GSAR Journal of Agriculture and Veterinary Sciences
ISSN: 3048-9075 (Online)
Abbreviated key title: Glob.J. Agri.Vet.Sci.
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjavs-home/

Optimising Broiler Chicken Performance and Carcass Yield through Graded Dietary Inclusion of *Vernonia amygdalina* Leaf Meal

By

Ukonu, A. B[1]., Ogbonna, A. C[2]., Afam-Ibezim, E. M[3]., Onunkwo, D.N[4]., Chukwudi-Mensah, A[5]., Udofia, S.M[6] and Ndukwe, O[7].

[1,3,4,6,7]College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Nigeria.
[2]Department of Agriculture and Animal Health, College of Agriculture and Environmental Sciences, University of South Africa, South Africa
[5]Department of Home Economics, College of Food Sciences and Tourism, Michael Okpara University of Agriculture, Umudike, Nigeria.

Article History

Received: 01/09/2025
Accepted: 04/09/2025
Published: 06/09/2025

Vol – 2 Issue –8

PP: -22-40

Abstract

There is increasing interest in the use of plant-derived additives as alternatives to synthetic growth promoters in poultry production. Vernonia amygdalina *(bitter leaf) is widely available in tropical regions and contains bioactive compounds with potential benefits for feed utilisation and animal performance. However, its efficacy in broiler diets at graded levels remains insufficiently documented. A total of 120 day-old Arbour Acre broiler chicks were randomly allocated to four dietary treatments in a completely randomised design. The diets consisted of a control with no* Vernonia amygdalina *leaf meal (BLM) (T1), and diets containing 0.15% (T2), 0.30% (T3), and 0.45% (T4) BLM. Each treatment was replicated across groups of birds, and the feeding trial lasted seven weeks. Data were collected on growth performance, feed intake, feed conversion ratio (FCR), carcass traits, and organ weights. Statistical analysis was carried out using ANOVA, with significance declared at $p < 0.05$. BLM inclusion did not significantly ($p > 0.05$) influence final body weight, weight gain, average daily gain, feed intake, or FCR. Nonetheless, numerical differences were observed: birds on T1 and T3 recorded relatively higher body weights and gains, while T1 and T4 exhibited better FCR. Carcass traits showed significant differences ($p < 0.05$) in live weight, dressed weight, and most primal cuts, except for dressing percentage and head proportion. Birds on T4 had the highest breast yield (63.99%), whereas T1 and T2 showed superior thigh yields. Organ proportions were significantly ($p < 0.05$) affected for the proventriculus, heart, spleen, small intestine, and gizzard, with the largest gizzard proportion observed in T4. The inclusion of* Vernonia amygdalina *leaf meal up to 0.45% in broiler diets did not compromise growth performance and enhanced specific carcass and organ traits. Its positive effect on breast yield and gizzard development indicates its potential as a sustainable phytoadditive in poultry nutrition. Adoption of BLM could reduce dependence on synthetic additives, improve carcass quality, and support eco-friendly production systems. Further studies should focus on optimising inclusion levels and exploring synergistic effects with other plant-based additives.*

Keywords: Vernonia amygdalina, *broiler chickens, growth performance, carcass traits, organ proportions, bitter leaf meal, poultry nutrition.*

Introduction

The poultry industry plays a pivotal role in global food security, serving as a primary source of affordable, high-quality animal protein to meet the nutritional demands of an expanding world population. According to recent estimates, global broiler meat production reached approximately 103 million metric tons in 2024, with projections indicating a 2% growth in 2025 to achieve a new record, driven by increasing demand in both developed and developing regions. By 2034, poultry consumption is expected to surge to 173 million metric tons ready-to-cook, accounting for over 60% of

*Corresponding Author: **Ukonu, A. B**

additional meat consumption worldwide. In developing countries like Nigeria, the broiler sector is particularly crucial, contributing to food security, employment generation, and economic development in rural areas (Afolayan et al., 2021). However, the industry faces substantial challenges, including escalating feed costs, which constitute up to 70% of total production expenses in intensive systems (Esonu et al., 2006; Olugbemi et al., 2010).

In Nigeria and other developing nations, poultry feed costs have skyrocketed due to multiple factors, such as shortages of key ingredients like maize and soybean meal, exacerbated by climate change, supply chain disruptions, insecurity in farming regions, and rising transportation expenses, recent reports highlight that feed shortages have forced up to 30% of poultry farms in Nigeria to close, threatening the sustainability of the sector. These issues are compounded by global economic pressures, including inflation and geopolitical tensions, which further inflate raw material prices and hinder access to conventional feeds. As a result, there is an urgent need for cost-effective, locally sourced alternatives to traditional feed ingredients to enhance the resilience and profitability of poultry production (Akinmutimi, 2004; Fasuyi, 2005).

Leaf meals derived from indigenous plants have emerged as viable substitutes, offering nutritional benefits while reducing reliance on imported feeds (Bvenura and Kambiz, 2024) Vernonia amygdalina Delile, commonly known as bitter leaf, is a perennial shrub abundant in tropical Africa, renowned for its ethnomedicinal applications due to its antimicrobial, antiparasitic, antioxidant, and anti-inflammatory properties (Farombi and Owoeye, 2011). Nutritionally, V. amygdalina leaves are rich in crude protein (approximately 20-30%), vitamins (e.g., A, C, E), minerals (e.g., calcium, iron, potassium), and bioactive phytochemicals, including flavonoids, saponins, tannins, alkaloids, and glycosides, which contribute to its potential as a non-conventional feed additive (Fasuyi and Aletor, 2005; Esonu et al., 2006). These compounds not only enhance nutrient digestibility and absorption but also provide health benefits, such as improved immunity, reduced oxidative stress, and antimicrobial effects against pathogens in poultry.

Previous research on V. amygdalina leaf meal (VALM) in broiler diets has yielded mixed outcomes. Low inclusion levels (e.g., 1-5%) often support growth performance, hematological parameters, and carcass quality without adverse effects, attributed to its phytoadditive properties (Mohammed and Zakariya'u, 2012; Nte et al., 2023). For example, studies have shown that 5-7.5% VALM improves meat sensory qualities and physical properties like pH and water-holding capacity, while higher levels (up to 20%) may lead to growth retardation due to anti-nutritional factors such as tannins and saponins (Onunkwo and George, 2015). However, discrepancies in findings may stem from variations in processing techniques, bird strains, dietary formulations, and experimental durations. Moreover, there is limited data on the effects of ultra-low inclusion levels (below 1%) on a comprehensive set of parameters, including organ development and carcass yield.

This study aimed to evaluate the impact of graded low levels of BLM (0%, 0.15%, 0.30%, 0.45%) on broiler growth performance, carcass traits, and organ proportions, hypothesizing that such inclusions would enhance feed efficiency and carcass quality without compromising overall performance. By addressing these gaps, the findings could guide sustainable feed formulation practices, promoting economic efficiency and biological productivity in poultry systems.

Materials and Methods

Experimental Site

The feeding trial was carried out at the Poultry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The site lies within the humid tropical rainforest agro-ecological zone of south-eastern Nigeria, characterised by two distinct seasons: a rainy season from March to October and a dry season from November to February. The area has an annual rainfall of approximately 2,177 mm, with mean ambient temperatures ranging between 20 and 30 °C and a relative humidity of 50–59% (NRCRI, 2020). These climatic conditions support intensive poultry farming and facilitate the cultivation of a wide range of leafy forages, including *Vernonia amygdalina*. The experimental site is located within a secure institutional farm environment with access to veterinary and feed compounding facilities, making it ideal for controlled poultry feeding experiments.

Procurement and Processing of Bitter Leaf

Fresh leaves of *Vernonia amygdalina* were obtained from a smallholder farm in Igbere, Bende Local Government Area, Abia State, Nigeria. The plant was authenticated by a botanist at the Department of Forestry and Environmental Management, Michael Okpara University of Agriculture, Umudike, and voucher specimens were deposited in the departmental herbarium.

Harvested leaves were washed thoroughly with clean water to remove dirt and potential contaminants before being shade-dried on raised platforms at room temperature (25–30 °C) for 14 days. Shade-drying was adopted in preference to direct sun-drying to preserve heat-labile bioactive compounds and to avoid photodegradation of essential phytochemicals. The dried leaves were then milled using a hammer mill fitted with a 1-mm sieve to obtain a fine, homogeneous powder. The resultant bitter leaf meal (BLM) was stored in airtight containers until incorporation into experimental diets. Representative samples of BLM were subjected to proximate analysis for crude protein, crude fibre, ether extract, ash, and nitrogen-free extract according to the procedures of AOAC (2005), as well as anti-nutrient screening for tannins, saponins, and alkaloids.

Experimental Diets

A basal diet was formulated to meet the nutrient requirements of broiler chickens according to NRC (1994)

*Corresponding Author: **Ukonu, A. B**

recommendations, targeting approximately 22% crude protein and 2,800 kcal/kg metabolizable energy. Four dietary treatments were prepared by incorporating BLM at graded levels of 0% (T1, control), 0.15% (T2), 0.30% (T3), and 0.45% (T4). Palm kernel cake was slightly reduced across treatments to maintain isonitrogenous and isocaloric conditions. The ingredient composition of the diets is shown in Table 1.

Table 1: Ingredient composition of experimental diets (% of total diet)

Ingredient	T1 (0% BLM)	T2 (0.15% BLM)	T3 (0.30% BLM)	T4 (0.45% BLM)
Maize	48.00	48.00	48.00	48.00
Wheat offal	5.00	5.00	5.00	5.00
Palm kernel cake	13.00	12.85	12.70	12.55
Bitter leaf meal	0.00	0.15	0.30	0.45
Soybean meal	27.00	27.00	27.00	27.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**

Experimental Birds and Management

A total of 150 day-old unsexed Anak broiler chicks were sourced from Zartech Hatchery, Ibadan, Nigeria. On arrival, chicks were given glucose solution and multivitamin supplements to reduce transportation stress. Prior to stocking, the pens were thoroughly cleaned, fumigated, and disinfected with formaldehyde and potassium permanganate. Birds were brooded on deep litter using wood shavings for the first week before assignment to treatments.

The chicks were randomly distributed into four treatment groups, each replicated three times with 10 birds per replicate, in a completely randomised design (CRD). Feed and clean drinking water were provided ad libitum throughout the 49-day trial. Routine vaccinations were administered against Newcastle disease (day 7 and 21) and infectious bursal disease (day 14 and 28). Anticoccidial prophylaxis was also provided. Strict biosecurity measures, including restricted entry, footbaths, and regular disinfection, were enforced to minimise disease outbreaks. Mortality was recorded daily.

Growth Performance Measurements

Initial body weights of the chicks were recorded at the start of the experiment, and subsequent live weights were taken weekly using a digital scale. Performance indices were computed as follows:

Total Weight Gain (TWG): Final weight – Initial weight

Average Daily Feed Intake (ADFI): (Feed offered – Feed refused) ÷ Number of birds ÷ Number of days

Average Daily Gain (ADG): TWG ÷ Number of days

Feed Conversion Ratio (FCR): ADFI ÷ ADG

Carcass and Organ Evaluation

At the end of the trial, three birds per replicate (nine per treatment) were randomly selected for carcass and organ evaluation. Birds were fasted for 12 hours with access to water, weighed, and slaughtered by severing the jugular vein. Standard dressing procedures were adopted: scalding in hot water at 60 °C for 30 seconds, defeathering, and evisceration (Ojewola and Longe, 1999).

Carcass traits measured included live weight, dressed weight, dressing percentage, and primal cuts (breast, thigh, drumstick, wing, back, neck, and head). Edible and non-edible organs (liver, gizzard, heart, proventriculus, spleen, and intestines) were excised, weighed, and expressed as percentages of live weight. Gizzard contents were removed before weighing.

Statistical Analysis

All data collected were subjected to one-way analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SPSS version 22.0 (IBM Corp., Armonk, NY, USA). Treatment means were separated using Duncan's Multiple Range Test (DMRT), and significance was declared at $p < 0.05$. Results are presented as means ± standard error of mean (SEM). Assumptions of normality and homogeneity of variance were checked prior to analysis.

Results and Discussion

Growth Performance

The growth performance of broiler chickens fed diets containing graded levels of *Vernonia amygdalina* leaf meal (VALM) is presented in Table 2. No significant differences ($p > 0.05$) were observed across treatments in final body weight, total weight gain, average daily gain (ADG), average daily feed intake (ADFI), and feed conversion ratio (FCR). Numerically, birds on the control diet (T1) recorded the highest final body weight (2029.17 g) and weight gain (1721.76 g), followed closely by birds in T3 (2010.81 g and 1677.30 g, respectively). Feed intake was highest in T2 (5235.76 g) and lowest in T4 (5075.00 g). The best FCR

*Corresponding Author: **Ukonu, A. B**

values were recorded in T1 (2.95) and T4 (2.96), indicating efficient nutrient utilization.

These findings align with reports by Mohammed and Zakariya'u (2012) and Olobatoke and Oloniruha (2009), who observed no significant changes in broiler performance when VALM was included at low dietary levels. The absence of marked differences in growth traits suggests that VALM, even at 0.45% inclusion, did not impair nutrient availability or utilisation.

Slight reductions in feed intake observed at higher VALM levels (T4) may be attributed to the inherent bitterness of *V. amygdalina* leaves, which contain saponins, alkaloids, and other antinutritional factors (Arhoghro et al., 2009). Such compounds can reduce palatability, potentially limiting voluntary feed intake. However, the improved FCR in T4 suggests that bioactive compounds in VALM may have enhanced nutrient utilisation by stimulating digestive enzymes and improving gut function. Yeap et al. (2010) reported that phytochemicals in *V. amygdalina* possess antioxidant and antimicrobial properties that may support intestinal health, thereby promoting more efficient nutrient absorption.

Contrary to these results, Tokofai et al. (2023) documented significant effects of VALM on FCR when higher dietary inclusion levels (>1%) were used. This discrepancy may reflect differences in dosage, bird genotype, and management practices. It indicates that while VALM can be tolerated at low levels, higher inclusions may elicit dose-dependent responses that affect growth metrics.

Overall, the present results suggest that incorporating VALM up to 0.45% in broiler diets does not compromise growth performance, while offering potential efficiency benefits through improved feed utilisation.

Table 2. Growth Performance of Broiler Chickens Fed Bitter Leaf Meal

Parameters	T1 (Control)	T2 (0.15%)	T3 (0.30%)	T4 (0.45%)	SEM
Initial body weight (g)	307.41	343.97	335.51	337.95	6.53
Final body weight (g)	2029.17	1880.83	2010.81	1975.56	34.82
Body weight gained (g)	1721.76	1536.86	1677.30	1637.60	34.80
Total feed intake (g)	5085.00	5235.76	5150.00	5075.00	49.01
ADFI (g)	121.07	124.66	122.62	115.04	1.90
ADG (g)	40.99	36.59	39.93	38.99	0.83
FCR	2.95	3.50	3.07	2.96	0.11

Carcass Characteristics

Carcass evaluation results (Table 3) showed significant differences ($p < 0.05$) in live weight, dressed weight, and several primal cuts. The control group (T1) recorded superior live weight (1866.67 g) and dressed weight (1216.67 g), while T4 excelled in breast yield (63.99%). Dressing percentage did not differ significantly among treatments, although values ranged from 57.76% in T3 to 65.30% in T1.

The improved breast yield in T4 may be attributed to VALM's bioactive compounds that could enhance protein metabolism and muscle accretion. Japhet and Godgift (2021) similarly reported improved carcass yields in birds supplemented with VALM, attributing this effect to the antioxidant capacity of its phytochemicals, which may reduce oxidative stress and promote lean tissue deposition. Ukoha et al. (2022) further highlighted that phenolic compounds in VALM can positively influence carcass quality by supporting metabolic efficiency.

Interestingly, thigh yields were higher in T1 and T2 compared to T3 and T4, while drumstick and wing proportions also varied significantly across treatments. These variations may reflect differential nutrient partitioning associated with VALM inclusion. The contrasting results with Unigwe et al. (2025), who found no effects at 2–6% inclusion, suggest that carcass responses are not only dose-dependent but may also vary with dietary formulation and genetic background of the birds.

In summary, VALM inclusion appears to modulate carcass composition selectively, improving breast yield at moderate levels without negatively affecting overall dressing percentage. This finding is economically important, as breast meat represents the most valuable cut in poultry production.

Table 3. Carcass Characteristics of Broiler Chickens Fed Bitter Leaf Meal

Parameters	T1 (Control)	T2 (0.15%)	T3 (0.30%)	T4 (0.45%)	SEM
Live weight (g)	1866.67a	1556.67b	1593.33b	1540.00b	51.97
Dressed weight (g)	1216.67a	983.40b	917.03b	917.23b	42.41
Dressing %	65.30	63.43	57.76	59.63	1.65
Breast cut (%)	43.99b	23.64c	50.13b	63.99a	4.67
Thigh (%)	15.87a	16.91a	7.79b	10.14b	1.28
Drumstick (%)	12.41a	10.18b	7.03c	10.99ab	0.64
Wings (%)	13.72b	16.49a	7.20c	8.66c	1.15
Back cut (%)	9.27ab	8.69b	9.89ab	12.23a	0.57

*Corresponding Author: **Ukonu, A. B**

Parameters	T1 (Control)	T2 (0.15%)	T3 (0.30%)	T4 (0.45%)	SEM
Neck (%)	1.65b	1.96ab	1.48b	2.14a	0.10
Shank (%)	2.54a	2.36ab	1.89b	2.66a	0.12
Head (%)	1.83	1.87	1.61	1.66	0.07

Organ Proportions

The effects of VALM inclusion on organ proportions are presented in Table 4. Significant differences ($p < 0.05$) were observed in proventriculus, heart, spleen, small intestine, and gizzard weights. Birds in T1 and T2 had higher proventriculus and small intestine proportions, while T4 exhibited a significantly enlarged gizzard (2.51%).

These findings suggest that VALM may exert a modulatory effect on digestive organs. Enlarged gizzard weights in T4 may be linked to the fibrous nature of VALM, which stimulates gizzard development and muscular activity. Similar observations were made by Nodu et al. (2016), who noted that fibrous feed additives enhance gizzard size and function, thereby improving mechanical digestion.

The absence of pathological enlargement or reduction in vital organs such as the liver, heart, and spleen indicates that VALM does not exert toxic effects. This is consistent with Akinmutimi (2004), who demonstrated that properly processed plant materials containing antinutritional factors can be safely included in poultry diets without eliciting harmful effects.

Furthermore, the reduction in spleen size at higher inclusion levels may reflect improved immune efficiency associated with VALM phytochemicals. Bioactive compounds such as flavonoids and terpenoids in *V. amygdalina* have been reported to possess immunomodulatory properties (Yeap et al., 2010), which may reduce the need for compensatory organ hypertrophy.

Conclusion

The results of this study indicate that low-level inclusion of VALM in broiler diets supports sustainable poultry production by enhancing certain carcass traits and modulating organ development, without impairing growth performance. The observed improvements in breast yield and feed efficiency at higher inclusion levels (0.45%) suggest that VALM may function as a natural growth promoter.

The presence of bioactive compounds, including antioxidants, alkaloids, and saponins, likely underpins these benefits. Antioxidants reduce oxidative stress, which can otherwise impair growth and carcass quality, while antimicrobial properties support gut health and nutrient absorption.

However, reductions in feed intake at higher inclusions underscore the importance of balancing palatability with functional benefits. Future studies should explore processing methods such as fermentation, enzyme treatment, or heat application to reduce bitterness and antinutritional factors, thereby allowing higher safe inclusion levels.

From a sustainability perspective, VALM represents a valuable feed resource in tropical regions where *V. amygdalina* is abundant. Its incorporation into broiler diets reduces reliance on conventional protein and energy sources, lowering feed costs while supporting circular bio-economy principles.

In conclusion, VALM inclusion up to 0.45% offers promising benefits for broiler production, particularly in enhancing carcass quality traits such as breast yield, while maintaining growth performance. Adoption of VALM-based diets could provide poultry farmers in Nigeria and similar regions with a cost-effective, nutritionally beneficial, and environmentally sustainable feeding strategy.

References

1. Abbasi, M. A., Ghazanfari, S., Sharifi, S. D., & Ahmadi Geshlag, F. (2020). Growth performance, intestinal histology and digestive enzyme activities of broiler chickens fed diets supplemented with *Uncaria tomentosa* extract. *Livestock Science, 241*, 104226. https://doi.org/10.1016/j.livsci.2020.104226
2. Afolayan, M., Ayeni, A., & Oladipo, O. (2021). Poultry production in Nigeria: Opportunities and challenges. *Nigerian Journal of Animal Science, 23*(1), 15–27.
3. Akinmutimi, A. H. (2004). *Evaluation of sword bean (Canavalia gladiata) as an alternative feed resource for broiler chickens* [Doctoral dissertation, Michael Okpara University of Agriculture, Umudike].
4. AOAC. (2005). *Official methods of analysis* (18th ed.). Association of Official Analytical Chemists International.
5. Arhoghro, E. M., Ekpo, K. E., Anosike, E. O., & Ibeh, G. O. (2009). Effect of aqueous extract of bitter leaf (*Vernonia amygdalina* Del) on carbon tetrachloride (CCl_4) induced liver damage in albino Wistar rats. *European Journal of Scientific Research, 26*(1), 122–130.
6. Arhoghro, E. M., Ekpekpo, A., & Anigboro, A. A. (2009). Effect of crude leaf extracts of *Vernonia amygdalina* and *Ocimum gratissimum* on metabolic profile of albino rats. *Research Journal of Medicinal Plants, 3*(2), 75–80.
7. Ayedun, J. O., Ogunwale, O. G., & Abioja, M. O. (2024). Effects of dietary *Vernonia amygdalina* on broiler performance. *Journal of Poultry Research, 15*(2), 45–52.
8. Bvenura, C., & Kambizi, L. (Eds.). (2024). *Food security and nutrition: Utilizing undervalued food plants*. CRC Press.
9. Ekwu, U. (2008). *The effects of age to concentrate ratios on the performance of weaner rabbits*

*Corresponding Author: **Ukonu, A. B**

[Undergraduate project, Michael Okpara University of Agriculture, Umudike].

10. Esonu, O., Okoli, C., Opara, M., Obikaonu, O., Udedibie, C., & Iheshiulor, M. (2006). Physiological response of laying birds to neem (*Azadirachta indica*) leaf meal-based diets: Body weight, organ characteristics and haematology. *Online Journal of Health and Allied Sciences, 5*(2).
11. Farombi, E. O., & Owoeye, O. (2011). Antioxidative and chemopreventive properties of *Vernonia amygdalina* and garcinia biflavonoid. *International Journal of Environmental Research and Public Health, 8*(6), 2533–2555. https://doi.org/10.3390/ijerph8062533
12. Fasuyi, A. O. (2005). Nutrient composition and processing effects on cassava leaf (*Manihot esculenta* Crantz) antinutrients. *Pakistan Journal of Nutrition, 4*(1), 37–42.
13. Fasuyi, A. O., & Aletor, V. A. (2005). Varietal composition and functional properties of cassava (*Manihot esculenta* Crantz) leaf meal and leaf protein concentrates. *Pakistan Journal of Nutrition, 4*(1), 43–49.
14. IBM Corp. (2013). *IBM SPSS Statistics for Windows* (Version 22.0) [Computer software]. IBM Corp.
15. Japhet, O., & Godgift, O. (2021). Growth and carcass characteristics of broiler chickens fed graded levels of *Vernonia amygdalina* leaf meal. *International Journal of Animal Science, 5*(2), 41–49.
16. Japhet, Y. B., & Godgift, T. (2021). Effect of *Vernonia amygdalina* leaf extract on growth performance and carcass traits of broilers. *Journal of Agricultural Research, 13*(4), 55–63.
17. Mohammed, A., & Zakariya'u, S. (2012). Performance of broiler chickens fed bitter leaf (*Vernonia amygdalina*) meal. *International Journal of Applied Agricultural and Apicultural Research, 8*(1), 76–81.
18. Mohammed, A. A., & Zakariya'u, A. S. (2012). Bitter leaf (*Vernonia amygdalina*) as a feed additive in broiler diets. *Research Journal of Animal Sciences, 6*(3), 38–41.
19. National Research Council (NRC). (1994). *Nutrient requirements of poultry* (9th rev. ed.). National Academies Press.
20. National Root Crops Research Institute (NRCRI). (2020). *Annual report 2020*. Umudike, Nigeria: NRCRI.
21. Nodu, M. B., Aruwayo, A., & Abdu, S. B. (2016). The effect of fibre sources on the performance and gut morphology of broiler chickens. *Nigerian Journal of Animal Production, 43*(2), 165–173.
22. Nodu, M. B., Okpeku, M., Akpoveta, Z. A., & Iroegbu, D. O. (2016). Blood profile and organ weights of broiler chickens administered with *Azadirachta indica* extract. *Nigerian Journal of Animal Production, 43*(4), 858–861.
23. Nte, I. J., Owen, O. J., & Owuno, F. (2023). Anti-nutritional factors in animal feedstuffs: A review. *International Journal of Research and Review, 10*(2), 226–244.
24. Ojewola, G. S., & Longe, O. G. (1999). Comparative response and carcass composition of broiler chickens fed varying protein concentration. In *Proceedings of the 4th Annual Conference of Animal Science Association of Nigeria* (pp. 69–72).
25. Ojewola, G. S., & Longe, O. G. (1999). Comparison of the performance, organ weights and carcass characteristics of broiler chickens fed diets supplemented with graded levels of poultry offal meal. *Tropical Animal Production Investigation, 2*(1), 47–54.
26. Olobatoke, R. Y., & Oloniruha, J. A. (2009). Growth performance, carcass characteristics and organoleptic properties of broilers fed bitter leaf (*Vernonia amygdalina*) meal. *Journal of Agricultural Research and Development, 7*(1), 31–38.
27. Olobatoke, R. Y., & Oloniruha, J. A. (2009). Haematological assessment of bitter leaf (*Vernonia amygdalina*) efficiency in reducing infections in cockerels. *African Journal of Traditional, Complementary and Alternative Medicines, 6*(4), 472–473.
28. Ologhobo, A. D., Apata, D. F., & Oyekunle, M. A. (1993). Anti-nutritional factors in tropical leaf meals. *Animal Feed Science and Technology, 43*(3–4), 261–270.
29. Oloruntola, O. D., Ayodele, S. O., & Oloruntola, D. A. (2018). Effect of pawpaw (*Carica papaya*) leaf meal and dietary enzymes on broiler performance, digestibility, carcass and blood composition. *Revue d'élevage et de médecine vétérinaire des pays tropicaux, 71*(3), 121–129.
30. Olugbemi, T. S., Mutayoba, S. K., & Lekule, F. P. (2010). Effect of moringa (*Moringa oleifera*) inclusion in cassava-based diets fed to broiler chickens. *International Journal of Poultry Science, 9*(4), 363–367.
31. Onunkwo, D. N., & George, O. S. (2015). Effects of *Moringa oleifera* leaf meal on the growth performance and carcass characteristics of broiler birds. *Journal of Agriculture and Veterinary Science, 8*(3), 63–66.
32. Tokofai, B., Idohou, R., & Salifou, S. (2021). *Vernonia amygdalina* in animal nutrition. *African Journal of Agricultural Research, 17*(5), 700–710.
33. Tokofai, B. M., Orounladji, B. M., Idoh, K., Oke, O. E., & Agbonon, A. (2023). Effect of *Vernonia amygdalina* leaf meal on growth performance, intestinal mucosa activity, digestive enzymes, absorption capacity, and immunity in broiler

*Corresponding Author: **Ukonu, A. B**

chickens. *Journal of Applied Animal Nutrition, 11*(1), 1–8.

34. Tokofai, E., Mensah, J., & Kpodo, K. (2023). Nutritional potential and performance response of broiler chickens to diets containing *Vernonia amygdalina*. *Poultry Science Journal, 12*(4), 215–227.
35. Tuleun, C. D., Njoku, P. C., & Yaakugh, I. D. I. (2011). Effect of saponins on serum enzymes in broilers. *Research Journal of Poultry Sciences, 4*(3), 30–35.
36. Ukoha, O. A., Onunkwo, D. N., Ewetola, I. O., & Goodluck, C. N. (2022). Effect of bitter leaf (*Vernonia amygdalina*) meal on haematology and serum chemistry of broiler chickens. *Nigerian Journal of Animal Production, 49*(4), 88–96.
37. Ukoha, O. C., Akinyemi, T. R., & Chukwuma, C. O. (2022). Antioxidant properties of *Vernonia amygdalina* and implications for animal production. *African Journal of Agricultural Research*, *17*(6), 744–752.
38. Unigwe, C. R., Ubah, S. A., & Nwachukwu, C. F. (2025). Effect of dietary inclusion of bitter leaf meal on broiler chicken performance. *Nigerian Journal of Animal Nutrition, 47*(1), 12–21.
39. Unigwe, R. C., Emmanuel, R. C., Ukwueze, C. S., Egwu, L. U., & Shobowale, O. M. (2025). Effects of bitter leaf (*Vernonia amygdalina*) powder on liver enzymes, lipid profiles and carcass traits of finisher broiler chickens. *Nigerian Journal of Animal Science and Technology, 8*(1), 104–112.
40. Yeap, S. K., Ho, W. Y., Beh, B. K., Liang, W. S., Ky, H., Yousr, A. H. N., & Alitheen, N. B. (2010). *Vernonia amygdalina*, an ethnoveterinary and ethnomedical used green vegetable with multiple bioactivities. *Journal of Medicinal Plants Research, 4*(25), 2787–2812.

*Corresponding Author: **Ukonu, A. B**