	59.00	56.20	53.40
Gliricidia Leaf meal	0.00	5.00	10.00
Soybean meal(42%CP)	17.00	14.80	14.00
Groundnut cake	15.30	15.30	13.70
Fish meal	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00
Oyster shell	0.50	0.50	0.50
Premix*(vitamins/minerals)	0.25	0.25	0.25
Methionine	0.30	0.30	0.30
Lysine	0.15	0.15	0.15
Salt	0.30	0.30	0.30
Vegetable oil	0.20	0.20	0.40
Total	100	100	100
Calculated analysis (%)			
Crude protein	23.63	23.83	24.00
Crude fibre	3.72	3.76	4.21
Calcium	1.38	1.38	1.38
Phosphorus	0.59	0.59	0.59

Metabolizable energy (kcal/kg)	3049.26	3026.55	3016.69

*Contained vitamins A (8,500,000 IU); D3 (1,500,000 IU); E (10,000mg); K3 (1,500mg); B1 (1,600mg); B2 (4,000mg); B6 (1,500mg); B12 (10mg); Niacin (20,000mg); Pantothenic acid (5,000mg); Folic acid (500mg); Biotin H2 (750mg); Choline chloride (175,000mg); Cobalt (200mg); Copper (3,000mg); Iodine (1,000mg); Iron (20,000mg); Manganese (40,000mg); Selenium (200mg); Zinc (30,000mg); and Antioxidant (1,250mg) per 2.5kg

Table 2. Gross composition of the finisher phase diets

Ingredients (%)	**Diet 1**	**Diet 2**	**Diet 3**
Maize	56.00	54.00	53.00
Gliricidia Leaf meal	0.00	5.00	10.00
Soybean meal(42%CP)	12.80	11.80	10.80
Groundnut cake	12.00	11.00	11.00
Wheat offals	9.00	8.00	5.00
Fish meal	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00
Oyster shell	1.00	1.00	1.00
Premix*(vitamins/minerals)	0.25	0.25	0.25
Methionine	0.30	0.30	0.30
Lysine	0.15	0.15	0.15
Salt	0.30	0.30	0.30
Vegetable oil	0.20	0.20	0.20
Total	100	100	100
Calculated analysis (%)			
Crude Protein	21.08	21.06	21.30
Crude fibre	3.39	3.78	4.04
Calcium	1.80	1.80	1.79
Phosphorus	0.78	0.76	0.72
Metabolizable energy (kcal/kg)	2862.72	2860.49	2893.00

*Contained vitamins A (8,500,000 IU); D3 (1,500,000 IU); E (10,000mg); K3 (1,500mg); B1 (1,600mg); B2 (4,000mg); B6 (1,500mg); B12 (10mg); Niacin (20,000mg); Pantothenic acid (5,000mg); Folic acid (500mg); Biotin H2 (750mg); Choline chloride (175,000mg); Cobalt (200mg); Copper (3,000mg); Iodine (1,000mg); Iron (20,000mg); Manganese (40,000mg); Selenium (200mg); Zinc (30,000mg); and Antioxidant (1,250mg) per 2.5kg

2.3 Management of birds and Experimental layout

A total number of 144 day-old chicks of arbor acre were assigned to 3 dietary treatments (3 replicates/treatment; 16 birds/replicate) in a completely randomized design experiment. Thereafter, their respective starter and finisher experimental diets were fed *ad libitum* for 1-28 and 29-56 days respectively during which the weekly feed consumption and weight changes were measured and feed conversion ratio were calculated.

2.4 Birds slaughtering, blood collection, carcass and relative organ evaluation

On day 56 of the experiment, 3 birds per replicate were randomly selected and slaughtered by cutting their jugular veins. Blood was allowed to flow freely into well-labeled ethylene diamine tetra-acetic acid (EDTA) bottles and plain bottles for haematological and serum biochemical studies, respectively. The blood samples for serum biochemical studies were spun and their serum was decanted and frozen at -20^{O}C prior to analysis. The slaughtered chicken was de-feathered after scalding in hot water (at 60-65^{o}C), dressed and eviscerated. The internal organs (liver, heart, lung, kidney, gall bladder, proventriculus, gizzard, and spleen) were carefully excised out, weighed with a sensitive scale and expressed as a percentage of slaughter weight.

2.5 Blood parameter analyses

Packed cell volume (PCV), haemoglobin concentration (HBc), red blood cells (RBC), and white blood cells (WBC) were determined as described by Lambs [20]. Creatinine, cholesterol, aspartate aminotransferase and alanine aminotransferase were determined with a Reflectron ® Plus 8C79 (Roche Diagnostic, GonbH Mannheim, Germany), using kits.

2.6 Computations and statistical analysis

All data on growth performance, carcass traits, and relative internal organ weights, blood parameters were subjected to one-way analysis of variance and where significant differences are found; the means were compared using Duncan Multiple Range Test using SAS version 9.

3. RESULTS AND DISCUSSION

3.1 Composition of the Gliricidia leaf meal

The result of the composition of Gliricidia leaf meal (GLM) is shown in Table 3. The GLM has relatively high crude protein (24.37%) and crude fibre (12.47%). Cyanide (0.68 mg/kg) and tannin (13.00 g/kg) was also detected in GLM. This suggests that GLM could be an important plant protein feed ingredient in livestock feeds formulation [21]. However, high fibre content and presence of cyanide and tannin could be a limiting factor to extent of GLM inclusion level because normal digestion interference by these anti-nutritional factors in animals had been reported [22, 23]. Consumption of sub-lethal dietary cyanide has reportedly caused impaired thyroid function and growth, neonatal deaths and lower birth rates in animals [24]. Tannins bring about their anti-nutritional influence by binding dietary proteins and digestive enzymes into not readily digestible complexes [25]. In addition, excess feeding of high fibre sources in monogastrics may lead to increased viscosity of the intestinal content, with a resulting decreased bioavailability of vitamin A, impaired dietary fats utilization and reduced body weight gain and carcass quality [25].

Table 3. Composition of Gliricidia leaf meal

Parameters	Quantity
Crude Protein (%)	24.37
Ash (%)	8.62
Crude fibre (%)	12.47
Ether Extract (%)	1.62
Nitrogen Free Extract (%)	45.39
*Gross Energy (kcal/100g DM)	385.74
Cyanide (mg/kg)	0.68
Tannin (%)	1.30

*Gross Energy = 5.7 kcal/g CP + 9.5 kcal/g Fat + 4.0 kcal/g CHO, where CHO = crude fiber + nitrogen free extract [27].

3.2 Performance of the broiler chicken

Table 4 shows the effect of GLM on the performance of broiler chicken. The observed similar ($P>0.05$) growth performance of birds fed 5% GLM inclusive diet (diet 2) compared to those fed the control diet (diet 1) in this study indicates nutritional adequacies and balances of the experimental diet 2 to support the normal growth of the broiler chickens. This result agreed with earlier reports of Oloruntola *et al*., [28] who recorded un-impaired growth performance in broiler chickens fed 5 and 10% *Alchornea cordifolia* leaf meal inclusive diet. In addition, the potentials of phytochemicals or phytogenic feed additives as growth promoters in animal production was reported by Valenzuela-Grijalva *et al*., [29]. The birds' final weight, total weight gain and daily weight gain of birds fed on 10% GLM inclusive diet (diet 3) was significantly ($P<0.05$) lower, compared to those fed on the control diet (0% GLM) and 5% GLM inclusive diet (diet 2). The observed depressed growth performances of the birds fed diet 3 in this study may be the product of the negative effects of anti-nutritional factors (e.g. cyanide and tannin) and high fibre in GLM on the birds [8]. This suggests that at 10% GLM inclusion level, the concentration of the anti-nutritional factors might have risen beyond the level that could be tolerated by the birds without having their growth performance impaired. Tannin, one of the anti-nutritional factors detected in GLM is known for causing decreased feed intake, growth rate and feed efficiency in monogastric animals [30]; while high dietary cyanide had been reported to be the possible cause of growth depression in rabbits fed processed cassava peels inclusive diets [22].

The total feed intake and daily feed intake of birds fed 5% GLM inclusive diet was similar (P>0.05) to those on the control diet but significantly (P<0.05) lower in those fed 10% GLM inclusive diet. The decrease feed intake recorded in birds may be due to the increased fibre content of the diet incorporating 10% GLM [31] which increased the bulkiness of the feed and impaired its palatability [1, 8].

Table 4. Effects of Gliricidia leaf meal on the performance of broiler chickens

	Inclusion levels (%)			SEM	P value
	0 Diet 1	5 Diet 2	10 Diet 3		
Initial weight (g/bird)	37.53	37.52	37.49	0.02	0.85
Final weight (g/bird)	2225.58^{a}	2191.83^{a}	1927.98^{b}	56.80	0.03
Total weight gain (g/bird)	2188.04^{a}	2154.31^{a}	1890.48^{b}	56.79	0.03
Daily weight gain (g/bird/d)	39.07^{a}	38.46^{a}	33.75^{b}	1.01	0.03
Total feed intake (g/bird)	5754.14^{a}	5579.04^{ab}	5188.90^{b}	104.32	0.04
Daily feed intake	102.75^{a}	99.62^{ab}	92.65^{b}	1.86	0.04
Feed conversion ratio	2.62	2.59	2.75	0.03	0.23

Means within rows having different superscripts are significantly different (P<0.05)

3.3 Carcass traits and relative organs weight of the broiler chickens

Table 5 shows the effect of gliricidia leaf meal on carcass traits and relative internal organ weights of broiler chickens. The slaughtered weight, dressed weight and dressed percentage of broiler chickens fed the control diet and 5% GLM inclusive diet were similar (P>0.05) but significantly (P<0.05) higher than those fed the 10% GLM inclusive diet. This implies that GLM inclusion will support the normal development of the muscle or the edible portion of the broiler chicken up to 5% level but declines at 10%. In addition, the result of the growth performance (total growth and daily growth) recorded in this study followed the same trend as the carcass traits. A possible correlation between growth performance and carcass traits of the experimental birds is suspected in this study. Olawumi [32] had earlier reported a strong (P<0.001) phenotypic correlation between live weight and dressed weight. Only the liver, kidney and gizzard relative weights were affected (P<0.05) by the dietary treatment in this study (Table 5). The relative weights of liver, kidney, and gizzards were higher (P<0.05) in birds fed 10% GLM inclusive diet compared to those fed the control diet and 5% GLM inclusive diet. In particular, the increased liver and kidney weights observed in these birds may be as a result of possible high anti-nutritional factors concentration in 10% GLM inclusive diet as these organs may have to be performing detoxification activities above the normal due to the relatively high concentration of antinutritional factors. Some anti-nutritional factors and their breakdown products may posse beneficial effect if present in small concentration; however, at high concentration (beyond tolerable concentration) may produce certain harmful effects [30, 33]. In the same direction, the enlargement of the gizzard being experienced in this study may be as a result of relatively high fibre content of the 10% GLM inclusive diet. Increase in dietary fibre had been reported as one of the causes of increased gizzard size in poultry [34, 35].

Table 5. Effects of Gliricidia leaf meal on carcass traits and relative internal organ weights (% slaughtered weight) of broiler chickens

	Inclusion levels (%)			SEM	P value
	0 Diet 1	5 Diet 2	10 Diet 3		
Slaughtered weight (g/bird)	2183.81^{a}	2150.31^{a}	1886.35^{b}	56.81	0.03
Dressed weight (g/bird)	1925.81^{a}	1892.31^{a}	1628.35^{b}	56.81	0.03
Dressed percentage (%)	88.18^{a}	87.99^{a}	86.25^{b}	0.38	0.04
Liver	2.20^{b}	2.25^{b}	2.72^{a}	0.10	0.04
Heart	0.47	0.45	0.46	0.01	0.86
Kidney	0.73^{b}	0.77^{b}	0.94^{a}	0.04	0.01
Lung	0.43	0.46	0.53	0.02	0.06
Spleen	0.09	0.08	0.12	0.01	0.12
Gizzard	3.61^{b}	3.21^{b}	4.77^{a}	0.27	0.02
Proventriculus	0.64	0.55	0.69	0.04	0.32

Means within rows having different superscripts are significantly different (P<0.05)

3.4 Haemato-biochemical indices of the broiler chickens

The haematological indices in the experimental birds were not affected (P>0.05) by the GLM inclusion except for the white blood cells count (Table 6). The stability of packed cell volume, haemoglobin concentration and red blood cell across the diets imply haematopoiesis was not affected by the GLM inclusion up to 10%. The white blood cell count of birds fed 10% GLM inclusive diet was significantly (P<0.05) higher compared to those fed the control diet and 5% GLM inclusive diet. A high white blood cell count in animals could be due to increased white blood production to fight an infection, reaction to a drug, immunomodulatory effect of phytogenic feed supplements [36, 28]. This result agreed with Oloruntola and Ayodele [37] who reported relatively higher white blood cells due to 10% pawpaw leaf meal inclusion in rabbits' diet. Biochemical markers are useful tools in diagnosis [38]. Creatinine is useful in renal dysfunction diagnosis; while aspartate aminotransferase and alanine aminotransferase are being used in the diagnosis of liver/biliary system diseases and myocardial injury/necrosis [39]. In this study, the creatinine, aspartate aminotransferase, and alanine aminotransferase level in the experimental birds were not affected (P<0.05) by the dietary treatment (Table 6). This may suggest that GLM inclusion up to 10% did not pose any threat to normal physiological and anatomical functions of the kidney, liver, and heart of the experimental birds. This implies that kidney atrophy was observed due 10% GLM inclusion being recorded in this study has not caused cellular damage because these enzymes are tissue-specific and increase in the blood concentration indicates some kind of tissue damage [37]. However, the blood cholesterol level was significantly (P<0.05) higher in birds fed 5 and 10% GLM inclusive diets compared to those fed the control diet. This result suggests that GLM has some phytochemicals which promote hypocholesterolemic activities. Phytogenic feed ingredients/additives were reported to possess hypocholesterolemic properties [30].

Table 6. Effects of Gliricidia leaf meal on haematological and serum-biochemical indices of broiler chickens

	Inclusion levels (%)			SEM	P value
	0 Diet 1	5 Diet 2	10 Diet 3		
Haematological indices					
Packed cell volume (%)	27.27	27.65	27.23	0.95	0.98
Haemoglobin concentration (pg)	16.19	17.16	16.43	0.23	0.22
Red blood cells (x10^9/l)	2.34	2.35	2.53	0.06	0.47
White blood cells (x10^9/l)	114.89^b	115.24^b	116.55^a	0.26	0.01
Serum-biochemical indices					
Creatinine (mg/dl)	0.53	0.48	0.47	0.01	0.21
Cholesterol (mg/dl)	116.07^a	95.37^b	87.42^b	4.80	0.01
Aspartate aminotransferase (µ/l)	411.77	420.94	322.26	17.07	0.97
Alanine aminotransferase (µ/l)	5.53	5.59	5.72	0.08	0.70

Means within rows having different superscripts are significantly different (P<0.05)

4. CONCLUSION

The dietary gliricidia leaf meal at 5% inclusion level supports normal weight gain, feed intake, carcass traits and normal health status of the rabbits.

ETHICAL APPROVAL

The author hereby declares that "guide for the care and use of laboratory animals" (National Research Council, Copyright 2011, 8th edition) were followed, as well as specific National Laws where applicable.

REFERENCES

1. Esonu B.O, Emenalom OO, Udedibie ABI, Herbert U, Ekpor C.F, Okoli IC, Iheukwumere FC. Performance and blood chemistry of weaner pigs fed raw Mucuna (Velvet bean) meal. Trop. Anim. Prod. Invest. 2001; 4:49-54.
2. Opara CC. Studies of the use of *Alchornia cordifolia* leaf meal as the feed ingredient in poultry diets. MSc Thesis. 1996; Federal University of Technology. Owerri, Nigeria.

3. Coon CN. Feeding egg-type replacement pullets. In: Commercial Chicken Meat and Egg Production. (Bell, D.D and Weaver, W.D. Eds.). Cluwer Academic Publishers, Dordrecht, the Netherlands, 2002; Pp 267-285.
4. Oruseibio SM, Smile GO. Evaluation of palm kernel cake in replacing soybean meal as a protein source in broiler chicken production. Proceedings of the 6th Annual Conference of Animal Science Association Nigeria, Maiduguri.September17th-19th, 2001. 2001; Pp. 39 – 42.
5. Aromolaran AK, Ademiluyi IO, Itebu OJ. Challenges of small poultry farms in layer production in Ibadan Oyo state Nigeria. Global J. Sci. Frontier Res. Agric. Vet. Sci. 2013; 13(2): 4-11.
6. Esonu BO, Iheukwumere FC, Emenalom OO, Uchegbu MC, Etuk EB. Performance, nutrient utilization and organ characteristics of broilers fed *Microdesmis puberula* leaf meal. Live. Res Rural Dev. 2002; 14(6).
7. Oloruntola OD, Daramola OT, Omoniyi SO. Effect of forages on performance, carcass cuts and haematological profile of weaner rabbits. Arch de Zootec. 2015; 64(245): 87-92.
8. Oloruntola OD, Ayodele SO, Agbede JO, Asaniyan EK. Performance and apparent digestibility of broiler starter fed diets containing Gliricidia sepium leaf meal. *Asian Journal of Biological and Life Sciences.* 2016; 5(1): 97-102.
9. Agbede JO. Characterization of the leaf meals, protein concentrates, and residues from some tropical leguminous plants. J. Food Sci. Agric. 2006; 86 (9): 1292 – 1297.
10. Agbede JO, Adegbenro M, Aletor O, Muhammed A. (2007): Evaluation of the nutritional value of *Vernonia amyggdalina* leaf protein concentrates for infant weaning foods. ACTA, Alimentaria. 2007; 36 (3): 387-393.
11. Fasuyi AO. Biochemical, nutrition and socio-economic aspects of cassava leaf utilization. Ph.D. Thesis. The Federal University of Technology, Akure, Nigeria. 2000; Pp 90:83-97.
12. Chadhkar RA. Gliricidia maculate- a promising legume fodder plant. World Anim. Rev. 1982; 44: 36-45.
13. Adejumo JO, Ademosun AA (1985). Effect of plant age at harvest and of cutting time frequency and height on the dry matter yield and nutritive value of gliricidia and *Cajanus cajan.* J. Anim. Prod. Res. 1985; 5: 1-12.
14. Odunsi AA, Ogunleke MO, Alagbe OS, Ajani TO. Effect of feeding Gliricidia sepium leaf meal on the performance and egg quality of layers. Int. J Poult. Sci. 2002; 1 (1): 26-28.
15. Kagya-Agyemang JK, Takyi-Boampong G, Adjei M, Karikari-Bonsu FR. A note on the effect of Gliricidia sepium leaf meals on the growth performance and carcass characteristics of broiler chickens. J. Anim and Feed Sci. 2007; 16: 104-108.
16. NRC. Nutrient requirement of Poultry. The nutrient requirement of farm animals. (National Academic of Science) 9th Revised edition. 1994.
17. AOAC. Association of Official Analytical Chemistry, Official Methods of Analysis 16th edition, Washington D.C. 1995.
18. Oboh G, Akindahunsi AA, Oshodi AA. Nutrient and antinutrients content of *Aspergillusniger* fermented cassava products (flour and gari). J. Food Comp. Anal. 2002: 15: 6127-622.
19. Makkar HPS, Goodchild MO. A bioassay for polyphenol (tannin In Vercauteren, J, Cheze, C, Dumon, M. C (Eds), Proceeding of the international conference of polyphenols. Polyphenols Comm.1996: 96(1):197- 198.
20. Lambs GN. Manual of veterinary laboratory technique. CIBA-GEIGY. Kenya. 1981; Pp. 96-107.
21. Oloruntola OD, Ayodele SO, Agbede JO, Oloruntola DA. Effect of feeding chickens with diets containing *Alchorneal cordifolia* leaf meal and enzyme supplementation. Arch. de Zootec. 2016; 65(252):489-498.
22. Oloruntola OD, Agbede JO, Onibi GE, Igbasan FA. Replacement value of rumen liquor fermented cassava peels for maize in growing rabbit. Arch de Zootec. 2016; 65(249): 89-97.
23. Barletta A (2011). Introduction: current market and expected developments. 2011; Pp. 1 – 11. In: Bedford MR and Patridge, GG (Eds.). Enzymes in Farm Animal Nutrition. CABI. Wallingford, United Kingdom.
24. Fatufe AA, Akanbi IO, Saba GA, Olowofeso O, Tewe OO (2007). Growth performance and nutrient digestibility of growing pigs fed a mixture of palm kernel meal and cassava peel meal. Livest. Res. Rural Dev. 2007; 19, Article #180. Retrieved September 26, 2008, from http://www.cipav.org.co/lrrd/lrrd19/12/fatu19180.htm.

    Dei HK, Rose SP, Mackenzie AM. (2007). Shea nut *(Vitellaria paradoxa)* meal as a feed ingredient for poultry. World's Poultry Sci. J. 2007; 63(4):611-624.
25. Janssen WMMA, Carré B. Influence of fiber on digestibility of broiler feeds. In Recent Advances in Animal Nutrition, DJA Cole and W Haresign, Eds (Butterworth-Heinemann, London) 1985; Pp. 78-93.

26. Ng WK, Wee KL. (1989). The nutritive value of cassava leaf meal in pelleted feed for Nile tilapia. Aquaculture. 1989; 83: 45-58.
27. Oloruntola OD, Ayodele SO, Agbede JO, Oloruntola DA, Ogunsipe MH, Omoniyi IS (2016). Effect of *Alchornea cordifolia* leaf meal and enzyme supplementation on growth, haematological, immunostimulatory and serum biochemical response of rabbits. Asian J. Biol. Life Sci. 2016;5(2): 190-195.
28. Valenzuela-Grijalva NV, Pinelli-Saavedra A, Muhlia-Almazan A, Dominguez-Diaz D (2017). Dietary inclusion effects of phytochemicals as growth promoters in animal production. J. Ani. Sci. Techn. 2017; 59:8.
29. Gemede HF, and Ratta N. Antinutritional factors in plant foods: Potential health benefits and adverse effect. Int J. Nut. Food Sci. 2014; 3(4): 284-289.
30. Osei SA, Opoku RS, Atuahene CC. Gliricidia leaf meal as an ingredient in layer diets. Anim. Feed Sci. Tech. 1990; 29: 303-308.
31. Olawumi SO. Phenotypic correlations between live body weight and carcass traits in Arbor acre breed of broiler chicken. Int. J. Sci. Nature. 2013; 4(1): 145-149.
32. Ayodele SO, Oloruntola OD, Agbede JO (2016). Effect of *Alchornea cordifolia* leaf meal inclusion and enzyme supplementation on performance and digestibility of rabbits. World Rabbit Sci. 2016; 24: 201-206.
33. González-Alvarado JM, Jiménez-Moreno E, Valencia DG, Lázaro R, Mateos GG. Effects of fiber source and heat processing of the cereal on the development and pH of the gastrointestinal tract of broilers fed diets based on corn or rice. Poult. Sci. 2008; 87: 1779-1795.
34. Mateos GG, Jimenez-Moreno E, Serrano MP, Lazaro RP (2012). Poultry response to high level of dietary fibre sources varying in physical and chemical characteristics. *The* J. Appl.Poultry Res. 2012; 21(1): 156-174.
35. Sultana R, Khanam S, Devi K (2011). Immunomodulatory effect of methanol extract of *Solanum xanthocarpum* fruits. Int. J. Pharma Sci.Res. 2011; 2(2): 93-97.
36. Oloruntola OD, Ayodele SO. Pawpaw leaf meal and exo-enzyme in rabbit diet: Effect on haematological and serum biochemical indices. Asian J. Agric. Res. 2017; 2(4): 1-8.
37. Tormey WP. The diagnosis and management of acute myocardial infarction-a role for biochemical markers? Ann Clin Biochem. 1996; 33: 477-81
38. Lording PM, Friend SCE. Interpretation of laboratory results. Aust.Vet.Pract. 1991; 21(4):188-193.