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Effect of feeding broiler chickens with diets containing *Alchornea cordifolia* leaf meal and enzyme supplementation

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ADDITIONAL KEYWORDS

Alchornea cordifolia.
Health status.
Performance.
Multi-enzyme.
Poultry.

SUMMARY

This study sought to evaluate the effect of *Alchornea cordifolia* leaf meal (ACLM) inclusion and exogenous enzyme supplementation on broiler chickens. Two hundred and fifty-two (252) arbour acre two weeks-old broiler chicken were selected from a larger flock that had been brooded on deep litter and raised on commercial diet. These birds were balanced for weight and thereafter distributed into 18 pens of 14 birds each. These pens were randomly allotted to six dietary treatment groups in such way that 3 replicates were fed on each experimental diet. For the starter and finisher phase, six experimental diets were formulated and designated as 0-E, 5-E and 10-E for the diets without enzyme and 0+E, 5+E and 10+E for diets with enzyme. Diet 0-E and 0+E serve as positive and negative control respectively. The experiment was carried out using a 2x3 factorial experiment comprising of 2 enzyme levels (0 and 0.35 g/kg) and 3 ACLM inclusion levels (0, 5 and 10%).The final weight (FW) and weight gain (WG) were significantly affected by enzyme supplementation ($p<0.05$) while ACLM inclusion levels caused significant ($p<0.05$) decrease of 15.13% and 11.61% in the total feed intake (TFI) and feed conversion ratio (FCR) respectively in the broiler chickens. Enzyme supplementation significantly ($p<0.05$) increased the slaughtering weight, drum stick and thigh by 4.90%, 5.06 and 5.33 % respectively, while the ACLM inclusion level reduced the dressing percentage, drum stick, wing weight, thigh, breast and back significantly ($p<0.05$), decreasing by 17.63%, 25.95%, 10.72%, 9.85%, 21.27% and 19.41% respectively, as the ACLM level increase ranged from 0 to 10 %. The internal organs of the broilers were not significantly affected ($p>0.05$) by the main factors and their interactions except for the liver and proventriculus that were affected by the level of inclusion of ACLM. Red blood cells (RBC) significantly increased ($p<0.05$) while mean cell haemoglobin (MCH), mean cell volume (MCV) and monocytes significantly ($p<0.05$) decreased with an increase in the level of ACLM inclusion ranging from 0 to 10%. Enzyme supplementation caused a significant ($p<0.05$) increase in cholesterol and SGPT levels and a significant ($p<0.05$) decrease in SGOT. ACLM also significantly ($p<0.05$) affected the serum parameters considered, except for total protein, albumin, globulin, creatinine, bilirubin and SGPT in a way in which the increase of the ACLM level ranging from 0 to 5% and then to 10 % in the broiler's diets promoted the declination in the cholesterol, urea, SGOT and glucose levels. Furthermore, the interaction of enzyme levels and ACLM has a significant ($p<0.05$) effect on cholesterol and SGPT levels. Basing on the data obtained in this study, ACLM is a potential useful feed material for feeding monogastrics. Therefore, it is suggested that 10% ACLM inclusion level could be used in broiler production.

Efecto de la alimentación de pollos broiler con dietas conteniendo harina de *Alchornea cordifolia* y suplementación enzimática

RESUMEN

En este estudio se trata de evaluar el efecto de la inclusión de harina de hojas de *Alchornea cordifolia* (ACLM) con inclusión de enzimas exógenos en la alimentación de pollos para carne. Doscientos cincuenta y dos pollos Arbor Acre de dos semanas de edad, fueron seleccionados de un lote grande criado mediante el sistema de cama profunda y alimentado con una dieta comercial. Las aves fueron equilibradas según peso y distribuidas en 18 corrales con 14 aves cada uno. Los corrales fueron asignados aleatoriamente a seis tratamientos de forma que hubiera tres réplicas en cada dieta experimental. Para las fases de iniciación y finalización se diseñaron seis tratamientos alimenticios denominados 0-E, 5-E y 10-E para las dietas sin enzima y 0+E, 5+E y 10+E para las dietas con enzima añadido. Las dietas 0-E y 0+E sirven como control negativo y positivo respectivamente. El experimento se realizó empleando un diseño factorial 2 x 3 incluyendo dos niveles de inclusión de enzima (0 y 0.35 g/kg) y tres niveles de inclusión de ACLM 0, 5 y 10%). El peso final (FW) y la ganancia de peso (WG) de los pollos, fueron afectados significativamente por la adición de enzima ($p< 0,05$), mientras que la inclusión de ACLM causo una disminución significativa del 15,13% de la ingestión total de alimento y del 11,61% de la tasa de conversión de alimento (FCR). La suplementación enzimática, aumento significativamente ($p<0,05$) el peso al sacrificio (4,90%) la pata (5,06) y el muslo (5,33%), mientras que la inclusión de ACLM de 0 a 10 %, redujo significativamente ($p<=,05$) el rendimiento a la canal (17.63%), peso de la pata (25.95%), ala (10.72%), muslo (9.85%), pechuga (21.27%), y lomo (19.41%). Los órganos internos de los pollos no fueron afectados significativamente ($p>0,05$) por los factores principales y sus interacciones, excepto para el hígado y el proventrículo, que fueron afectados por el nivel de inclusión de ACLM. Las células rojas de la sangre (RBC) incrementaron de modo significativo ($p<0,05$), mientras que, al aumentar la inclusión de ACLM del 0 al 10%, disminuyeron la hemoglobina celular (MCH), volumen celular medio (MCV) y los monocitos, La suplementación enzimática originó un incremento ($p<0,05$) en los niveles de colesterol y SGPT y una disminución significativa ($p<0,05$) de la SGOT. La inclusión de ACLM afectó ($p<0,05$) a los parámetros séricos considerados excepto proteína total, albúmina, globulinas, creatinina, bilirrubina y SGPT, de modo que el aumento de ACLM al 5 y al 10%, en la dieta de los pollos determinó la disminución de los niveles de colesterol, urea, SGOT y glucosa. La interacción de los niveles de enzima y de ACLM tuvo un efecto significativo ($p<0,05$) sobre los niveles de colesterol y SGPT. En función de los datos obtenidos en este estudio se deduce que el ACLM es un material potencialmente utilizable en la alimentación de monogástricos. Se sugiere que en la alimentación de broilers, puede emplearse un 10% de ACLM.

PALABRAS CLAVE ADICIONALES

Alchornea cordifolia.
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INTRODUCTION

Availability of feed ingredients and the ability to produce high quality products in a cost effective manner is among the major problems facing the feed industry presently (Chauynarong *et al.,* 2009). This scenario has greatly affected the expansion and sustainability of existing poultry production levels in the developing countries. The conventional feed stuffs for poultry are not always available and affordable by most farmers who are medium scaled (Ogungbesan *et al.,* 2013). The consequence of this is rise in the cost of finished feed, which is 60-80% of total cost of production; resultant fall in the poultry production in developing countries (Zanu *et al.,* 2012) and inability to meet the domestic animal protein consumption requirement of 63 g per day per caput as recommended by (FAO, 1986; 1992). This calls for the need for the poultry producers to look beyond these lowly available and highly cost conventional feed ingredients that could not keep pace with increasing poultry production (Chauynarong *et al.,*. 2009).

Leaf meals from tropical legumes, browse plants and shrubs is among the possible feed ingredient that can be included in formulation of ration for poultry and other monogastrics (Agbede and Aletor, 2004; Ogungbesan *et al.,* 2013). Leaf meal has been reported as a good source of protein, minerals and vitamins (Esonu *et al.,* 2003). Their nutrient profiles are favourably comparable to some relatively expensive and scarce conventional feed ingredients; while some satisfactory performance have been reported of various leaf meals such as *Microdesmis puberula* (Esonu *et al.,* 2002), *Leucaena leucocephala* leaf meal (Zanu, 2012), *Gliricidia sepium* leaf meal (Ogungbesan *et al.,* 2013) among others in diets of various classes of poultry.

Alchornea cordifolia, an erect or straggling perennial shrub, a common tropical flora in West Africa is widely distributed in West Africa, mostly Nigeria (Oliver 1986) and Zaire Republic. *Alchornea cordifoli*a has exploitable proximate composition of 17.94% crude protein, 39.53% carbohydrate, 4.34% crude fat, 11.38% ash and 16.85% fibre (Alikwe *et al.,* 2014). The *Alchornea* leaves has been reported to be high in xanthophylls and when included in poultry diets results in yellowish coloration of the shanks and egg yolk of broilers and layers respectively (Udedibie and Opara, 1998). The leaf also possesses phytochemicals such as alkaloids, anti-tumour, antioxidants and antibacterial compounds; which are of high medicinal value in veterinary medicine (Adeshina *et al.*, 2011; Jacob *et al.,* 2014). The dry leaf of *Alchornea* is a major ingredient in some blood tonic production (Jacob *et al*., 2014). The leaves of *Alchornea cordifolia* was reported to possess isopenteny guanidine, which is factor for its antibacterial activity on *Staphylococcus aureus* and *Escherichia coli.* (Lamikar *et al.,* 1990). *Alchornea cordifolia* leaf meal has been used against gonorrhoea and urinary infection (Ogungbamila and Samuelsson 1990; Muanza *et al.,* 1994). Considerable amount of antibiotics were used during the last few decades in animal production, both as therapeutic and as growth promoting agents (Falcao-e-Cunha *et al.* 2003). However, due to the antimicrobial property of *Alchornea cordifolia* leaf meal, its inclusion in chicken diets may be beneficial as an alternative to antibiotic growth promoters, particularly when there is presently a ban on usage of antimicrobial growth promoters in many countries (Falcao-e-Cunha *et al.,* 2003). However, high fibre content and presence of anti-nutritional factors are major factors limiting the utilization of leaf meals generally in poultry (Tewe 1991). In an attempt to address these limitations, the use of exogenous enzyme supplement in poultry diets is now being considered to improve nutrient utilization, performance and health status of the birds (Bedford 2000). Therefore, the objective of this study is to determine the effect of *Alchornea cordifolia* leaf meal supplemented with enzyme on performance and health status of broiler.

MATERIALS AND METHODS

EXPERIMENTAL SITE

The experiment was carried out at the Teaching and Research Farm of the Agricultural Technology Department, The Federal Polytechnic, Ado Ekiti, Nigeria. The study areas is situated at about 437 mm above sea level with latitudes of7°37´N and 7°12´N and longitudes 5°11´E and 5°31´E; and mean annual temperature of 26.2°C. The mean annual rainfall is 1247 mm.

COLLECTION, PRODUCTION AND CHEMICAL ANALYSIS OF *ALCHORNEA CORDIFOLIA* LEAF MEAL (ACLM)

The *Alchornea cordifolia* leaves were harvested fresh from various undeveloped plots in Ikere Ekiti and Iyin Ekiti, Nigeria, chopped into smaller pieces, spread lightly to air-dry under a shed for 14 days, and sun-dried for 2 hour just before being hammer milled. The leaf meal was analysed for proximate composition (AOAC 1995), phytate (Wheeler and Ferrel 1971) and oxalate (Day and Underwood 1986). The gross energy was determined against thermo-chemical-grade benzoic acid using combustion calorimeter (Model: e2k combustion calorimeter, www.cal2k.com). Each sample was analysed thrice.

EXPERIMENTAL DIETS AND PREPARATION

For the starter and finisher phase, six experimental diets were formulated and designated as 0-E, 5-E and 10-E for the diets without enzyme and 0+E, 5+E and 10+E for diets with enzyme. Diet 0-E and 0+E serve as positive and negative control respectively (**tables I** and **II**). The experiment was carried out in a 2x3 factorial experiment comprising of 2 enzyme levels (0 and 350 g/kg) and 3 ACLM inclusion levels (0, 5 and 10%).

MANAGEMENT OF BIRDS

Permission for the use of animal and animal protocol was obtained from the Research and Ethics Committee of the Federal Polytechnic, Ado-Ekiti, Nigeria. Two hundred and fifty two (252) arbour acre two weeks-old broiler chicken were selected from a larger flock that had been brooded on deep litter and raised on commercial diet. These birds were balanced for weight and thereafter distributed into 18 pens of 14 birds each. These pens were allotted to six dietary treatment groups randomly such that each experimental diet was fed to 3 replicate. The initial body weight of the birds was 237.38±6.57 (mean±SD). All the birds were fed *ad libitum* during the experimental period. All other standard management and health practices were provided for the birds throughout the 6 weeks of the experiment.

Table I. Proximate analysis (g/kg), energy (kcal/kg) and anti-nutrients (g/kg) of *Alchornea cordifolia* leaf meal (Principios inmediatos (g/kg), energía (kcal/kg) y factores anti-nutritivos g/kg) de harina de hojas de *Alchornea cordifolia*)

Parameters	Quantity
Moisture	87.90
Crude protein	180.30
Ash	128.40
Crude fibre	129.50
Ether extract	41.20
Nitrogen free extract	432.70
Gross energy	3379.43
Phytate	10.80
Oxalate	13.00

Slaughtering of birds and blood collection

At the end of the feeding trial, three birds from each replicate were starved overnight, weighed, tagged and slaughtered by cutting the jugular vein and allowing blood to freely flow into two set of bottles, one containing EDTA and the other without EDTA for haematology and serum chemistry analysis respectively.

Carcass trait and relative organ weight measurement

The slaughtered chicken was de-feathered after scalding in hot water, dressed and eviscerated; thereafter, head, crop and shank were removed, weigh and used for estimation of dressing percentage. The dressed chickens were dissected into parts (drum stick, wing, thigh, breast and back) and weighed. The internal organs such as liver, heart, lung, kidney, gizzard, proventriculus, spleen and gall bladder were also excised out, weighed and expressed as percentage of live weight.

Haematological studies and serum analysis

The blood indices; packed cell volume (PCV), red blood cells (RBC), mean cell haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), mean cell volume (MCV), haemoglobin con-

Table II. Composition of experimental broiler starter fed diets (%) (Composición de las dietas experimentales de iniciación de los pollos (%).

Ingredients (%)	Level of *A cordifolia* leaf meal (%) with or without enzyme					
	0-E	0+E	5-E	5+E	10-E	10+E
Maize	54.00	54.00	48.00	48.00	42.00	42.00
Cassava peel	5.00	5.00	6.00	6.00	7.00	7.00
ACLM	0.00	0.00	5.00	5.00	10.00	10.00
GNC	15.50	15.50	15.50	15.50	15.50	15.50
Soybean meal (42%CP)	17.00	17.00	17.00	17.00	17.00	17.00
Fish meal (72%CP)	5.00	5.00	5.00	5.00	5.00	5.00
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis (%DM)						
Crude protein	23.21	23.21	23.63	23.63	24.06	24.06
Crude fibre	3.80	3.80	4.48	4.48	5.16	5.16
Energy	3045	3045	3043	3043	3041	3041
Ca	1.28	1.28	1.30	1.30	1.31	1.31
P	0.57	0.57	0.57	0.57	0.56	0.56
Methionine	0.70	0.70	0.69	0.69	0.69	0.69
Lysine	1.28	1.28	1.27	1.27	1.26	1.26
Determined analysis (%)						
Dry matter	89.79	89.76	90.21	90.22	91.14	91.12
Crude protein	23.23	23.25	23.59	23.61	24.09	24.07
Ether extract	4.23	4.22	4.21	4.20	4.19	4.20
Crude fibre	3.84	3.86	4.51	4.53	5.14	5.17

*Provided per kg diet: Vitamins A: 8500000 IU; D3:1500000 IU; E:10000 mg; K_3:1500 mg; B_1:1600 mg; B_2:4000 mg; B_6:1500 mg; B_{12}:10 mg; Niacin:20000 mg; Pantothenic acid:5000 mg; Folic acid:500 mg; Biotin H_2:750 mg; Choline chloride:175000 mg; Cobalt:200 mg; Copper : 3000 mg; Iodine:1000 mg; Iron: 20000 mg; Manganese: 40000 mg; Selenium:200 mg; Zinc:30000 mg; and Antioxidant:1250 mg per 2.5 kg.

centration (HBc), white blood cells (WBC), lymphocytes (LYMP), monocytes (MONO) and granulocytes (GRA) were determined as described by Lambs (1981) while the serum chemistry indices were determined as described by Baker and Silverton (1986).

Statistical analysis

All data collected during the experiment were subjected to analysis of variance from General Linear Model procedures using SPSS version 20 (SPSS 2011) while means were separated using Duncan's multiple range test from the same software package.

RESULTS

The results of chemical analysis of *Alchornea cordifolia* leaf meal (ACLM) presented in **table I** showed that it has considerable protein content (180.30 g/kg), ash (128.40 g/kg), high fibre content (129.50 g/kg) and energy (3379.43 kcal/kg). The analysed composition of the experimental diets for broiler starter and finisher is shown in **table II** and **III** respectively. In the starter phase diets, the crude protein (CP) and crude fibre (CF) ranged from 23.21 to 24.06% and 3.80 to 5.16% respectively while for the finisher phase, CP and CF ranged from 18.05 to 18.96% and 4.08 to 5.18% respectively.

Table IV shows that the final weight (FW) and weight gain (WG) were significantly ($p<0.05$) affected by enzyme while levels of inclusion of ACLM caused significant ($p<0.05$) decrease of 15.13% and 11.61% in the total feed intake (TFI) and feed conversion ratio (FCR) respectively in the broiler chickens. However, the performance characteristics were not affected by the interaction of these two main factors (enzyme supplementation and ACLM inclusion levels).

Effect of commercial enzyme supplementation and graded levels of ACLM on retail cuts are shown in **table V**. The enzyme supplement significantly ($p<0.05$) increased the slaughtering weight, drum stick and thigh by 4.90%, 5.06 and 5.33 % respectively while the

Table III. Composition of experimental broiler finisher fed diets (%) (Composición de las dietas experimentales de finalización (%).

Ingredients (%)	Level of *A cordifolia* leaf meal (%) with or without enzyme					
	0-E	0+E	5-E	5+E	10-E	10+E
Maize	49.00	49.00	47.00	47.80	45.85	45.85
Cassava peel	12.00	12.00	9.00	9.00	11.40	11.40
ACLM	0.00	0.00	5.00	5.00	10.00	10.00
PKC	11.25	11.25	11.25	11.25	11.25	11.25
Soybean meal (42%CP)	17.75	17.75	17.75	17.75	17.75	17.75
Fish meal (72%CP)	5.00	5.00	5.00	5.00	5.00	5.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis (%DM)						
Crude protein	18.05	18.05	18.61	18.61	18.96	18.96
Crude fibre	4.08	4.08	4.20	4.20	5.18	5.18
Energy (kcal/kg)	2979	2979	2971	2971	2972	2972
Ca	1.81	1.81	1.81	1.81	1.83	1.83
P	0.70	0.70	0.69	0.69	0.69	0.69
Methionine	0.65	0.65	0.63	0.63	0.63	0.63
Lysine	1.10	1.10	1.11	1.11	1.07	1.07
Determined analysis (%)						
Dry matter	90.02	90.04	90.15	90.19	90.33	90.31
Crude protein	18.11	18.13	18.63	18.64	18.97	18.95
Ether extract	2.43	2.45	2.42	2.40	2.38	2.37
Crude fibre	4.09	4.07	4.22	4.21	5.19	5.22

*Provided per kg diet: Vitamins A: 8500000 IU; D3:1500000 IU; E:10000 mg; K_3:1500 mg; B_1:1600 mg; B_2:4000 mg; B_6:1500 mg; B_{12}:10 mg; Niacin:20000 mg; Pantothenic acid:5000 mg; Folic acid:500 mg; Biotin H_2:750 mg; Choline chloride:175000 mg; Cobalt:200 mg; Copper : 3000 mg; Iodine:1000 mg; Iron: 20000 mg; Manganese: 40000 mg; Selenium:200 mg; Zinc:30000 mg; and Antioxidant:1250 mg per 2.5 kg.

ACLM inclusion level reduced significantly (p<0.05) the dressing percentage, drum stick, wing weight, thigh, breast and back decreased by 17.63%, 25.95%, 10.72%, 9.85%, 21.27% and 19.41% respectively as the ACLM level increase from 0 to 10 %. The internal organs of the broilers were not affected (p>0.05) significantly by the main factors and their interactions except for the liver and proventriculus that were affected by the level of inclusion of ACLM, although this effect does not follow a particular trend (**table VI**).

Table VII shows that the blood indices were not affected by the main factors and their interactions except for the red blood cells (RBC) that increased significantly (p<0.00), mean cell haemoglobin (MCH), mean cell volume (MCV) and monocytes that significantly (p<0.05) decreased with increase in level of ACLM inclusion from 0 to 10% .

The enzyme supplementation caused significant (p<0.05) increase in the cholesterol and SGPT levels and significant (p<0.05) decrease in SGOT (**table VIII**). ACLM also significantly (p<0.05) affected the serum parameters considered except for the total protein, albumin, globulin, creatinine, bilirubin and SGPT such that increase of ACLM level from 0 to 5% to 10 % in the broiler's diets promoted declination in the cholesterol, urea, SGOT and glucose levels. Furthermore, the interaction of enzyme levels and ACLM has significant (p<0.05) effect on the cholesterol and SGPT levels.

DISCUSSION

The crude protein (CP) of 180.30 g/kg reported in this study suggests that the leaf meal could be important contributor to source of plant protein in livestock feed. For instance, CP content of *Alchornea cordifolia* compared favourable with 173 g/kg CP for *Microdesmis puberula* leaf (Esonu *et al.*, 2002), higher than 97.3 g/kg for guava leaf (Zaminur *et al.*, 2013), and but lower than 243.8 g/kg for gliricidia leaf meal (Ogungbesan, *et al.*, 2013). In the same vein, the crude fibre (CF) content of *Alchornea cordifolia* (129.50 g/kg) is lower than 248 g/kg for *Microdesmis puberula* leaf (Esonu, *et al.*, 2002), 169 g/kg for *Ipomea asarifolia* leaf meal (Madubuike and Ekenyem, 2006) and comparable to 124.5 g/kg for gliricidia leaf meal (Ogungbesan, *et al.*, 2013). Nutritional importance of fibre content of feed ingredients is that excess feeding of fibre source in monogastrics may lead to enlargement of intestinal villi as a result of the physical stimulation of villous growth and resultant increase in the goblet cell numbers which adversely affects absorption. Excessive use of fibre sources in diets also increase viscosity of intestinal content which lead to impaired vitamin A bioavailability, impaired utilization of dietary fat and adverse effect on the body weight gain and carcass quality (Janssen and Carre, 1985). The improvement in weight gain as a result of enzyme supplementation further support the earlier report of Chot (2006) that exogenous enzymes supplement the digestive enzymes of monogastrics in aid-

Table IV. Effect of commercial enzyme supplementation and graded levels of Alchornea cordifolia leaf meal (ACLM) on the performance characteristics of broilers (2-8 weeks) (Efecto de la suplementación con enzimas comerciales y diferentes niveles de harina de hojas de *Alchornea cordifolia* (ACLM) sobre el rendimiento de pollos (2-8 semanas).

Diets	Enzyme (g)	ACLM (%)	IW	FW	WG	DWG	TFI	DFI	FCR
	0.00		234.45	1657.19	1422.73	33.87	7419.70	176.66	5.22
	0.35		240.08	1742.66	1502.57	35.78	7598.72	180.92	5.06
	SEM		2.18	18.80	18.74	0.45	166.13	3.96	0.12
	p value		0.09	0.01	0.01	0.01	0.46	0.46	0.37
		0	237.38	1719.57	1482.20	35.29	8103.31[a]	192.94[a]	5.48[b]
		5	239.19	1710.00	1470.81	35.02	7386.23[b]	175.86[b]	5.03[ab]
		10	235.25	1670.19	1434.94	34.17	7038.10[b]	167.57[b]	4.91[a]
		SEM	2.67	23.03	22.95	0.55	203.47	4.84	0.15
		p value	0.59	0.31	0.35	0.35	0.01	0.01	0.04
	Enzyme x ACLM								
1	0.00	0	238.38	1763.63	1525.26	36.32	8110.72	193.11	5.33
2	0.35	0	236.38	1675.51	1439.13	34.27	8095.90	192.76	5.63
2	0.00	5	243.37	1750.65	1507.28	35.89	7526.92	179.21	4.99
3	0.00	5	243.37	1750.65	1507.28	35.89	7526.92	179.21	4.99
4	0.35	5	235.00	1669.35	1434.35	34.15	7245.53	172.51	5.06
5	0.00	10	238.50	1713.68	1475.18	35.12	7158.51	170.44	4.85
6	0.35	10	232.00	1626.70	1394.70	33.21	6917.68	164.71	4.96
	SEM		3.78	32.57	32.46	0.77	287.74	6.85	0.21
	p value		0.69	0.99	0.98	0.98	0.98	0.88	0.83

*Means with different superscripts in the same row are significantly different (p<0.05).

IW: Initial live weight (g/rabbit); FW: Final live weight (g/rabbit); WG: Weight gain (g/bird); DWG: Daily weight gain (g/bird/day); TFI: Total feed intake (g); DFI: Daily feed intake (g/bird/day); FCR: Feed conversion ratio.

ing the breakdown of non-starchy polysaccharides, protein and anti-nutritional factors resulting in the increase in their nutritional value. This result agreed with Ogungbesan *et al.,* (2013) who observed improvement in weight gain of chicken broilers fed enzyme supplemented diet. The decrease in feed intake with increase in inclusion level of *Alchornea cordifolia* leaf meal (ACLM) may not be unconnected to increase in fibre content and bulkiness of the feed as a result of the increase in ACLM inclusion level (Esonu *et al.*, 2002). Secondly, reduced feed intake in correlation to the increase in ACLM inclusion rate observed in this study could be that ACLM imparted an unpalatable taste to the feed (Omekam, 1994). Similar result was recorded by Kagya-Agyemang, *et al.,* (2007) and Zanu *et al.,* (2012) with glaricidia leaf meal and leucaena leaf meal respectively in broiler chickens. However, disagreed with report of Bonso *et al.,* (2012) who observed insignificant (p>0.05) difference in feed intake of broiler chickens fed varying levels of *Azadirachta indica.*

The increase in the proportional weight of retail cuts of broiler in relation to enzyme supplementation may be due to the enhancing effect of natuzyme to release nutrients needed for muscle development. The reducing effect of ACLM on dressing percentage, drum stick, wing, thigh, breast and back of the broiler chickens could be attributed to increase in fibre content and possible increase in the level of anti-nutrients of the diet as the ACLM inclusion rate increases. This result is supported by the earlier report of Collins (1976) and Ogunsipe *et al.,* (2014) that rich fibre diets lowered slaughtering yield in rabbits. In addition, Moharrery and Mohammad (2005) reported that higher fibre diets disrupts intestinal microvillus and depresses nutrient absorption.

Organs are composed of several types of tissues and are also capable of carrying out several specialised functions (Sarojini, 2005). The relative organs weights in this study were not affected by the ACLM inclusion rates except for liver and proventriculus. The liver weights at 0 and 10% ACLM inclusion rate are similar and higher than 5% ACLM inclusion rate. The abnormal enlargement of organs had earlier been linked with the detoxifying activities due to the presence of anti-nutritional factors (Adeyemi, 2003). However, in this study, the change in liver weight did not follow a particular trend and therefore may not be pinned on dietary treatment as other factors order than ACLM could have been responsible.

Haematology is one of the means of assessing the clinical and nutritional health status of animal in feeding trials (Aletor and Egberongbe, 1992). In particular, the haematological indices such as RBC, WBC, PVC and Hbc are usually used for disease diagnosis and feed stress monitoring (Togun and Oseni, 2005). The increase in the inclusion rate of ACLM, though precipitated increase in RBC count of the bird, did not signalled any possible health hazard (relative polycythaemia or absolute polycythaemia) as the RBC range (2.04-2.42 x10^6mm^3) falls within the normal range (2.0-

Table V. Effect of commercial enzyme supplementation and graded levels of *Alchornea cordifolia* leaf meal (ACLM) on the proportional weight (% live weight) of retail cuts of broilers (2-8 weeks) (Efecto de la suplementación con enzimas comerciales y diferentes niveles de harina de hojas de *Alchornea cordifolia* (ACLM) sobre sobre la proporción (% peso vivo) del despiece de pollos(2-8 semanas).

Diet	Enzyme (g/kg)	ACLM (%)	Live weight	Dressing %	Drum stick	Wing weight	Thigh	Breast	Back
	0.00		1657.19	69.47	9.95	8.16	11.18	20.85	14.02
	0.35		1742.66	73.10	10.48	8.75	11.81	22.12	14.71
	SEM		18.80	1.61	0.14	0.24	0.18	0.81	0.28
	P value		0.01	0.14	0.02	0.11	0.03	0.28	0.10
		0	1719.57	80.19^a	11.55^a	9.19^a	12.72^a	24.57^a	16.59^a
		5	1710.00	65.48^b	9.93^b	7.88^b	10.18^c	19.62^b	13.14^b
		10	1670.19	68.17^b	9.17^c	8.30^{ab}	11.58^b	20.26^b	13.37^b
		SEM	23.03	1.97	0.17	0.29	0.22	0.99	0.34
		P value	0.31	0.00	0.00	0.03	0.00	0.01	0.00
	Enzyme x ACLM								
1	0.00	0	1763.63	78.12	11.28	8.87	12.39	23.96	16.22
2	0.35	0	1675.51	82.26	11.81	9.50	13.05	25.19	16.96
3	0.00	5	1750.65	63.92	9.70	7.01	9.91	12.17	12.80
4	0.35	5	1669.35	67.05	10.16	8.06	10.44	20.08	13.48
5	0.00	10	1713.68	66.37	8.88	7.90	11.25	19.42	13.04
6	0.35	10	1626.70	69.98	9.45	8.67	11.92	21.11	13.70
	SEM		32.57	2.79	0.24	0.42	0.31	1.40	0.48
	P value		0.99	0.98	0.98	0.87	0.97	0.96	9.99

*Means with different superscripts in the same row are significantly different (p<0.05).

4.0 x10^6mm^3) reported for broiler chicken by Akinola and Abiola (1991). MCH and MCHC are useful in feed toxicity monitoring (Etim *et al*., 2014). Also, when MCH, MCV is abnormally high and MCHC is abnormally low, poor quality protein of the test diets is suggested (Tewe, 1985; Awoniyi *et al.,* 2000). The values obtained for MCH (64.1-69.5 pg) in this study is higher than 42.20-43.46 pg reported for normal range by Awoniyi *et al.,* 2000, while the MCV values (104.5-114 fl) falls within normal range reported by Akinmutimi (2004). The abnormally increase in the MCH value could not be attached to the presence of toxin or anti-nutrients in the feed because the value for MCH at 0 ACLM inclusion rate (69.35fl) is also outside the normal range. This suggests that the abnormal high value of MCH may be as a result of other factor different from the ACLM inclusion rate. Monocytes are type of white blood cells which are produced by the bone marrow from precursors called monoblast. State of excess monocytes (monocytosis) is associated to chromic inflammation, stress response, necrosis, internal haemorrhage, immune-mediated disorders among others while monocytopenia did not have clinical significance (Peter and Susan, 1991). Therefore, the progressive decrease in monocytes count with increase in ACLM inclusion level in this study further supports the safety of ACLM inclusion in broiler diets. The reduction in cholesterol level in association with increase in ACLM inclusion rate in this study reflects the hypocholesterolemic properties attributed to the defatted part of leaves which are high in fibre as they may block absorption of cholesterol in the intestine (Lansky, *et al.,* 1993). This finding is in consonance with findings of Ghazalah and Ali (2008) and Umit *et al.,* (2011) who fed chickens diets supplemented with *Rosmarinus officianalis L* and Obikaonu *et al.,* (2012) who fed broiler starter with leaf meal of *Azadiracta indica.* Although, urea concentration may not have much value in detecting renal disease in many avian species (broiler inclusive), it could be used as a sensitive indicator of dehydration. High urea plasma levels has been linked to conditions such as dehydration and ureteral obstructions that caused low urine flow (Lumeij, 1998). On the other hand, decreased urea value has been reported to be associated with decreased urea synthesis, mal-absorption, protein malnutrition and advanced liver disease (Peter and Susan, 1991). The decrease in urea level with increase in ACLM inclusion rate in this study is similar to the report of Obikaonu *et al.,* (2012) who observed decrease in urea level from 30.53 mg/dl to 27.03 mg/dl in broiler as the dietary inclusion level of neem leaf meal increased from 0% to 10%.

SGOT which is an enzyme found in cardiac muscle, skeletal muscle, kidney, brain and red blood cell can be defined as a biochemical marker for the diagnosis of acute myocardial infarction (Gaze, 2007). Myocardial degeneration has been identified as a major cause of sudden death and serious losses in broiler industry (Kwada *et al.,* 1994) which in most cases is the resultant effect of burden imposed on heart due to procedures adopted for growing chickens to produce a fast body weight gain of about 3kg in 60 days (Masegi *et al.,* 1993).

The progressive reduction in the SGOT levels of the broilers with the increase in ACLM inclusion level indicate the safety of inclusion of the leaf meal in broiler ration at the rates stated in this study and

Table VI. Effect of commercial enzyme supplementation and graded levels of *Alchornea cordifolia* leaf meal (ACLM) on the proportional weight (% live weight) of the internal organ of broilers (2-8 weeks) (Efecto de la suplementación con enzimas comerciales y diferentes niveles de harina de hojas de *Alchornea cordifolia* (ACLM) sobre sobre la proporción (% peso vivo) de órganos internos de pollos(2-8 semanas).

Diets	Enzyme (g)	ACLM (%)	Liver	Heart	Lung	Kidney	Gizzard	Spleen	Proventriculus	Gall bladder
	0.00		2.73	0.56	0.52	0.74	3.38	0.12	0.56	0.10
	0.35		2.87	0.59	0.57	0.78	3.90	0.13	0.59	0.11
	SEM		0.12	0.12	0.03	0.02	0.13	0.02	0.04	0.01
	p value		0.41	0.13	0.30	0.28	0.50	0.72	0.61	0.71
		0	3.03[a]	0.57	0.61	0.77	3.76	0.16	0.73[a]	0.11
		5	2.16[b]	0.61	0.51	0.81	4.12	0.11	0.48[b]	0.11
		10	3.21[a]	0.54	0.52	0.71	3.63	0.12	0.51[b]	0.09
		SEM	0.15	0.02	0.04	0.03	0.16	0.02	0.05	0.01
		p value	0.01	0.08	0.18	0.10	0.12	0.12	0.01	0.32
	Enzyme	ACLM								
1	0.00	0	2.93	0.56	0.58	0.75	3.66	0.17	0.72	0.10
2	0.35	0	3.13	0.59	0.64	0.79	3.87	0.16	0.74	0.12
3	0.00	5	2.11	0.60	0.50	0.79	4.02	0.11	0.47	0.12
4	0.35	5	2.21	0.63	0.52	0.82	4.21	0.11	0.50	0.11
5	0.00	10	3.15	0.52	0.49	0.69	3.64	0.10	0.49	0.09
6	0.35	10	3.28	0.57	0.55	0.73	3.61	0.13	0.53	0.10
	SEM		0.21	0.03	0.05	0.04	0.22	0.03	0.70	0.01
	p value		0.97	0.93	0.92	1.00	0.84	0.81	0.99	0.67

*Means with different superscripts in the same row are significantly different (p<0.05).

Table VII. Effect of commercial enzyme supplementation and graded levels of *Alchornea cordifolia* leaf meal (ACLM) on the haematology of broilers (2-8 weeks) (Efecto de la suplementación con enzimas comerciales y diferentes niveles de harina de hojas de *Alchornea cordifolia* (ACLM) sobre la hematología de pollos (2-8 semanas).

Diets	Enzyme (g/kg)	ACLM (%)	PCV	RBC	M CH	MCV	MCHC	HBC	WBC	LYMP	MONO	GRA
	0.00		24.13	2.21	67.85	111.42	60.93	14.75	104.04	75.33	15.19	9.48
	0.35		23.57	2.18	67.45	109.33	61.73	14.25	102.48	74.15	16.80	8.95
	SEM		0.56	0.05	0.45	0.98	0.30	0.35	3.65	2.65	1.86	0.94
	P value		0.49	0.68	0.55	0.15	0.08	0.33	0.77	0.76	0.55	0.70
		0	23.02	2.04^{b}	69.35^{a}	114.00^{a}	60.80	13.98	95.25	68.53	20.00^{a}	11.48
		5	23.36	2.13^{b}	69.50^{a}	112.63^{a}	61.84	8.18	103.87	74.93	16.86^{ab}	8.18
		10	25.15	2.42^{a}	64.10^{b}	104.50^{b}	61.35	8.00	110.67	80.78	11.13^{b}	8.00
		SEM	0.69	0.06	0.56	1.20	0.36	1.15	4.47	3.25	2.28	1.15
		P value	0.10	0.00	0.00	0.00	0.17	0.22	0.09	0.06	0.05	0.10
	Enzyme	ACLM										
1	0.00	0	24.15	2.05	70.55	118.00	59.80	14.40	95.21	68.30	20.20	11.50
2	0.35	0	21.90	2.04	68.15	110.00	61.80	13.55	95.30	68.75	19.80	11.45
3	0.00	5	23.82	2.23	68.90	111.75	61.72	14.70	106.01	76.75	14.28	8.95
4	0.35	5	22.91	2.03	70.10	113.50	61.95	14.15	101.72	73.10	19.45	7.40
5	0.00	10	24.42	2.37	64.10	104.50	61.25	15.15	110.92	80.95	11.10	8.00
6	0.35	10	25.89	2.48	64.10	104.50	61.45	15.05	110.43	80.60	11.15	8.00
	SEM		0.98	0.09	0.78	1.70	0.51	0.60	6.31	4.60	1.63	1.63
	P value		0.19	0.23	0.11	0.03	0.17	0.83	0.93	0.89	0.64	0.87

*Means with different superscripts in the same row are significantly different ($p<0.05$). PCV: Packed cell volume (%); RBC: Red blood cells ($x10^{12}/l$); MCH: Mean cell haemoglobin (pg); MCV: Mean cell volume (fl); MCHC: Mean cell haemoglobin concentration (g/dl); HBC: Haemoglobin conc. (g/dl); WBC: White blood cells ($x10^{9}/l$); LYM: Lymphocytes ($x10^{9}/l$); MON: Monocytes ($x10^{9}/l$); GRA: Granulocytes ($x10^{9}/l$).

Table VIII. Effect of commercial enzyme supplementation and graded levels of *Alchornea cordifolia* leaf meal (ACLM) on the serum biochemistry of broilers (2-8 weeks) (Efecto de la suplementación con enzimas comerciales y diferentes niveles de harina de hojas de *Alchornea cordifolia* (ACLM) sobre sobre la bioquímica del suero de pollos (2-8 semanas).

Diets	ENZYME (g/kg)	ACLM (%)	TPR	ALB	GLO	CHO	URE	CRE	BIL	SGOT	SGPT	GLU
	0.00		5.17	2.15	3.03	101.33	19.67	0.57	0.99	34.89	21.38	228.83
	035		5.22	2.05	3.17	103.33	19.66	0.59	0.92	29.80	23.02	215.00
	SEM		0.21	0.22	0.29	0.53	0.41	0.02	0.08	9.14	0.45	6.20
	p value		0.88	0.75	0.73	0.02	1.00	0.68	0.47	0.01	0.03	0.14
		0	5.58	2.12	3.45	107.00^{a}	21.50^{a}	0.60	1.03	34.87^{b}	22.72	229.00^{a}
		5	5.23	2.02	3.21	100.50^{b}	19.50^{b}	0.58	0.99	34.50^{ab}	21.38	232.75^{a}
		10	4.78	2.14	2.64	99.50^{b}	18.00^{b}	0.55	0.84	29.67^{a}	22.52	204.00^{b}
		SEM	0.26	0.27	0.36	0.65	0.50	0.03	0.09	1.07	0.56	7.59
		p value	0.14	0.95	0.30	0.00	0.00	0.49	0.34	0.02	0.22	0.04
	Enzyme	ACLM										
1	0.00		5.83	2.10	3.73	101.00	20.50	0.59	1.18	37.33	21.50	250.00
2	0.35		5.34	2.15	3.18	113.00	22.50	0.61	0.89	32.40	23.93	208.00
3	0.00		5.29	2.05	3.24	101.50	20.00	0.59	0.94	35.00	21.90	232.50
4	0.35		5.16	2.00	3.17	99.50	19.00	0.57	1.05	30.00	20.85	233.00
5	0.00		4.40	2.29	2.11	101.50	18.50	0.54	0.87	32.33	20.75	204.00
6	0.35		5.17	1.99	3.18	97.50	17.50	0.58	0.81	27.00	24.28	203.00
	SEM		0.37	0.38	0.51	0.91	0.71	0.04	0.13	1.52	0.79	10.74
	p value		0.25	0.89	0.29	0.00	0.09	0.73	0.37	0.99	0.03	0.12

*Means with different superscripts in the same row are significantly different ($p<0.05$). TPR: Total protein (g/l); ALB: Albumin (g/l); GLO: Globulin (g/l); CHO: Cholesterol (mg/dl); URE: Urea (mg/dl); CRE: Creatinine (mg/dl); BIL: Bilirubin (µ/l); SGOT: Serum glutamic oxalate acetic transaminase (µ/l); SGPT: Serum glutamic pyruvic transaminase (µ/l); GLU: Glucose (mg/dl).

possibility of reducing cases of myocardial infarction in broilers by the inclusion of ACLM in their diets. However, this result contradicts the report of Owen and Amakiri (2012) who recorded increase in SGOT level at 10% and 15% bitter leaf meal inclusion level in broiler finisher's ration. The observed decrease in serum glucose level in correlation to increase in ACLM inclusion level in this study could be due to presence of bioactive compounds contained in *Alchornea cordifolia* leaf which is capable of blocking the energy metabolic pathway (Chattopadhay, 1996). This result is similar to the report of Nnenna and Okey (2013) who had the glucose level of broiler chicken reduced by aqueous extract of neem leaf, disagreed with Obun *et al.,* (2013) who reported increased glucose level in broiler chicks fed graded levels of neem leaf meal.

In conclusion, based on data obtained from this study, ACLM can be very useful in poultry nutrition. It is suggested that 10% ACLM inclusion level could be used in broiler production without compromising their performance, carcass characteristics and health status. In addition, nutrients in ACLM are better utilized by exogenous enzyme supplementation.

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