Journal of Arid Agriculture

J. Arid Agric. 2025, Vol. 26 (3): 83 - 90

https://jaaunimaid.ng/index.php/home

0189-7551
https://doi.org/10.63659/jaa.v26i3.107

HAEMO-BIOCHEMICAL RESPONSES, PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS FED GRADED LEVELS OF *KALGO*POD MEAL (*Piliostigma thonningii*)

B. Ahmed[*1], A. Yusuf[2], N. Bature[3], S. Zubairu[4], and Z.A. Saleh[4]

[1]Department of Animal Science, Umaru Musa Yar'adua University P.M.B 2218, Katsina State
[2]Department of Animal Science, Federal University, Dutsin-Ma Katsina State
[3]Department of Animal Science, Federal University, Dutse, Jigawa State
[4]Department of Biology, Umaru Musa Yar'adua University, Katsina.

Corresponding Author's email: bishirahmed944@gmail.com Phone: +2347030286505

ABSTRACT: An experiment was conducted to determine the effect of Kalgopod meal (KPM) on haemo-biochemical responses, performance and carcass characteristics of broiler finisher. Completely randomized design was used with four treatment groups replicated six times for four weeks designated as: 0, 5, 7, 5 and 10% KPM. Feed and water were supplied ad libitum. The results were analyzed using GraphPad InStat Statistical Package (GraphPad InStat®, version 3.05, 32 bits for Win 95/NT, GraphPad Software Inc., 2000). The results indicated that there were no significant (P>0.05) differences across haemo-biochemical parametres considered PCV (28.66-34.00 %), Hb (7.73-10.00 g/dL), RBC (2.33-3.46 $\times 10^{12}$), WBC (20.00-25.00$\times 10^{9}$), MCV (110.33-133.33 fl), MCH (24.46-43.56 pg), ALT (13.35-21.00 U/L), AST (157.33-168.67/UL), ALP (33.33-55,66), Glucose (17.33-21.33 mmol/L), Total protein (26.33-36.00 mmol/L), Creatinine (0.12-0.23 µmol/L) and Cholesterol (P<0.05) (156.00-170.00 mmo/L). Altogether, were within the normal range for both blood parameters. In growth performance parameters, there were significant differences (p<0.05) across treatment groups, in fact, treatment four with higher inclusion level of test ingredient was found to have been well utilized by the birds. Carcass analyses illuminated that significant differences (p<0.05) were observed in slaughter weight and dressing percentage while neck, wings, breast, back, thigh, drum stick and shank. Inclusion of KPM in poultry feeding had no adverse effect on performance and carcass characteristics. Thus, implied that of *kalgo*pod meal can be used in broiler diet as it has no negative effect on haemo-biochemical indices therefore, heath status may not be impaired.

Keywords: Broiler, Kalgopod meal, Haemo-biochemical, performance and carcass

INTRODUCTION

Poultry can thrive well where humans are living particularly tropical areas (Mogesse, 2007). Moreover, poultry are able to adapt to most areas of the world and have short generation interval (Smith, 2001). They are resources that are available to even the poorest family (Banerjee, 1998). They plays a vital role in meeting the global demand for animal protein, especially in developing countries where broiler chickens serve as a major source of affordable meat. The rapid growth rate and feed conversion efficiency of broilers have positioned them as a preferred source of high-quality protein for human consumption. However, the high cost of conventional feed ingredients, particularly protein and energy sources such as maize, soybean meal and groundnut cake, remains a major constraint in poultry production (Afolayan *et al*., 2019: Oladokun and Adeola 2020). This challenge has led researchers to explore alternative feed resources that are locally available, cost-effective, and nutritionally adequate, without compromising growth performance, health, or carcass quality of broiler chickens (Bukar *et al*., 2021)

How to cite this Article: Ahmed, B., Yusuf, A., Bature, N., Zubairu, S. and Saleh, Z.A. (2025). Haemo-Biochemical Responses, Performance and Carcass Characteristics of Broiler Chickens Fed Graded Levels of Kalgopod Meal (*Piliostigma thonningii*). *Journal of Arid Agriculture*, *26*(3), 83 - 90. https://doi.org/10.63659/jaa.v26i3.107 Retrieved from https://jaaunimaid.ng/index.php/home/article/view/107

Maharjan *et al.* (2021) highlighted that food production system needs to be sustainable including poultry sector to feed the increasing global population. One promising approach is the incorporation of unconventional feed ingredients, such as plant-based meals derived from underutilized crops, into poultry diets. *Kalgo*pod also known as (Piliostigma thonningii), a locally available plant product, has recently gained attention as a potential feed ingredient due to its nutritional profile and availability in rural communities. *Kalgo*pod meal is rich in energy, and its use in poultry feed could help reduce feed costs while promoting the utilization of indigenous resources (Yakubu *et al*., 2020). However, there is a need for empirical evidence on its effects on poultry health and production traits to ensure its safety and efficiency as a feed component (Adamu *et al*., 2021). Moreover, the availability of maize all year round for poultry feed has reduced and this could be attributed to competition for maize by humans and animals, irregular rainfall pattern and high cost of maize (Oladimije *et al*., 2020). The present insecurity that has devastated most parts of Northern Nigeria and caused declined in maize production (Ogunwole, *et al.,* 2016). In view of these limiting circumstances, it becomes imperative to search for non-conventional feed sources that will be well suited for sustainable poultry production (Oyebimpe *et al.,* 2006). And it was found to be very common practice in animal nutrition (Ahmed *et al*., 2024). *Kalgo*pod meal has been used as rich source of energy (Adeyemo and Borried, 2002). It has been established that feed may affect heamatological and performance of the animals (Madubuik and Ekenyem, 2006).

Information on blood biochemical and haematological indices are greater assets as indicators of an animal's health status, metabolic activity, and physiological responses to dietary changes (Ciesla, 2007). Evaluating these parameters provides critical insights into how dietary inclusion of *kalgo*pod meal may influence the overall well-being of broiler chickens (Etim *et al*., 2014). Furthermore, carcass characteristics are essential in determining the market value and consumer acceptance of poultry meat, making them a vital aspect of poultry production research (Adeniji and Jimoh, 2007). Assessing both haemo-biochemical indices and carcass quality is therefore crucial in determining the suitability of *kalgo*pod meal in broiler nutrition.

This study was conducted to investigate the effect of *kalgo*pod meal on the haematological and biochemical parameters, as well as carcass characteristics of broiler chickens. The findings are expected to provide valuable information on the nutritional potential of *kalgo*pod meal as an alternative feed resource, contributing to sustainable poultry production and reduced dependence on conventional protein sources. Ultimately, this research aims to enhance food security and profitability for poultry farmers through the adoption of cost-effective and locally sourced feed ingredients (FAO, 20921).

MATERIALS AND METHODS

Experimental Site, Birds and their Management

The experiment was conducted at the Department of Biology, Faculty of Natural and Applied Sciences, Umaru Musa Yar'adua University, Katsina. Located on (GPS Coordinates: 12° 59' 52"N, 7° 35' 58"E) (KTSG, 2013). A total of twenty- four Cobb500 broiler chicks (from Olam Hatcheries) of 2-weeks old were purchased from Danhassan Livestock and Poultry Services, Katsina. Adopted for eleven days and manage on deep litter system. They were fed commercial diet during acclimatization and experimental diet during the experiment. Three days to commencement of the experiment commercial diet was gradually withdrawn at the rate of: 25+75%, 50+50% and 75+25% experimental and commercial diets respectively. Feed and water were provided *ad libitum* throughout acclimatization and experimental periods. The experiment lasted for four weeks all other management practices were strictly adhered to.

Sample Size Determination, Experimental Design, Meal Preparation and Gross Composition of Experimental Diets

Sample Size

The resource equation described by Mead, Gilmour and Mead (2012) was used to determine the sample size. This equation is as follows:
N-1 = T + E

Where,
N = Number of experimental units

T = Number of test group-1
E = Number that estimates the error

Mead and colleagues indicated that, the number that estimates the error (E) should be between 10 and 20. Therefore, the current study used twenty-four birds which gave 20 as an estimate of error (E) that was within the range recommended by Mead *et al*. (2012).

The experimental treatments were arranged in a completely randomized design with four treatment group replicated six times designated as 0-control, 5, 7.5 and 10% *kalgo*pod meal corresponding to treatments T1, T2, T3 and T4 respectively.

Meal was prepared by harvesting of *Piliostigma thoningii* (*Kalgo*pods), air dried and pulverized with pestle and mortar. Anti-nutritional factors in the pods were chelated by heating using frying pan.

Table1: Gross composition of the experimental diets

Feed Ingredients		Treatments		
	T1	T2	T3	T4
Maize	51.80	52.05	52.05	48.80
Maize offal	15.00	10.00	0.00	0.00
Wheat offal	12.00	12.50	15.25	16.00
*Kalgo*pod meal	0.00	2.50	7.50	10.00
Groundnut cake	10.00	10.00	10.00	10.00
Soybean meal	6.00	10.00	10.00	10.00
Blood meal	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Salt	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20
Vitamin premix*	0.50	0.50	0.50	0.50
Total (%)	100.00	100.00	100.00	100.00
Proximate analysis				
ME(Kcal/kg)	2817.05	2810.21	2816.98	2817.00
Crude protein	19.00	19.19	19.29	19.37

*ME: metabolisable energy; composition of premix (Biomix) supplying the following per kg diet. Vit. A=12000IU, Vit. E=15000IU, Folic acid=100mg, Vit. D_3=2.500IU, Nicotine acid=400mg, Panthothenic acid=15000mg. I=1750mg, Fe=40,000mg, Zn=50,000mg, Mn=1,000mg, Biotin=600mg, Vit. C=30,000mg, Cu=200mg, Si=100mg.

Data Collection

Haemo-Biochemical Profile

Blood samples of 5 ml of blood samples were collected from the wing vein as described by Bermudez and StewartBrown (2003), using a sterile syringe. The spots where blood was collected were swabbed thoroughly with a clean cotton wool dipped in methylated spirit. The blood vessel was engorged by gentle tapping, after which the sterile needle was inserted into the vein. Afterwards, 3 ml of the collected blood was transferred into sterile EDTA universal bottles for haematological analysis (Packed Cell Volume (PCV), Hemoglobin (Hb), Red Blood Cell, (RBC), White Blood Cell (WBC), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) was assessed), while 2 ml was transferred into a plain bottle without EDTA for serum biochemical analysis. Blood sample was transported to the laboratory on ice pack in a Styrofoam box for further processing. In order to allowed for clotting at room temperature for two hours. A wooden stick was used to dislodge the clot.

The samples were centrifuged using (Centrifuge 800D®, Techmel & Techmel, USA) for 30 minutes at 4000 revolutions per minute to recover the serum. The recovered serum samples were incubated using a laboratory incubator (DIGITAL TT9052®, Techmel & Techmel, USA). The biochemicals analyzed are: ALT, AST, ALP, Glucose, Total Protein, Cholesterol and Creatinine using colorimeter (Colorimeter 257, CIBA CORNING®) at a wavelength of 546 nm using principles, methods and reagents based on the instructions of the manufacturers of the respective commercial kits.

Journal of Arid Agriculture. 2025, Vol. 26 (3): 83 – 90

Performance and Carcass Characteristics

Performance and carcass characteristics, an electronic scale (Sartorius, CP 245S) was used for weights of all parameters considered in the research

Data Analysis

Haemo-biochemical data were subjected ANOVA using GraphPad InStat Statistical Package (GraphPad InStat®, version 3.05, 32 bit for Win 95/NT, GraphPad Software Inc., 2000). Performance and carcass characteristics parameters were analyzed using Microsoft Excel (Version 2017) Statistical Package.

RESULTS AND DISCUSSION

Haemo-Biochemical Indices of Broiler Chickens

The result of haemo-biochemical indices of broiler chicken fed graded level of *kalgo*pod meal is presented in Table 2. The result showed that there were no significant (P>0.05) differences across all haemo-biochemical parameters considered except cholesterol (156.00±2.64-170.33±10.01). Packed cell volume (PCV) and red blood cell (RBC) counts increased with higher levels of *kalgo*pod meal, peaking in T4 (34.00 ± 1.00% PCV; 3.26 ± 0.15 × 10^{12}/L RBC). This suggests that *kalgo*pod meal supplementation may enhance erythropoiesis and improve oxygen transport capacity (Adenkola *et al.,* 2009). The increase in PCV with *kalgo*pod meal inclusion aligns with reports that plant-derived feed additives with bioactive compounds can stimulate red blood cell production (Oyawoye and Ogunkunle, 2004).

Haemoglobin (Hb) concentrations fluctuated between 7.73 ± 0.56 and 10.00 ± 2.10 g/dL, with the highest value recorded in the control group, indicating no adverse effect of KPM on haemoglobin synthesis. White blood cell (WBC) counts remained stable (20.00-25.00 × 10^9/L), showing no signs of systemic infection or immune suppression due to KPM supplementation. Similarly, mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) values showed no consistent trend across treatments, though T4 recorded a lower MCH (24.46 ± 0.55 pg), possibly reflecting dietary-induced erythrocyte adaptation (Etim *et al.,* 2014). Overall, the haematological indices suggest that KPM inclusion up to 10% does not impair blood health and may have a mild erythropoietic effect.

Table 2: Haemo-biochemical indices of broiler chickens fed graded levels of *kalgo* pod meal (*Piliostigma thonningii*)

Parametres	Treatments			
	T1(0%KPM)	**T2(5%KPM)**	**T3(7.5%KPM)**	**T4(10%KPM)**
PCV (%)	28.66±7.57	28.66±6.71	30.00±2.64	34.00±1.00
Hb (g/dL)	10.00±2.10	9.33±1.33	7.73± 0.56	8.03±0.15
RBC (×10^{12})	2.40±0.45	2.33±0.30	2.46±0.50	3.26±0.15
WBC (×10^9)	21.33±10.97	25.00±5.00	20.66±3.78	20.00±1.00
MCV (fl)	118.00±11.79	121.33±14.22	123.33±15.30	110.33±15.56
MCH (pg)	43.56±17.11	43.13± 9.33	32.10±6.50	24.46±0.55
ALT (U/L)	14.00±5.56	21.00±11.53	19.66±4.04	13.35±4.93
AST (U/L)	160.00±10.58	162.67±11.59	157.33±1.53	168.67±19.39
ALP (U/L)	37.33±16.65	35.66±10.12	33.33±8.50	55.66±4.51
Glucose (mmol/L)	17.33±4.73	19.33±4.12	18.66±5.85	21.33±7.23
Protein (mmol/L)	31.33± 9.50	26.33±5.03	36.00± 4.35	32.33±8.62
Cholesterol(mmol/L)	156.00±2.64 ^{b}	156.33±6.02 ^{b}	156.67±1.00 ^{b}	170.33±10.01 ^{a}
Creatinine µmol/L)	0.12± 0.33	0.19±0.31	0.13± 0.41	0.23± 0.81

^{a,b,c,d} means in the same rows with different superscripts differ significantly (p<0.05)

Biochemical Indices, also demonstrated dietary influences, Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities remained within reference values, suggesting no hepatic damage at any KPM inclusion level (Kaneko *et al.,* 2008). Alkaline phosphatase (ALP) activity was significantly higher in T4 (55.66 ± 4.51 U/L), which may indicate increased metabolic activity or biliary stimulation rather than pathology, as similar elevations have been reported in response to high-fiber diets (Onyimonyi *et al.,* 2009). Serum glucose concentrations increased with dietary KPM, peaking at 21.33 ± 7.23 mmol/L in T4, reflecting possible improvements in energy metabolism.

Total protein levels (26.33-36.00 mmol/L) remained within physiological limits, suggesting efficient protein metabolism and nutrient utilization (Etim *et al.,* 2014). A significant effect ($p < 0.05$) was observed in cholesterol concentrations, with T4 recording a higher level (170.33 ± 10.01 mmol/L) compared to the other treatments (156 ± 2.64 mmol/L). The increase in cholesterol at higher KPM inclusion could be linked to the lipid components of *Piliostigma thonningii* seeds, as plant-based feeds rich in certain phytochemicals can modulate lipid metabolism (Oloruntola *et al.,* 2018). Creatinine values remained low and comparable across all treatments, indicating no renal dysfunction or protein catabolism issues (Kaneko *et al.,* 2008).

Performance and Carcass Characteristics of Broiler Finisher Chickens

In the growth parameters of the broiler shows significant differences in all parameters tested. Al-Beitawi and Goushein (2008) observed significant improvement in the final live weight of broilers fed diets supplemented with black seed at 1.5% inclusion level. Carcass weight and dressing percentage were improved in birds fed 5% and 7.5% of *Kalgo*pod meal in the present study; the differences observed in weight gained could be ascribed to varying graded levels of *Kalgo*pod meal (*Piliostigma thonnigii*) and possibly to genetic characteristics for different growth patterns as suggested by (Soares *et al.* 1991). The result of current study showed that, carcass weight was significantly affected by treatments. The carcass weights recorded ranged from 871.20±0.36 to 174.52±0.44g significantly different ($p<0.05$), variation in weights might be associated with the glycogen stores in the muscle of the birds. However, this result is in line with the findings of Denli et al. (2003). The final body weight ranged from 1,094.86 g in birds fed 7.5% *kalgo*pod meal (T3) to 1,196.60 g in birds fed 5% *kalgo*pod meal (T2), with T2 recording the highest weight gain ($p<0.05$). Similarly, total weight gain was highest in T2 (876.60 g) and lowest in T3 (773.29 g), showing that moderate *kalgo*pod meal inclusion promotes growth. Daily weight gain (DWG) followed a similar trend, with T2 birds gaining 41.74 g/day compared to only 30.31 g/day in T4 (10% KPM), suggesting that excessive *kalgo*pod meal inclusion may depress growth, likely due to anti-nutritional factors such as tannins and saponins reported in *Piliostigma* species (Yakubu *et al.,* 2020).

Daily feed intake (DFI) was highest in T4 (122.61 g) and lowest in T1 (108.33 g), indicating compensatory feeding at higher *kalgo*pod meal levels to offset nutrient dilution. However, this was not efficiently converted into weight gain, as reflected in the feed conversion ratio (FCR), which was lowest (best) in T2 (2.79) and poorest in T4 (4.08). This observation aligns with Amaefule et al. (2011), who reported that moderate inclusion of unconventional feedstuffs enhances nutrient utilization up to a threshold beyond which performance declines. Akinmutimi and Onen (2008) reported that diets *kalgo*pod meal resulted in increased feed utilization efficiencies so their assertion on the above, FCR feed intake and weight gain are expected to be improved.

Carcass traits also varied significantly ($p<0.05$) among treatments. Birds on T2 recorded the highest carcass weight (871.12 g) and slaughter weight (1178.34 g), confirming that moderate *kalgo*pod meal inclusion supports meat yield. Dressing percentage ranged from 68.46% (T3) to 70.42% (T4), with T4 showing the highest percentage despite lower growth, possibly due to altered carcass composition or fat deposition as a result of fiber and phytochemical intake (Oladunjoye and Ojebiyi, 2010).

Among cut-up parts, breast meat yield was notably highest in T3 (30.84%), though highly variable, while other parts such as wings, thighs, and drumsticks showed moderate but significant differences. The high breast yield at 7.5% *kalgo*pod meal could indicate nutrient partitioning influenced by plant bioactive compounds, as observed in previous studies on leguminous feed ingredients (Akinmutimi *et al.,* 2017). The implication of 5% *kalgo*pod meal inclusion (T2) appears optimal for broiler finishers, providing superior growth performance, carcass yield, and feed efficiency. Higher inclusion levels (7.5-10%) reduced growth efficiency, likely due to the anti-nutritional compounds in KPM, although the higher dressing percentage at 10% suggests carcass quality benefits. These findings highlight KPM as a promising locally sourced feed ingredient, though processing techniques (e.g., soaking, fermentation) may be required to reduce anti-nutritional factors, enabling higher inclusion levels.

Journal of Arid Agriculture. 2025, Vol. 26 (3): 83 – 90

Table 3: Performance and carcass characteristics of broiler finisher chickens fed with varying graded levels of *Kalgo*Pod Meal (*Pillostigma thonnigii*)

Parameters (g)	T1control 0%KPM	T2 5% KPM	T3 7.5 KPM	T4 10% KPM
Initial weight	320.0±0.81	320.0±0.81	321.0±0.95	320.0±0.81
Final body weight gained	1096.31±2.44[d]	1196.60±0.81[a]	1094.86±10.53[c]	1160.31±8.16[b]
Total weight gained	775.31±2.78[c]	876.60± 0.73 [a]	773.29±1.62[d]	838.56±4.22[b]
Daily weight gained	36.96±0.81[b]	41.74±2.90 [a]	36.85±3.27[b]	30.31±3.10[c]
Daily feed intake	108.33±2.16[c]	116.66±2.15[b]	115.87±2.16[b]	122.61±0.82[a]
F.C.R.	2.93±0.01[c]	2.79±0,14[c]	3.14±0.01[b]	4.08±0.00 [a]
Carcass parameters (g)				
Final live weight	1096.31±0.59[c]	1196.60±0.34[a]	1094.86±0.47[c]	1160.31±1.6[b]
Slaughtered weight	1076.31±0.37[c]	1178.34±0.49[a]	1068.50±0.3[d]	1140.54±0.7[b]
Defeathered weight	1034.22±0.20[d]	1139.14±1.21[a]	1043.85±0.23[c]	1113.02±0.1[b]
Carcass weight	753.64±1.77[c]	871.12±0.36[a]	749.52±0.44[d]	832.42±0.25[b]
Dressing percentage (%)	68.74±0.24 [b]	68.74. ±0.20[b]	68.46±0.07[b]	70.42±0.05[a]
Cut-parts expressed as % of Live weight				
Neck	3.79 ±0.81[b]	3.76±0.81[b]	3.980±0.81[a]	3.960±0.81[a]
Wings	8.28±0.81[a]	6.84 ±0.81[d]	7.485±0.82[c]	7.90±0.81[b]
Breast	21.31±1.25[d]	21.91±0.95[c]	30.84±14.17 [a]	22.96±0.81 [b]
Back	10.88 ±0.18[a]	9.97±0.81[c]	10.83±0.18[a]	10.36±0.81[b]
Thigh	8.74±0.83[a]	8.11±0.81[d]	8.64±0.18[b]	8.47±0.18[c]
Drumstick	8.59±0.018[a]	8.06 ±0.18[d]	8.55±0.18[b]	8.22±0.18[c]
Shanks	4.42±0.18[b]	4.19±0.18[c]	4.06±0.18[d]	4.75±125[a]

[a,b,c,d] means in the same rows with different superscripts differ significantly ($p<0.05$). F.C.R. feed conversion ratio

CONCLUSION AND RECOMMENDATIONS

By implication, the research findings showed that the incorporation of *kalgo*pod meal into broiler chicken diets can be safely achieved without adverse effects on blood health, growth performance and carcass quality. Haematological and serum biochemical parameters remained within normal physiological ranges across all treatment groups, indicating that *kalgo*pod meal is a safe and non-toxic feed ingredient when properly processed. Moderate dietary inclusion levels supported optimal body weight gain and feed conversion ratio, showing its potential as a cost-effective alternative to conventional feed components.

Furthermore, carcass traits, including dressing percentage, breast muscle yield, and thigh weight, were not significantly affected, confirming that *kalgo*pod meal can be incorporated into broiler diets without compromising meat quality. Overall, *kalgo*pod meal offers a promising option for reducing feed costs and improving feed resource utilization in poultry production systems. And the following recommendations were deduced: K*algo*pod meal can be included in broiler chicken diets at moderate levels (up to 10%) without compromising performance or carcass yield, Proper processing and detoxification of *kalgo*pod meal should be ensured to maintain safety and nutritional value, Further studies should focus on the long-term health effects, cost-benefit analysis, and nutrient digestibility of *kalgo*pod meal in poultry diets and Adoption of *kalgo*pod meal in commercial feed formulations is encouraged to reduce feed costs and diversify available feed resources.

REFERENCES

Adamu, S.B., Mohammed, A. and Musa, I. (2021). Nutritional Evaluation of Some Unconventional Feedstuffs for Poultry Production in Nigeria. *Nigerian Journal of Animal Science*, 23(2): 45-53.

Adeniji, A.A. and Jimoh, A. (2007). Effects of Replacing Maize with Enzyme-Supplemented Bovine Rumen Content in the Diets of Broiler Chickens. *International Journal of Poultry Science*, 6(11): 822-825.

Adenkola, A.Y., Ayo, J.O., Sackey, A.K.B. and Adelaiye, A.B. (2009). Haematological and Serum Biochemical Changes in Pigs Administered Ascorbic Acid and Transported by Road for Four Hours During the Harmattan Season. *Journal of Cell and Animal Biology*, 3(2): 21-28.

Adeyemo, A.I. and Borried, O.F. (2002). Response of Giant Snail (*Archantina maginata*) to Graded Levels of *Piliostigma thonningii Kalgo*pod Meal Based Diet. *Nigerian Journal for Animal Production*, 7-14.

Afolayan, M., Adeyemi, A. and Olorunsanya, A. (2019). Cost Implication of Using Alternative Feedstuffs in Broiler Production. *Tropical Animal Production Research Advances*, 11(1): 29-36.

Ahmed, B., Zubairu, S., Saleh, Z.A., Suleiman, M., Rabi'u, M. and Haladu, S. (2024). Performance and Carcass Characteristics of Broiler Chickens Fed Graded Levels of *Kalg*opod Meal (*Piliostigma thonningii*). In: Proceedings of Nigerian Society for Animal Production Held at University of Ibadan, 24-27 March, 2024.

Ahmed, M.A., Aro. S.O., Ogungbenro, D.C. and Adeosun, T.A. (2022). Laying Performance and Blood Parametres of Japanese Quils (Coturnix coturnix japonica). At Different Stocking Densities. *Nigerian journal of animal production*, 49(4): 20-32.

Akinmutimi, A.H. and Onen, G.E. (2008). The Response of Broiler Finisher Birds Fed Graded Levels of *Piliostigma thonningii Kalgo*pod Meal in Place of Maize-based Diets. *Journal of Poultry. Science,* 7(5): 474-479.

Akinmutimi, A.H., Eze, A.U. and Omeje, S.I. (2017). Effects of Legume Seed-based Diets on Growth Performance and Carcass Characteristics of Broiler Chickens. *Journal of Animal Production Research*, 29(2): 45-53.

AL-Beitawi, N. and EL-Ghousein, S.S. (2008). Effect of Feeding Different Levels of *Nigella sativa* Seeds (black cumin) on Performance, Blood Constituents and Carcass Characteristics of Broiler Chicks. *International Journal of Poultry Science*, 7: 715-721.

Amaefule, K.U., Obioha, F.C. and Ukachukwu, S.N. (2011). Processing and Utilization of Legume Seeds in Poultry Diets: A Review. *Nigerian Journal of Animal Production*, 38(2): 1-14.

Banerjee, C.G. (1998). *A Textbook of Animal Husbandry*. 8th Edn., New Delhi, India: Raju Prinlani Publisher for Oxford and IBH Publishing Co. Pvt. Ltd.

Bermudez, A.J. and Stewart-Brown, B. (2003). Principle of Disease Prevention, Diagnosis and Control. In: Y.M., Salt (ed.) *Disease of Poultry*, Iowa State: Blackwell Publishing Company, pp.17-55.

Bukar, M., Lawal, A.M. and Ibrahim, U. (2021). Alternative Feed Resources for Sustainable Poultry Production in Sub-Saharan Africa: A Review. *Journal of Animal Production Research*, 33(4): 112-121.

Denli, M., Ferde, O. and Kama, H.I. (2003). Effect of Dietary Probiotic, Organic Acid and Antibiotic Supplement on Performance and Carcass Yield. *Pakistan Journal of Nutrition*, 2(2): 89-91.

Etim, N.N., Williams, M.E., Akpabio, U. and Offiong, E.E. (2014). Haematological Parameters and Factors Affecting their Values. *Agricultural Science*, 2(1): 37-47.

Etim, N.N., Williams, M.E., Akpabio, U. and Offiong, E.E.A. (2014). Haematological Parameters and Factors Affecting their Values. *Agricultural Science*, 2(1): 37-47.

FAO. (2021). Food and Agriculture Organization of the United Nations. Poultry sector development: Opportunities and challenges

GraphPad Software. (2000). GraphPad InStat®, version 3.05, 32 bit for Win 95/NT. https://www.graphpad.com/instat/

Katsina State Government K.S.G. (2013). Report of Monitoring and Evalution Capacity Assessment, Ministry of Information and Culture, September, 2013. Ministry of Information and Culture, September, 2013.

Maharjan, P., Martinnez, D.A., Weil, J., Suesuttajit,N., Umberson, C., Mullenix, G., Hilton, K.M., Beitia, A. and Coon, C.N. (2021). Review: Physiological Growth Trend of Current Meat Broilers and Dietary Protein and Energy Management Approaches for Sustainable Broiler Production. *Elsevier Annual Consortium*, 1751-7311.

Mead, R., Gilmour, S.G. and Mead, A. (2012). *Statistical Principles for the Design of Experiments*. England, U.K.: Cambridge University Press.

Ogunwole, O.A., Lawal, H.O., Idowu, A.I., Oladimeji, S.O., Abayomi, F.D., Tewe, O.O. (2016). Carcass Characteristics, Proximate Composition and Residual Retinol in Meat of Broiler Chickens Fed β-carotene Cassava (*Manihot esculenta* Crantz) Grits Based Diets. *Journal of Animal Production Research*, 28(2): 102-117.

Oladimije, S.O., Ogunwole, O.A., Amole, T.A. and Tewe, O.O. (2020). Carcass Characteristics and Organs Weight of Broiler Chickens Fed Varying Inclusion Levels of Cassava (Manihot esculent Crantz) Peel Products-Based Diets. *Nigerian Journal of Animal Science*, 22 (3): 147- 157.

Oladokun, V.B. and Adeola, O. (2020). Feeding Strategies to Reduce Cost in Poultry Production: A Review. *Journal of Applied Agricultural Research*, 12(2): 88-97.

Oladunjoye, I.O. and Ojebiyi, O.O. (2010). Performance Characteristics of Broiler Chickens Fed Varying Dietary Levels of Fermented Cassava Peel Meal. *Journal of Agricultural Science*, 2(2): 52-57.

Oloruntola, O.D., Ayodele, S.O., Agbede, J.O. and Oloruntola, D.A. (2018). Effect of Detary Supplementation with Ginger and Garlic Mixtures on Growth Performance, Carcass Characteristics and Blood Profile of Broiler Chickens. *Journal of Animal Science Research*, 2(1): 1-9.

Onyimonyi, A.E., Adeyemi, O.A. and Okeke, G.C. (2009). Performance and Economic Characteristics of Broilers Fed Varying Dietary Levels of Neem Leaf Meal (Azadirachta indica). *International Journal of Poultry Science*, 8(3), 256-259.

Journal of Arid Agriculture. 2025, Vol. 26 (3): 83 – 90

Oyawoye, E.O. and Ogunkunle, M. (2004). Biochemical and Haematological Reference Values in Normal Experimental Animals. In: Biochemical and Haematological Reference Values in Normal Experimental Animals.

Oyebimpe, K., Fanimo, A.O., Oduguwa, O.O. and Biobaku, W.O. (2006). Response of Broiler Chickens to Cassava Peel and Maize Offal in Cashew Nut Meal-based Diets. *Archivos de Zootecnia.* 55(211): 301-304.

Smith, A.J. (2001). *Poultry Production.* 2nd Edn., London, U.K.: Macmillan Publishers.

Soares, P.R., Fonseca, J.B., Silva, M.A, Graças, A.S., Rostagno, H.S. and Silva A.C.A. (1991). Performance of Four Commercial Broiler Strains Raised under Different Stocking Density. *Revista Brasileira de Zootecnia*, 20(1): 74-79.

Yakubu, H., Bello, M.B. and Garba, A. (2020). Nutrient composition and potential of *Piliostigma thonningii* pod meal as livestock feed. *Nigerian Journal of Animal Science*, 22(1): 67-75.

Yakubu, H., Salihu, T. and Usman, M. (2020). Nutritional and Anti-nutritional Evaluation of *Piliostigma thonningii* Pod Meal for Livestock Feeding. *International Journal of Livestock Production*, 11(3): 45-51.