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Effects of dosage and plant parts of *Petiveria alliacea* used as phytobiotics on growth, nutrient digestibility and blood profile of Pullet chicks

Muhammad, S.B.[1@]; Sobayo, R.A.[1]; Oso, A.O.[1]; Sogunle, O.M.[2]; Ayoola, A.A.[2]; Adeyemo, A.A.[2] And Basiru, Y.T.[2]

[1]Department of Animal Nutrition, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.
[2]Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

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SUMMARY

Four hundred and fifty (450) Isa brown pullet chicks were used to evaluate the effects of feeding diets containing Petiveria alliacea leaf meal (PLM) and Petiveria alliacea root meal (PRM) on growth, nutrient digestibility and blood profile of pullet chicks. The birds were divided into ten treatment groups of forty-five chicks with three replicate of fifteen chicks each. The diets contained PLM and PRM at five levels of inclusion; 0, 1000, 1500 and 2000 and 2500 mg/kg. The experiment was arranged in a 2 × 5 factorial design in a completely randomized design. Addition of PLM at 2000 mg/kg and PRM at 1500 mg/kg increased (P<0.05) mortality (%). The contents of haemoglobin and red blood cell were higher (P<0.05) in birds fed 2500 mg/kg of PRM than that of other varying concentration levels. Mean Corpuscular Heamoglobin content were poorer (P<0.05) in birds fed diets with 1000 mg/kg of PRM than those of other dietary concentrations. Birds fed diets with 1500 mg/kg of PLM showed superior (P<0.05) total protein and albumin in comparison to other. The content of serum globulin was higher (P<0.05) in birds fed of 1500, 2000 of PLM and 2500 mg/kg of PRM than that of other concentrations of PLM and PRM. Serum ALT in birds fed diets containing control and 2000 mg/kg of PRM was lower (P<0.05) in comparison to other dietary groups. When compared with 1000 mg/kg of PRM, uric acid content decreased (P<0.05) in birds fed diets with 2500 mg/kg of PLM. Among varying concentrations, 2500 mg/kg of PLM, 1500 and 2500 mg/kg of PRM had best (P<0.05) HDL while serum LDL was higher (P<0.05) in birds fed diets with 1000 mg/kg of PLM than 2000 mg/kg of PRM. It could be concluded that incorporation of Petiveria parts at varying concentration could serve as an immune booster for pullet chicks.

Efectos de la dosificación y partes de plantas de *Petiveria alliacea* utilizado como fitobióticos sobre el crecimiento, digestibilidad de nutrientes y perfil sanguíneo de los polluelos

Palabaras clave adicionales
Hoja y harina de raíz de *Petiveria alliacea*
Polluelos.
Rendimiento.
Digestibilidad.
Suero y hematología.

RESUMEN

Se utilizaron cuatrocientos cincuenta (450) polluelos de Isa Brown para evaluar los efectos sobre el crecimiento, la digestibilidad de los nutrientes y el perfil sanguíneo de las dietas de alimentación que contienen harina de hoja de Petiveria alliacea (PLM) y harina de raíz de Petiveria alliacea (PRM). Las aves se dividieron en diez grupos de tratamiento de cuarenta y cinco polluelos con tres réplicas de quince polluelos cada una. Las dietas contenían PLM y PRM en cinco niveles de inclusión; 0, 1000, 1500 y 2000 y 2500 mg/kg. El experimento se organizó en un diseño factorial de 2 x 5 completamente aleatorio. La adición de PLM a 2000 mg/kg y PRM a 1500 mg/kg aumento significativamente (P<0.05) mortalidad (%). El contenido de hemoglobina y glóbulos rojos fue mayor (P<0.05) en aves alimentadas 2500 mg/kg de PRM que en otros niveles de concentración. El contenido medio de hemaglobina corpuscular fue más pobre (P<0.05) en las aves alimentadas con 1000 mg/kg de PRM que las de otras concentraciones dietéticas. Las aves alimentadas con dietas alimentadas con 1500 mg/kg de PLM mostraron proteína y albúmina totales superiores (P<0.05) en comparación con las otras. El contenido de globulina sérica fue mayor (P<0.05) en aves alimentadas de 1500, 2000 de PLM y 2500 mg/kg de PRM que el de otras concentraciones de PLM y PRM. La ALT sérica en las aves alimentadas con el control y 2000 mg/kg de PRM fue menor (P<0.05) en comparación con otros grupos dietéticos. En comparación con 1000 mg/kg de PRM, el contenido de ácido úrico disminuyó (P<0.05) en las dietas alimentadas con aves con 2500 mg/kg de PLM. Entre las diferentes concentraciones, 2500 mg/kg de PLM, 1500 y 2500 mg/kg de PRM tuvieron mejor (P<0.05) HDL mientras que el suero LDL fue mayor (P<0.05) en aves alimentadas con 1000 mg/kg de PLM que 2000 mg/kg de PRM. Se podría concluir que la incorporación de partes de Petiveria a una concentración variable podría servir como un refuerzo inmune para los polluelos.

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babatunde.muhammad9@gmail.com

INTRODUCTION

Feed additives have been added in poultry diets to promote growth, protect health and maximize the genetic potential of broiler and layer hybrids for several decades. One of these growth promoters is antibiotics which have been used at sub therapeutic doses in ani-

mal feeds to improve feed conversion efficiency among other uses (Engberg *et al.,* 2000, p. 1311). Antibiotics are naturally-occurring synthetic or semi-synthetic compounds with antimicrobial activity. They can be administered orally or topically and are used in human and veterinary medicine to treat and prevent disease and for other purposes including growth promotion in animals (Phillips *et al.,* 2004, p. 28). The use of antibiotics as growth promoters is facing serious criticism (Iji *et al.,* 2001, p. 505). There are some important reasons that restrict the use of antibiotics such as the drug resistance in bacteria and residues in meat (CAFA, 1997). Herbal agents could serve as safer alternatives as growth promoters due to lower cost, reduced toxicity and minimum health hazards. Kumar (1991, p. 37) reported that biological trials of certain herbal formulations as growth promoter have shown encouraging results and some of the reports have demonstrated to be improved weight gain and feed efficiency, lowered mortality, and increased immunity and viability in poultry. The mechanism of phytogenic additives has not been explained entirely, Cross *et al.* (2007, p. 496) opined that the efficiency of phytogenic additives depends on differences in their chemical composition while Ciftci *et al.* (2005, p. 851) reported that birds' response to phytogenic products could be related to their inclusion level in the diet and variety of Essential Oils (EO). Nigeria is blessed with wide range of medicinal herbs scattered over a large area, due to the favourable climatic condition. These herbs possess a number of chemical substances for use in poultry as feed additives (Akhtar *et al.,* 1984, p. 6). Among these medicinal plants is *Petivera alliacea* popularly called guinea hen weed around the world. In Western parts of Nigeria it is popularly called "awogba" meaning something that can be used to cure all ailments. In Nigeria, *Petiveria alliacea* (awogba) is used as herbs in the treatments of ailments such as pie, de-*wormer* and cancer etc. Quadros *et al.* (1999, p. 109) reported that mice administered *Petiveria alliacea* extract showed increased immunity against infection and stimulated immune cell production such lymphocytes were recorded. However, the use of this plant as a medicinal herb on poultry is novel. Phytochemical extracts investigated by Ekunseitan *et al.* (2016, p. 289) on *Petiveria alliacea* leaves and *Lagenaria breviflora* revealed that the phytochemical component of *P alliacea* leaves were far better than those found on *L breviflora*. In pursuit of improved pullet health and in order to fulfil consumer expectation in relation to food quality there is a need to explore the medicinal properties of natural herb (Gardzielewska *et al.,* 2003, p. 12). This study was therefore, conducted to evaluate the effects of *Petiveria alliacea* on growth, nutrient digestibility and blood parameters of pullet chicks.

MATERIALS AND METHODS

Processing of test ingredients

Petiveria alliacea root was washed, chopped into bits followed by sun drying for 14 days (≤ 90% DM) and pulverised using laboratory mill (1mm sieve) to obtain a product herein referred to as *Petiveria* root meal (PRM). *Petiveria alliacea* leaves were washed, air dried under a shed (29±2^{0}C) until they are crispy to touch, while retaining their greenish colouration. The leaves were milled (1mm sieve) using a laboratory mill to obtain a product referred to as *Petiveria* leaf meal (PLM). The entire test ingredients were stored in an air tight container at room temperature until when needed.

Management of pullet chicks

This study was conducted at the Poultry Unit of the Teaching and Research Farms, Federal University of Agriculture Abeokuta, Ogun State, Nigeria. A total of 450 one-day-old ISA brown pullets obtained from a commercial hatchery in Ogun State, Nigeria and were reared intensively together under a deep litter housing system for a 56 days experimental trial. Dried wood shavings were used as litter material. Brooding of pullet chicks was done for 0–21 d of age, and normal ambient temperature prevailed after the brooding period. Pullet chicks were fed with mash diets based on maize-soybean meal according to NRC requirements. During the experiment, feed and fresh water were supplied ad libitum.

Dietary treatments and composition

A total of 450 one-day-old ISA brown pullets were allotted to 10 treatments with 3 pens (dimension, 3.0 × 1.0 m) per treatment and 15 pullet chicks per pen in a 2×5 factorial experimental design. The diets contained PLM and PRM at five levels of inclusion each; 0, 1000, 1500, 2000 and 2500 mg/kg. A total of 30 similar floor pens were used in this study. The pens were furnished with wood shavings as beddings. The nutrient composition of experimental diets is given in **Table I**.

Growth performance

Records of weight gain (g)/bird: (final weight - initial weight), feed intake (g)/bird: (feed supplied – left over/ number of birds), mortality: (number of dead birds/total number of birds × 100), feed conversion ratio: (total feed intake/total body weight gain) were obtained.

Nutrient digestibility

Metabolism trial was conducted at day 56 of the study. Two birds per replicate was randomly selected and housed separately in appropriate metabolism cages fitted with individual feed troughs and facility for separate excreta collection. The chicks were acclimatized for 2 days prior to the commencement of 3 days collection period. Excreta collected per replicate per day was oven dried (60 °C) and used for analysis. Proximate composition of feed and dried excreta samples were analysed for dry matter crude fibre, ether extract, ash and crude protein using standard methods (AOAC, 2000).

Blood sample collection

At 56 d of trial, blood sample (2.5 mL each) was collected from the brachial wing vein of one pullet chicks per pen (selected at random) into a bottle containing ethylene diamine tetra-acetate for the determination of haematological indices. Another set of blood was collected into plain bottles (without ethylene diamine tetra-acetate), centrifuged (2500×g for 15 min at 8 °C), and used for serum chemistry analysis.

Table I. Gross Composition (%) of Experimental diets of Chick starter, (0-8 weeks) (Composición bruta (%) de dietas experimentales de Chick starter, (0-8 semanas)

	PLM (mg/kg)					PRM (mg/kg)				
Ingredients	0	1000	1500	2000	2500	0	1000	1500	2000	2500
Maize	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00
Wheat offal	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70
SBM	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
GNC	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
FM (72%)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PKM	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
BM	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Oyster Shell	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
PLM	-	+	++	+++	++++	-	-	-	-	-
PRM	-	-	-	-	-	-	+	++	+++	++++
Total	100	100	100	100	100	100	100	100	100	100
Calculated Proximate composition (%)										
ME (kcal/kg)	2829.60	2829.60	2829.60	2829.60	2829.60	2829.60	2829.60	2829.60	2829.60	2829.60
CP	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94	19.94
CF	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42
EE	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65
Ash	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87

Vit./Min. Premix contains B_1 1g; B_2 6g; B_{12} 0.02g; K_3 3g; E, 30g; biotin, 0.05g; folic acid, 1.5g; choline chloride, 250g; nicotinic acid, 30g; Ca-Pantothenate, 15g; Co, 0.4g; Cu, 8g; Fe, 32g; I, 0.8g; Zn, 40g; Mn, 64g; Se, 0.16g, BHT, 5g. *Petivera* Leaf Meal PRM: *Petivera* Root Meal. – = exclusion levels. + = 1000 mg/kg, ++ = 1500mg/kg, +++ = 2000mg/kg, ++++ =2500mg/kg. SBM: Soy bean meal, GNC: Groundnut cake, FM: Fish meal, PKM: Palm kernel meal, BM: Bone meal. ME: Metabolizable Energy, CP: Crude Protein, CF: Crude Fibre, EE: Ether Extract.

Haematological indices

Hemoglobin concentration (Hb) was estimated using the cyanmethaemoglobin method (Cannan, 1958). Packed cell volume (PCV), red blood cell (RBC), and white blood cell counts (WBC) were determined with Wintrobe haematocrit tube according to the method of (Schalm *et al.,* 1975). MCHC (Mean Corpuscular Haemoglobin Concentration) was calculated by dividing the haemoglobin by the packed cell volume (PCV) as described by (Van Beekvelt *et al.,* 2001, p. 511). MCV (Mean Corpuscular Volume) The mean corpuscular volume, or mean cell volume (MCV) reported as part of a standard complete blood count Tonnesen *et al.* (1986, p. 515) was calculated by dividing Packed Cell Volume by the Red Blood Cell. MCH (Mean corpuscular haemoglobin) reported as part of a standard complete blood count Van Beekvelt *et al.,* (2001, p. 511) is calculated as average mass of haemoglobin per red blood cell in a sample of blood.

Serum chemistry

Total serum protein Varley *et al.* (1980, p. 535) and serum uric acid concentrations Wootton (1964, p. 86) was measured according to standard procedures of Tietz (1995) and (Fossati *et al.,* 1980) respectively. Albumin concentration was determined by the Bromocresol Green (BCG) method (Peters *et al.,* 1982, p. 325). Globulin concentration was computed as the difference between total protein and albumin concentrations. Glucose was measured according to procedure of Tietz (1995). Serum triglyceride, low density lipoprotein and high density lipoprotein were carried according to standard procedure describe by (Randox, 2012). Serum enzymes such as aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined according to Bergmeyer (1983, p. 126) with the aid of commercial kits (Roche COBAS testing Kits, Roche, Basel, Switzerland). Cholesterol was determined as described by (Coles, 1986).

Statistical Analysis

Data were subjected to 2-way analysis of variance in a 2 × 5 factorial layout. Significant ($p<0.05$) differences among treatment means were determined using Duncan Multiple Range Test Duncan (1955, p. 1) as contained in Statistical Analysis Software package (SAS, 2000).

RESULTS

Effects of Petiveria parts (PLM and PRM), Petiveria concentration and interaction of Petiveria parts and Petiveria concentration on growth performance of pullet chicks (0-8 weeks old)

Table II showed the effects of *Petiveria* parts (PLM and PRM), *Petiveria* concentration and interaction of *Petiveria* parts and *Petiveria* concentration on growth

performance of pullet chicks (0-8 weeks old). *Petiveria* parts reflected no significant (P>0.05) effect on growth parameter measured. However, mortality rate was affected (P<0.05) by *Petiveria* concentration. When compared with other level of concentration; chicks fed diets with 1500 and 2000 mg/kg had similar mortality value of (1.14%). At the interaction between *Petiveria* parts and *Petiveria* concentration existed significant (P<0.05) effect on mortality of growth parameter measured (0-8 weeks old). Mortality rate (2.27%) of birds fed diet incorporated with 2000 mg/kg of PLM and 1500 mg/kg of PRM recorded the highest (P<0.05) when compared to other groups.

Table III showed effects of Petiveria parts (PLM and PRM), Petiveria concentration and Interaction of Petiveria parts and Petiveria concentration on apparent nutrient digestibility of pullet chicks (0-8 weeks old).

Table III showed effects of *Petiveria* parts (PLM and PRM), *Petiveria* concentration and Interaction of *Petiveria* parts and *Petiveria* concentration on apparent nutrient digestibility of pullet chicks (0-8 weeks old). Apparent nutrient digestibility parameter measured were not affected (P>0.05) by engagement of *Petiveria* parts and *Petiveria* concentration. More also Interaction between *Petiveria* parts and *Petiveria* concentration showed no influence (P>0.05) on apparent nutrient digestibility measured.

The effect of Petiveria parts (PLM and PRM), Petiveria concentration and Interaction of Petiveria parts and Petiveria concentration on haematological indices of pullet chicks (0-8 weeks old).

The effect of *Petiveria* parts (PLM and PRM), *Petiveria* concentration and Interaction of *Petiveria* parts and *Petiveria* concentration on haematological indices of pullet chicks (0-8 weeks old) is presented in **Table IV**. There occurred significant (P<0.05) effect of *Petiveria* parts on basophil and monocyte of haematological parameter measured. Birds on diets added with PRM had least (P<0.05) basophil and monocyte in comparison to the PLM. And concentration of *Petiveria* parts significantly (P<0.05) affected heterophil, eosinophil, basophil and mean corpuscular volume. Birds on diets included with concentration of 1500 mg/kg was reduced (P<0.05) than other concentrations. Incorporation of 0 mg/kg concentration elevated (P<0.05) eosinophil when compared to other concentrations. Basophil in

Table II. Effects of main and interactive of PLM and PRM on growth performance of pullet chicks (0-8) weeks
(Efectos de la PLM y PRM principales e interactivas en el rendimiento de crecimiento de los polluelos Isa Brown (0-8) semanas)

Treatment		Initial weight (g/p)	Final weight (g/p)	Weight gain (g/p)	Daily weight gain (g/p/day)	Feed intake (g/p)	Feed/gain ratio	Mortality (%)
Petiveria parts	Concentration							
PLM		33.18	424.00	391.37	6.98	41.58	5.96	0.45
PRM		33.47	416.89	383.42	6.85	40.57	5.93	0.45
SEM		0.781	9.992	9.316	0.166	0.933	0.143	0.244
	0	32.63	409.35	376.72	6.73	39.84	5.93	0.00[b]
	1000	33.67	409.81	376.15	6.72	41.54	6.20	0.00[b]
	1500	31.77	423.84	392.20	7.00	41.87	5.98	1.14[a]
	2000	34.56	432.65	393.29	7.02	40.58	5.77	1.14[a]
	2500	34.02	16.24	398.63	7.12	41.54	5.85	0.00[b]
	SEM	1.230	16.240	15.114	0.270	1.541	0.230	0.204
PLM	0	32.29	421.88	389.59	6.96	39.80	5.72	0.00[b]
	1000	33.33	401.45	368.12	6.57	42.56	6.48	0.00[b]
	1500	32.29	415.54	383.25	6.84	41.47	6.06	0.00[b]
	2000	34.00	431.22	397.22	7.09	41.38	5.83	2.27[a]
	2500	34.00	452.67	418.67	7.48	42.67	5.71	0.00[b]
PRM	0	32.97	396.82	363.85	6.50	39.88	6.14	0.00[b]
	1000	34.00	418.17	384.17	6.86	40.52	5.91	0.00[b]
	1500	31.25	432.39	401.14	7.16	42.26	5.90	2.27[a]
	2000	35.11	424.46	389.35	6.95	39.78	5.70	0.00[b]
	2500	34.04	412.63	378.59	6.76	40.40	5.98	0.00[b]
SEM		1.924	24.291	22.366	0.399	2.371	0.343	0.026[b]
P-values								
Petiveria parts		0.7969	0.6089	0.5681	0.5681	0.4760	0.8732	1.0000
Concentration		0.5393	0.7966	0.7713	0.7713	0.8807	0.7508	0.0206
Petiveria parts x concentration		0.9463	0.8988	0.8496	0.8496	0.9848	0.8635	0.0001

[ab] Means on the same row having different superscript were significant (P<0.05), g/p: gramme/pullet

Table III. Effects of main and interactive of PLM and PRM on apparent nutrient digestibility of pullet chicks (0-8) weeks (Efectos de la PLM y PRM principal e interactivo en la digestibilidad aparente de nutrientes de los polluelos (0-8) semanas).

Treatment		Dry matter (%)	Crude protein (%)	Crude fiber (%)	Ether extract (%)	Ash (%)
Petiveria parts	Concentration					
PLM		82.33	80.00	54.02	73.85	58.86
PRM		81.32	79.80	57.23	70.90	59.33
SEM		2.007	1.968	1.345	2.200	1.756
	0	78.94	77.79	56.58	68.85	56.08
	1000	82.49	80.91	58.39	75.86	58.97
	1500	86.04	80.24	53.05	70.73	58.57
	2000	83.53	77.44	55.97	68.26	59.69
	2500	78.12	83.60	54.09	78.18	62.15
	SEM	3.103	3.126	2.205	3.260	2.747
PLM	0	82.75	78.04	54.95	71.71	56.36
	1000	82.33	85.45	58.67	78.95	62.14
	1500	84.88	79.67	51.67	78.16	62.80
	2000	82.59	74.23	53.47	63.63	52.63
	2500	79.10	82.62	51.33	76.83	60.39
PRM	0	75.13	77.55	58.21	65.99	55.80
	1000	82.65	76.37	58.11	72.78	55.80
	1500	87.21	80.83	54.43	63.30	54.33
	2000	84.47	80.65	58.48	72.89	66.74
	2500	77.14	84.57	56.85	79.52	63.90
SEM		4.724	4.618	3.211	4.179	3.412
P-values						
Petiveria parts		0.7242	0.9978	0.1065	0.3256	0.8623
Concentration		0.3884	0.6557	0.4413	0.1636	0.6816
Petiveria parts x Concentration		0.7777	0.7840	0.6382	0.0681	0.1117

birds on diets included with 1000 mg/kg concentration was lowered (P<0.05) when compared with concentration of 1000 mg/kg. In addition, MCV was decreased (P<0.05) at 2500 mg/kg *Petiveria* concentration in comparison to the control. The interaction between *Petiveria* parts and *Petiveria* concentration was significant (P<0.05) for haematological parameter measured except for Packed Cell Volume (PCV), White Blood Cell (WBC), heterophil and lymphocyte. Incorporation of 2500 mg/kg concentration of PRM to diets showed better (P<0.05) haemoglobin than those on 2500 mg/kg of PLM and 1000 mg/kg of PRM. When compared to other varying concentrations, red blood cell was best (P<0.05) in birds fed diets added with 2500 mg of PRM. Amidst varying concentrations eosinophil was reduced (P<0.05) in birds fed diets containing 2000 and 2500 mg/kg of PLM, 1000 and 1500 mg/kg of PRM. Basophil in birds fed diets included with 2000 and 2500 mg/kg of PRM was decreased (P<0.05) when compared to higher values obtained in birds on 1000 mg/kg, 1500 mg/kg, 2500 mg/kg of PLM and 1000 mg/kg of PRM. Addition of 0 mg/kg concentration of *Petiveria* parts increased (P<0.05) mean corpuscular volume but decreased with other inclusion concentration. Mean corpuscular haemoglobin was reduced (P<0.05) in birds fed diets included with 1000 mg/kg of PRM concentration but statistically similar to that of 1500 mg/kg of PLM concentration. When compared with 1000 mg/kg of PRM, mean corpuscular haemoglobin concentration was elevated in birds fed diets containing 1000 and 2000 mg/kg of PLM.

Serum biochemical of pullet chicks (0-8 weeks old) as affected by Petiveria parts (PLM and PRM), Petiveria concentration and Interaction of Petiveria parts and Petiveria concentration

Serum biochemical of pullet chicks (0-8 weeks old) as affected by *Petiveria* parts (PLM and PRM), *Petiveria* concentration and Interaction of *Petiveria* parts and *Petiveria* concentration is shown in **Table V**. *Petiveria* parts significantly influenced glucose and uric acid. Addition of PRM to diets increased (P<0.05) serum glucose and uric acid in comparison to PLM. *Petiveria* concentration showed no significant (P>0.05) effect on Glucose, Alanine Transaminase (ALT), Uric acid, Triglyceride and Very Low Density Lipoprotein (VLDL). Total protein in birds included with 1500 mg/kg was elevated (P<0.05) when compared with other levels of *Petiveria* concentration. Amidst varying concentration of *Petiveria*, highest (P<0.05) serum albumin was obtained in birds added with 1500 mg/kg. When compared to other *Petiveria* concentrations, addition of 0 and 1000 mg/kg *Petiveria* concentration lowered (P<0.05) serum globulin. Birds fed with 0 mg/kg of *Petiveria* concentration recorded reduced (P<0.05) alanine transaminase in comparison to others. Incorporation of 2500

Table IV. Effects of main and interactive of PLM and PRM on haematological indices of pullet chicks (0-8) weeks (Efectos de la PLM y PRM principal e interactivo en los índices hematológicos de los polluelos (0-8) semanas).

Treatment		PCV (%)	Hb (g/dl)	RBC ($\times10^{12}$/l)	WBC ($\times10^{9}$/l)	HET (%)	LYM (%)	EOS (%)	BAS (%)	MON (%)	MCV (fl)	MCH (Pg)	MCHC (g/dl)
Petiveria parts	Levels of Inclusion												
PLM		30.42	9.58	2.48	12.76	31.30	65.60	0.70	0.80^{a}	1.60^{a}	119.39	38.34	31.16
PRM		33.05	10.36	2.70	12.56	30.40	67.80	0.60	0.40^{b}	0.80^{b}	126.02	38.37	30.72
SEM		0.914	0.353	0.088	0.380	0.942	1.590	0.180	0.084	0.209	5.908	1.284	1.048
	0	32.00	9.30	2.25	12.40	32.00^{a}	64.50	1.75^{a}	0.50^{bc}	1.25	156.58^{a}	41.80	27.90
	1000	30.00	9.20	2.60	13.85	29.50^{ab}	67.25	0.50^{b}	1.00^{a}	1.75	114.80^{b}	34.50	29.88
	1500	33.50	10.43	2.78	11.90	27.25^{b}	70.25	0.50^{b}	0.75^{ab}	1.25	121.15^{b}	36.75	30.40
	2000	27.50	10.88	2.68	12.23	32.50^{a}	66.00	0.25^{b}	0.25^{c}	1.00	122.75^{b}	40.68	33.18
	2500	30.25	10.05	2.65	12.93	33.00^{a}	65.50	0.25^{b}	0.50^{bc}	0.75	98.25^{c}	38.05	33.35
	SEM	1.443	0.527	0.123	0.560	1.248	2.555	0.161	0.078	0.281	5.282	1.789	1.448
PLM	0	31.50	8.95^{de}	2.20^{d}	11.50	33.00	62.50	1.50^{b}	0.50^{b}	2.50^{a}	156.40^{a}	40.35^{ab}	27.20^{cd}
	1000	29.50	9.90^{abcde}	2.25^{bcd}	15.20	32.00	64.50	1.00^{c}	1.00^{a}	1.50^{c}	115.50^{b}	38.90^{ab}	33.75^{a}
	1500	32.50	9.40^{cde}	2.70^{abcd}	12.00	27.00	68.50	1.00^{c}	1.00^{a}	2.50^{a}	121.30^{b}	33.30^{bc}	27.65^{bcd}
	2000	33.00	11.15^{abc}	2.75^{abc}	11.85	32.00	66.50	0.00^{e}	0.50^{b}	1.00^{d}	119.95^{b}	40.55^{ab}	33.80^{a}
	2500	25.50	8.50^{e}	2.20^{d}	13.25	32.50	66.00	0.00^{e}	1.00^{a}	0.50^{e}	83.80^{c}	38.60^{ab}	33.40^{ab}
PRM	0	32.50	9.65^{bcde}	2.30^{cd}	13.30	31.00	66.50	2.00^{a}	0.50^{b}	0.00^{f}	156.75^{a}	43.25^{a}	28.60^{abcd}
	1000	30.50	8.50^{e}	2.65^{abcd}	12.50	27.00	70.00	0.00^{e}	1.00^{a}	2.00^{b}	114.10^{b}	30.10^{c}	26.00^{d}
	1500	34.50	11.45^{ab}	2.85^{ab}	11.80	27.50	72.00	0.00^{e}	0.50^{b}	0.00^{f}	121.00^{b}	40.20^{ab}	33.15^{ab}
	2000	32.50	10.60^{abcd}	2.60^{bcd}	12.60	33.00	65.50	0.50^{d}	0.00^{c}	1.00^{d}	125.55^{b}	40.80^{a}	32.55^{abc}
	2500	35.00	11.60^{a}	3.10^{a}	12.60	33.50	65.00	0.50^{d}	0.00^{c}	1.00^{d}	112.70^{b}	37.50^{ab}	33.30^{ab}
SEM		1.830	0.576	0.149	0.731	1.622	3.435	0.038	0.035	0.069	7.084	2.214	1.786
P-values													
Petiveria parts		0.0540	0.1128	0.0638	0.7057	0.4361	0.3467	0.5201	0.0001	0.0109	0.1758	0.9858	0.7490
Levels of Incl.		0.3595	0.1526	0.0686	0.1840	0.0188	0.5683	0.0001	0.0001	0.2954	0.0001	0.0686	0.0856
Petiveria parts x Levels of Incl.		0.0670	0.0040	0.0068	0.0736	0.0709	0.8425	0.0001	0.0001	0.0001	0.0001	0.0175	0.0168

^{abcde} means on the same row having different superscript were significantly (P<0.05) different.
SEM: Standard Error of Mean, Incl: Inclusion, PCV: Packed Cell Volume, Hb; haemoglobin, RBC: Red Blood Cell, WBC: White Blood Cell, HET: Heterophil, LYM: Lymphocyte, EOS: Eosinophil, BAS: Basophil, MON: Monocyte, MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Haemoglobin, MCHC: Mean Corpuscular Haemoglobin Concentration.

mg/kg of *Petiveria* concentration had better (P<0.05) High density lipoprotein in comparison to 0 and 1000 mg/kg. When compared with 1000 mg/kg of *Petiveria* concentration, reduced (P<0.05) LDL was recorded in birds on diets added with 0, 1000, 2000 and 2500 mg/kg of *Petiveria* concentration. The interaction between *Petiveria* parts and *Petiveria* concentration was not significant (P<0.05) for glucose, triglyceride, cholesterol and VLDL. Birds fed diets incorporated with 1500 mg/kg of PLM concentration increased (P<0.05) serum total protein in comparison to 1000 mg/kg of PLM and 1000 mg/kg of PRM. Similarly serum albumin was elevated (P<0.05) in bird fed diets containing 1500 mg/kg of PLM and PRM concentration compared to 1000 mg/kg of PRM concentration. Serum AST across the dietary groups were similar, however it was reduced (P<0.05) in birds fed with 0 mg/kg of PRM and 1000 mg/kg of PLM concentration. When compared to other treatments, birds fed diets included with 0 and 2000 mg/kg of PRM concentration decreased (P<0.05) serum ALT. Inclusion of 2500 mg/kg of PLM concentration reduced (P<0.05) serum uric acid but similar to 1500 and 2000 mg/kg of PLM concentrations than those on 1000 mg/kg of PRM concentration. Birds fed diets incorporated with 2500 mg/kg of PRM, 1500 and 2500 mg/kg of PRM concentration showed increased (P<0.05) HDL when compared to 1000 mg/kg of PRM. Low density lipoprotein was reduced (P<0.05) in birds fed diets added with 2000 mg/kg of PRM concentration in comparison to 1000 mg/kg of PLM.

DISCUSSION

The findings of the present study which showed no effect of *Petiveria* parts at varying concentration on growth parameters could be due to bitter taste of tannin and presence of anti-nutritional factors that lower feed intake of diets in which it is incorporated (Olobatoke and Oloniruha, 2009, p. 472). This result was also in tandem with the report of Fadlalla *et al.*

(2010, p. 182) and Onibi *et al*. (2009, p. 511) where they observed no differences in body weight gain and feed intake between control groups of broilers fed with garlic. Botsoglou *et al.* (2002, p. 223) showed that oregano oil had no growth promoting effect when administered at 50 or 100 mg/kg of feed. In addition, Chowdhury *et al.* (2002, p. 1856) who added different levels of garlic to layers diet reported no significant effects of this supplementation on growth rate, feed intake and feed efficiency In contrast, Tekeli *et al*. (2006, p. 10) demonstrated that plant extract (*Z. officinale* at 120 ppm inclusion) improved live weight gains and feed conversion ratio of broiler. More so, Al-Kassie and Jameel, (2009) reported that several research findings on herbal extracts showed increase broiler performance by improving live weight gain and FCR of broiler chicken. Higher mortality rate were obtained in birds fed with 2000 mg/kg of PLM and 1500 mg/kg of PRM concentration. Findings by Sarker *et al.* (2007, p. 283) showed that nitrogenous present in alkaloid function in the defence of plants against herbivores and pathogens and poisonous due to their potent biological activities. More so, Lopez *et al.* (1999, p. 841) reported about toxic effects of alkaloid on rabbits.

Nutrient utilization is the degree to which an ingested nutrient from a particular source is absorbed in a form that can be utilized in metabolism by the animal (Ammerman *et al*., 1995, p. 441). Interaction between *Petiveria* parts and *Petiveria* concentration displayed no significant effect on apparent nutrient digestibility. This could be attributed to the presence of saponin which is said to have significant effects on all phases of metabolism, from the ingestion of feed to the excretion of wastes (Cheeke, 1996, p. 377). The result from the trial was in line with the findings of Jamroz *et al.* (2005, p. 485) who indicated no effect of phytogenic feed additives on apparent ilea digestibility of nutrients. Furthermore, Makkar *et al.,* (1993, p. 897) and Makkar and Becker, (1997, p. 311) reported that phytochemicals in moringa are capable of reducing nutrient availability and/or utilization. On the contrary, Kamel, (2001, p. 135) suggested that herbs, spices, and various plant

Table V. Effects of main and interactive of PLM and PRM on serum biochemical of pullet chicks (0-8) weeks
(Efectos de la PLM y PRM principal e interactivo en suero bioquímico de los polluelos (0-8) semanas).

Treatment		Total Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Glucose (mg/dl)	AST (u/l)	ALT (u/l)	Uric acid (mg/dl)	CHOL (mg/dl)	TRG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)
Petiveria parts	Levels of Inclusion												
PLM		4.31	2.36	1.95	109.20^{b}	65.10	28.50	2.57^{b}	89.80	101.86	52.00	17.44	20.36
PRM		4.22	2.38	1.84	118.10^{a}	67.60	27.70	2.92^{a}	89.80	94.80	54.00	16.84	18.96
SEM		0.201	0.146	0.069	2.774	2.643	1.247	0.089	2.790	2.737	2.180	0.772	0.547
	0	3.88^{bc}	2.18^{b}	1.70^{b}	109.25	62.75	22.75^{c}	2.85	83.75	94.75	48.00^{c}	16.80^{b}	18.95
	1000	3.58^{c}	1.90^{b}	1.68^{b}	110.75	59.75	27.00^{b}	3.03	88.50	100.50	48.25^{c}	20.15^{a}	20.10
	1500	5.40^{a}	3.30^{a}	2.10^{a}	116.50	74.25	30.50^{ab}	2.50	93.25	95.00	56.75^{ab}	17.50^{ab}	19.00
	2000	4.18^{bc}	2.25^{b}	1.93^{ab}	119.50	64.00	27.25^{b}	2.75	84.25	100.25	49.75^{bc}	14.45^{b}	20.05
	2500	4.30^{b}	2.23^{b}	2.08^{a}	112.25	71.00	33.00^{a}	2.60	99.25	101.00	62.25^{a}	16.80^{b}	20.20
	SEM	0.189	0.118	0.085	4.748	3.673	1.356	0.140	3.823	4.559	2.662	0.968	0.920
PLM	0	3.75^{de}	1.95^{cd}	1.80^{abcd}	103.50	71.00^{ab}	23.50^{c}	2.70^{bc}	84.50	106.50	49.00^{bcd}	14.20^{de}	21.30
	1000	3.60^{e}	1.95^{cd}	1.65^{cd}	106.50	49.50^{c}	25.00^{bc}	2.80^{abc}	97.00	103.00	53.00^{abc}	22.90^{a}	20.60
	1500	5.65^{a}	3.50^{a}	2.15^{a}	110.00	76.50^{a}	30.50^{a}	2.55^{bcd}	88.50	98.50	51.00^{bcd}	17.80^{bc}	19.70
	2000	4.55^{bcd}	2.40^{bc}	2.15^{a}	113.00	58.50^{ab}	31.50^{a}	2.65^{bcd}	81.50	106.00	44.50^{cd}	15.80^{cde}	21.20
	2500	4.00^{cde}	2.00^{bcd}	2.00^{abc}	113.00	70.00^{ab}	32.00^{a}	2.15^{d}	97.50	95.00	62.00^{a}	16.50^{bcd}	19.00
PRM	0	4.00^{cde}	2.40^{bc}	1.60^{d}	115.00	54.50^{c}	22.00^{c}	3.00^{ab}	83.00	83.00	47.00^{bcd}	19.40^{b}	16.60
	1000	3.55^{e}	1.85^{d}	1.70^{bcd}	115.00	70.00^{ab}	29.00^{a}	3.25^{a}	80.00	98.00	43.00^{d}	17.40^{bcd}	19.60
	1500	5.15^{ab}	3.10^{a}	2.05^{ab}	123.00	72.00^{a}	30.50^{a}	2.45^{cd}	98.00	91.50	62.50^{a}	17.20^{bcd}	18.30
	2000	3.80^{cde}	2.10^{bcd}	1.70^{bcd}	126.00	69.50^{ab}	23.00^{c}	2.85^{abc}	87.00	94.50	55.00^{ab}	13.10^{e}	18.90
	2500	4.60^{bc}	2.45^{b}	2.15^{a}	111.50	72.00^{a}	34.00^{a}	3.05^{ab}	101.00	107.00	62.50^{a}	13.10^{e}	21.40
SEM		0.246	0.137	0.109	6.562	3.831	1.622	0.158	5.185	5.675	3.060	0.990	1.135
P-values													
Petiveria parts		0.6121	0.8570	0.1633	0.0338	0.4718	0.5401	0.0052	1.0000	0.0955	0.4216	0.5245	0.0955
Levels of Incl.		0.0001	0.0001	0.0027	0.4675	0.0694	0.0005	0.0595	0.0539	0.7469	0.0034	0.0147	0.7469
Petiveria parts x Levels of Incl.		0.0001	0.0001	0.0034	0.4237	0.0009	0.0002	0.0047	0.0610	0.1272	0.0006	0.0001	0.1272

^{abcde} means on the same row having different superscript were significantly different (P<0.05). SEM: Standard Error of Mean. Incl. Inclusion, AST: Aspartate transaminase, ALT: Alanine Transaminase, CHOL: Cholesterol, TRG: Triglyceride. HDL: High Density Lipoprotein, LDL: Low Density Lipoprotein, VLDL: Very Low Density Lipoprotein

extracts have appetite, digestion-stimulating properties and antimicrobial effects. Ertas *et al.* (2005, p. 879) also reported that phytogenic additives have been shown to influence improvement of digestibility and gain of broiler chickens. Cross *et al.* (2007, p. 496) opined that the presence of alkaloids and flavonoids have been reported to influence digestion and secretion of digestive enzymes.

Findings by Yakubu *et al*. (2007, p. 434) opined that assessment of haematological parameters can not only be used to determine the extent of deleterious effect of extracts on the blood of an animal, but it can also be used to explain blood relating functions of a plant extract or its products. Phytochemical in plant such as tannin have capacity to act as powerful antioxidants, scavenge free radicals, terminate oxidative reactions and chelation of transition metals and inhibition of prooxidative enzymes (Yilmaz and Toledo, 2004, p. 255; Molan *et al.*, 2009, p. 1). Hence, could be responsible for the observed differences obtained on haematological indices between interaction of *Petiveria* parts and *Petiveria* concentration in the experiment trial. The PCV and Hb values fell within the reference range of 24.9 - 45.2% and 7.40 - 13.10% for healthy birds as reported by Mitruka and Rawnsley (1977, p. 54). Onyeyilli *et al*. (1992, p. 101) reported that reduction in RBC, Hb and PCV is an indication of either the destruction of RBC or their decreased production, which may lead to anaemia. Furthermore, an increase in the count of RBC, Hb and PCV is suggestive of polycythemia and positive erythopoisis (Iranloye, 2002, p. 81; Okpuzor *et al*., 2009, p. 57). Hence, values obtained ($2.1\text{-}3.2\times10^{12}$) in this experiment were elevated than the range of $2\text{-}4\times10^{6}$ reported by Mitruka and Rawnsley, (1977, p. 54). White blood cell obtained were within the reported range of ($9\text{-}56\times10^{3}$) reported by (Aiello *et al.,* 1998). Reports about WBC counts have pointed out that increased count of WBC is supposed to be helpful in boosting immune system (Adedapo *et al*., 2007, p. 29), a decreased count of WBC shows the suppression of leucocytes and their production from bone marrow (Odesanmi *et al*., 2010, p. 1). MCV values were better than the reference range of 60.0fl - 65.7fl (Ayoola *et al*., 2010, p. 126). Indicating there is no regenerative anaemia/ blood destruction. Observed MCH values were higher than the range of 19.29Pg - 23.20Pg reported by Ayoola *et al*., (2010, p. 126). MCHC obtained in all the phases were within the reference range of 31.90 - 35.52% reported by (Ameen *et al.,* 2007, p. 176) indicating sufficient iron in the blood/mild on-regenerative anaemia apart from those fed control, 1500mg/kg of PLM and 1000 mg/kg of PRM.

Interaction effects reflected an improved serum biochemical in bird fed diets containing PLM and PRM at varying concentration in the experimental trial. The observed values fell within the reported range for total protein (3.25g/dl to 7.61g/dl) recorded by Rajurker *et al.* (2009, p. 58), albumin (1.25- 2.20 g/dl) observed by (Akinmutimi and Onen 2008, p. 474) and globulin (2.13g/dl-3.02g/dl) reported by (Adeyemo, 2008, p. 23). Improved total protein, albumin and globulin could be attributed to the presence of antioxidant and beneficial bacteria in the intestine (Nascimeto *et al.*, 2000, p. 217). Furthermore, AST (143µl/ml to 187µl/ml) and ALT (32 to 62µl/ml) values were lower than the reported range by (Fasina *et al.,* 2004, p. 3). The influence of PRM and PLM at varying concentration on AST and ALT could be attributed to the presence of alkaloid which is said to have effect on blood. This result was in line with the findings of Janbaz and Gillani (2000, p. 25) who reported reduction in serum ALT and ALP levels in rodents by feeding berberine, which is the active alkaloid in *Berberis lyceum*. The results corroborate the findings of Yousef, (2009, p. 1), who worked on mixture of medicinal plants reported significantly lower ALT values. The values obtained for uric acid concetration for birds fed diets containing PLM and PRM at varying concentration was lower than (3.68-3.77 mg/dl) reported by Sogunle *et al.,* (2007, p. 32). This is indication that the bird in the study did not suffer kidney damage since adequate utilization of protein makes better excretion of nitrogen in form of urica acid (Eggum, 1970, p. 938). Oduguwa and Ogunmodede (1995, p. 81) reported high serum uric acid concentrations could due to inefficient protein utilization. Conversely, Adebayo *et al.,* (2003, p. 69); Abubakar *et al.,* (2010, p. 26); Kolawole *et al.,* (2011, p. 602) reported increased in blood level of uric acid and creatinine by feeding *khaya senegalensis*. Superior HDL and LDL recoreded in birds fed diets incorporated with 2500 mg/kg of PRM could be attributed to the higher presence of saponin in PRM which is said to reduced LDL-cholesterol selectively in the serum of rats, gerbils and human (Matsuura, 2001, p. 1000). This observation was in tandem with the reports of Prasad *et al*. (2009, p. 270) where total cholesterol, triglycerides, LDL sand VLDL were significantly decreased by *Alluim sativum*.

CONCLUSION

It could be concluded that inclusion of *Petiveria alliacea* at different concentration reflected no significant effect on growth performance and nutrient digestibility however, increased haemoglobin and white blood cell were recorded at 2500 mg/kg of PRM; high density lipoprotein were improved with reduced low density lipoprotein obtained at the same concentration of PRM. The implication of this is that 2500 mg/kg of PRM could be adopted for better health status of the animals and the consumers.

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