Majestic Journal of Zoology
Volume 1, 2026, **pp.** 1-8, **Article ID:** CM2601117003

CONTENT MAJESTIC PUBLISHER

Research Article

Performance Characteristics of Starter Broilers Administered with Three Leaf Meal Extracts (Neem, Moringa and Lemongrass)

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Article History

Received: 11 May, 2026 Revised: 13 July, 2026 Accepted: 10 August, 2026 Published: 09 September, 2026

Abstract:

Introduction: There has been considerable increase in the production of farm animals over the years, especially poultry and is attributed to the genetic improvements in livestock breeds and incorporation of feed additives into poultry diets. The competition between humans and livestock for conventional feed ingredients along with limitation on use of synthetic feed additives has posed the need for sustainable and economic substitutes to ensure safety in poultry products without compromising the quality of the products. Therefore, the present study evaluates the performance characteristics of starter broiler chickens administered extracts of neem, moringa and lemongrass extracts as potential natural feed additives.

Methods: 180-day-old Sayeed broiler chicks were used to conduct the experiment that lasted 27 days. Four treatment groups were randomly assigned, with each consisting of 45 birds, divided into three replicates with each replicate containing 15 birds set out in the completely randomized design (CRD) pattern. Statistical analysis was performed using ANOVA and Duncan's Multiple Range Test and values $P < 0.05$ were considered statistically significant.

Results: Growth performance parameters differed significantly ($P < 0.05$) among the treatment groups. The highest values of 1359.60g, 1180.50g, 56.21g and 1.12 for final body weight, body weight gain, daily weight gain and feed conversion ratio were respectively obtained in treatment 4 with 15 mL/liter leaf meal extract. Cost-benefit analysis demonstrated superior economic returns in treatment 4, where the total cost of production was relatively lower (₦3599.83) with a higher revenue, net profit and cost benefit ratio of ₦6,118.20, ₦2,518.37 and 1.43 respectively.

Conclusion: It can be concluded that the administration of leaf meal extract of neem, moringa and lemongrass can be administered at levels up to 15 mL/liter, with the best results obtained in treatment 4 (15 mL/liter).

Keywords: Growth performance, cost benefit analysis, starter broilers, leaf meal extract, neem, moringa, lemongrass.

1. INTRODUCTION

Poultry farming plays a major role in solving the problem of protein deficiency in developing countries. The nutritional requirements in poultry are considered a key factor affecting growth performance and productivity (David *et al*., 2024). However, the high cost of conventional feed ingredients is a major challenge in the poultry industry, therefore, farmers seek alternative as well as sustainable feed sources for birds (Alagbe, 2017).

Synthetic feed additives are widely used to enhance the growth and productivity of poultry (Zhang *et al*., 2017). There have been increasing concerns about the usage of feed additives for prolonged duration as these substances may be harmful to animals as well as consumers of those poultry products (Azodo *et al*., 2023). To reduce the risk associated with use of antibiotics as growth promoters and synthetic growth hormones, much focus has been laid to the use of natural feed additives such as prebiotics, probiotics and phytogenic materials in the poultry industry (David *et al*., 2024; and Tesfaye *et al*., 2013). However, despite these advantages, phytochemicals such as tannins, saponins and cyanogenic substances may affect nutrient absorption at high doses in animal feed. The efficiency of plant-based feed additives depends on plant source, dosage,

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Cite as: David, O.A., Christiana, N., Chioma, A.K., Mishael, A. (2026). Performance characteristics of starter broilers administered with three leaf meal extracts (Neem, Moringa and Lemongrass). *Majestic Journal of Zoology*, *1*, 1–8. Article ID: CM2601117003.

composition, and mode of action of phytogenic compounds (Hafeez *et al*., 2016).

Unlike ruminants, poultry does not contain microbiota in the digestive system to break down the glycosidic bonds in fiber. Consequently, poultry has a low capacity to digest high-fiber feed along with high susceptibility to develop intestinal infections by pathogenic microorganisms and compromise immune functions and overall health. Antibiotic have thus been used as growth promoters to counteract such infections, enhance growth performance and maintain overall animal health. The extensive use of these compounds has led to the development of antimicrobial resistance and thus, World Health Organization (WHO) has discouraged use of antibiotic growth promoters as they pose significant risks to both animal and human health (Azodo *et al*., 2023).

Plant extracts are standard bioactive products known for their diverse biological attributes, including antimicrobial, antiviral and antifungal activities. These plant extracts stimulate appetite, promote secretion of endogenous enzymes, alleviate digestive and respiratory ailments while exhibiting antioxidant and immune-modulatory effects (Azodo *et al*., 2023; Olabode *et al*., 2023). The rising demand for increased efficiency in poultry production has led to the growing use of feed additives, making feed additives as an integral component of poultry nutrition (Onyimonyi & Ernest, 2009; Oloruntola *et al*., 2018).

It has been reported that plant leaf extracts are effective natural alternatives to synthetic antibiotic growth promoters in broiler production. Phytogenic plants used as natural alternatives include neem, pawpaw, guava, moringa, lemongrass, bitter leaf and scent leaf (David *et al*., 2024). These phytobiotics as feed additives are reported to improve gut health, stimulate digestion, enhance immunity, reduce serum cholesterol levels and pathogenic loads without compromising growth performance.

Neem tree (*Azadirachta indica*) is an indigenous tropical plant with antiviral and hypocholesterolemic properties in its fruits, seeds, leaves, barks and roots (Obun *et al*., 2013). According to (Ubua *et al*., 2019), neem leaves consist mainly of flavonoids and β-sibosterol (nimbosterol) as well as limonoids (nimbin) and its derivatives (Bonsu *et al*., 2012). Other biologically active compounds include azadarachtin, meliacin, gedunin, salanin and vilassin (Ubua *et al*., 2019). Studies reveal that incorporation 1% neem leaf powder yields optimal feed conversion ratios and enhanced overall weight gain (Shankar *et al.,* 2009; Onyimonyi & Ernest, 2009).

Moringa (*Moringa oleifera*) also known as the miracle tree has been found to possess wide range of medicinal uses. Moringa leaves are rich sources of protein and amino acids. The leaves and green pods are rich in ascorbic acid and carotenoids. The high nutrient composition of moringa leaves has attracted its use as a rich food source of protein, calcium, iron and vitamin C, suitable for utilization in many of the developing regions of the world where nourishment is a major concern (Zanu & Asiedu, 2012). (Benhammouche *et al*., 2021) reported that moringa leaf meal has high pepsin and total soluble protein than other parts of the plant. According to (Mahfuz & Piao, 2019) moringa leaf meal is the most nutritive part of the plant being a significant source of vitamin A, vitamin C, pro-vitamin A as β-carotene, magnesium and protein among other nutrients. Studies show that dietary inclusion of moringa leaf meal at levels up to 5% improves growth performance and feed efficiency in broiler chicken, supporting its use as a natural growth promoting feed additive (Macambira *et al*., 2022; Sadid & Anam, 2025).

Lemon grass (*Cymbopogon citratus*) is an aromatic plant that belongs to the Graminae familyand contains rich deposits of phytochemicals like tannins, flavonoids and phenols (Ogbonna *et al*., 2017). The compounds identified in lemongrass are terpenes, alcohols, ketones, aldehydes and esters. Studies indicate that *Cymbopogon citratus* possesses various pharmacological activities such as anti-amoebic, antibacterial and antifungal effects. Other effects include antimalarial, antioxidant and hypoglycemic activities (David *et al*., 2024). They are also known for their high citral and organic acid content. Trials indicate that lemongrass extracts lower intestinal pH, limits the growth of harmful bacteria and acts as a natural dewormer. Research confirms that dietary inclusion of lemongrass leaf meals at levels up to 3% in diet of broiler birds can promote healthy growth (Sariozkan *et al*., 2016).

The study evaluated performance characteristics of starter broiler chickens administered leaf meal extracts of neem, moringa and lemongrass.

2. MATERIALS AND METHODS

2.1. Experimental Site

The research work was conducted at Olatioye's poultry farm at Owode-Ede, in Osun state, from the month of July to August, 2025.

2.2. Ethical Considerations

The experiment was conducted using broiler chicken in accordance with guidelines for care and use of animals for research (National Research Council, 2011) and ARRIVE 2.0 Guidelines for reporting research on animals (Percie du Sert *et al*., 2020). The study being conducted in Nigeria was approved by Animal Ethics Committee of the Federal College of Agriculture (FCAI), Ishiagu, Nigeria. Moreover, field inspections of the experimental facility were carried out by members of National Institute of Animal Science (NIAS), South-East zone, Nigeria.

2.3. Source and Processing of Raw Materials

Leaves of neem, moringa and lemongrass were collected from Olatioye's farm and Owode-Ede environment. The following procedure was followed in preparation of the leaf extracts:

1. Fresh, green, young to medium mature leaves were harvested in the morning. Insect-damaged, yellow and moldy leaves were avoided.
2. The leaves were washed twice with water to remove sand and debris.

3. The leaves were spread on trays in well-ventilated shade. The leaves were turned five times due to high humidity during rainy season. The drying process took a week, after which the leaves were then placed in the sun for 2 hours to get crisp leaves for proper grinding.
4. The leaves were ground using hammer mill at the feed mill. The grind leaves were sieved with a 2mm sieve to remove big stalks and veins.
5. The grind leaves were then packed into airtight polythene lined sacks.

The composite leaf powder was prepared using 1:4:2 ratio of neem, moringa and lemongrass (using 100g of neem leaf powder, 400g of moringa leaf powder and 200g of lemongrass powder dissolved in 5 liters of water) respectively. The extract was administered at the rate of 0, 5, 10 and 15 mL/liter corresponding to treatments 1 (control), 2, 3 and 4 in a completely randomized design (CRD). The composition of the experimental diets supplemented with leaf extracts was determined according to methods of (Horwitz & Latimer, 2005) and protocol previously described by author (David *et al*., 2024) on neem, moringa and lemongrass leaf extracts. The extracts were provided to the birds three times a week on Monday, Wednesday and Friday. One quality diet was produced for the research work (Table **1**).

2.4. Experimental Design and Management of Birds

One hundred and eighty (180) day-old broiler chicks of Sayeed breed were used for the experiment. They were selected into four treatment groups, each treatment divided thrice in a completely randomized design (CRD) with 15 birds each per replicate and a total of 45 birds per treatment. The chicks were brooded with wood shavings as a source of litter and bedding material to provide warmth for the chicks. Electric bulbs were used as a source of illumination in the brooding house where charcoal served as a source of heat. Thermometer and movement of the chicks per time were used to check the temperature in the brooding house. Temperature maintained during brooding and raising of the chicks provided in Table **2**.

Feed and water were provided *ad-libitum* during the experiment. All necessary drugs and vaccination were duly administered as at when due (Table **3**).

Drugs and vaccines were administered as mentioned in Table **3**. The birds were brooded for one week after which they were distributed. Data collection lasted for a period of 27 days. Antibiotics were administered to only birds in treatment 1 (control), while the leaf extract served as a natural alternative to antibiotics for birds in treatment 2, 3 and 4 respectively.

2.5. Data Collection

a. Growth Performance

*Initial body weight was determined by weighing the birds at the beginning of the experiment.

*Final body weight was determined by weighing the birds at the end of the experiment.

*Weight gain was determined by subtracting the initial weight from the final weight of the birds.

*Feed intake was determined by subtracting the left-over feed from the total quantity of feed given to the birds the previous day.

*Feed conversion ratio was determined by dividing the feed intake by weight gain.

Table 1. Experimental diet for starter broiler birds administered with three different leaf meal extract.

Ingredients	Quantity
Maize	54.00
Wheat offal	7.90
Soya bean meal	12.00
Groundnut cake	13.95
Fishmeal	3.50
Blood meal	3.50
Limestone	1.50
Bonemeal	2.50
Lysine	0.20
Methionine	0.35
Starter premix	0.35
Salt	0.25
Total	100
Calculated value	
Crude protein (%)	22.69
Metabolizing Energy (Kcal/kg)	3001.90
Crude fiber (%)	4.30
Ether extract (%)	4.97
Calcium (%)	1.20
Phosphorus (%)	0.58
Methionine (%)	0.62
Lysine (%)	1.10

Table 2. Temperature and weeks of chick raising.

Number of Weeks	Temperature Range
Week one	32 ºC – 35 ºC
Week two	29 ºC – 32 ºC
Week three	27 ºC – 29 ºC
Week four	25 ºC – 27 ºC

b. Cost-Benefit Analysis

Cost benefit analysis was calculated using the formula given by (Olabode *et al.,* 2022) as follows;

- Cost of chick = Amount expended or spent on purchase of chick
- Cost per kg of feed = Cost of feed/25kg
- Cost of feed consumed = Total feed intake x cost per kg of feed/1000
- Other cost or managerial cost = Cost expended on transportation, litter materials, vaccines, drugs etc
- Total cost of production = Cost of bird + cost of feed consumed + managerial cost
- Revenue = Average final Weight of birds x cost per kg of current market price of 1kg meat of broiler/1000
- Benefit/Profit = Revenue - cost of production
- Cost-benefit ratio = Cost of production/Benefit

2.6. Statistical Analysis

The results obtained in the research work were subjected to Analysis of Variance (ANOVA) and significant differences were observed among treatment means. Duncan Multiple Range Test (DMRT) was used for mean separation at 5% level of significance ($P < 0.05$). Data was analyzed using the Advanced Statistics Module in SPSS software.

Table 3. Drug administration in broiler birds.

Number of Days	Vaccine Intervention
Day 1	Marek vaccine (given at the hatchery or point of collection of the chicks or on arrival of the chicks to the farm). Antistress plus multivitamin or glucose or sugar solution was given to the birds on arrival to ease transportation stress.
Day 2 to 5	Multivitamin and antibiotics (Mild antibiotics)
Day 6 to 8	Anticoccidial drug and vitamin (minus vitamin B1 (thiamine))
Day 9	Gumboro vaccine (i/o-intraoccular (via eye) or oral (drinking water))
Day 10	Vitamins
Day 11 to 13	Anticoccidial drug (Different from day 6 to 8 brand) and vitamin (minus vitamin B1(thiamine))
Day 14	LaSota vaccine mixed with skimmed milk
Day 15 to 20	Vitamins
Day 21	Second Gumboro vaccine (i/o or oral)
Day 22 to 24	Ordinary water
Day 25 to 27	Vitamins

Source: *Sayeed Hatching Company, Nigeria Ltd.*

3. RESULTS

Impact of starter broilers administered with three different leaf meal extracts is mentioned in Table **4**. The final body weight was highest (1359.60g) for birds in treatment 4 and differed significantly ($P < 0.05$) among other treatments. Moreover, birds in treatment 1 had the lowest final body weight (996.55g) and had no significant difference ($P > 0.05$) from those observed in treatment 2. Body weight gain was recorded highest in treatment 4 with value of 1180.50g and differed significantly ($P < 0.05$) among other treated groups. Moreover, significant differences were observed among all treatment groups ($P < 0.05$) as indicated by different superscript. The daily weight gain followed a similar trend with final body weight with highest recorded weight in treatment 4 (56.21g) followed by treatment 3 (50.97g) with significant differences ($P < 0.05$) observed among both treatments. Moreover, no significant differences ($P > 0.05$) were observed between treatment 1 and treatment 2. Feed intake among all treated groups differed significantly ($P < 0.05$) with highest value recorded in treatment 1 (1592.01g) followed by treatment 2 (1498.35g) and lowest weight recorded in treatment 4 (1326.36g). The daily feed intake was recorded highest in treatment 1 with 75.80g which varied from the recorded value obtained in treatment 2 (71.35g). The daily feed intake was lowest in treatment 4 (63.16g) and all treatment groups were significantly ($P < 0.05$) different. Feed conversion ratio was recorded highest in treatment 4 (1.12), while the least value was obtained in treatment 1 (1.95). Birds in treatment 2 and 3 had feed conversion ratio of 1.70 and 1.33 respectively which were significantly different ($P < 0.05$) among each other.

The cost-benefit analysis was also assessed and is presented in Table **4**. The cost of day-old chicks and cost of per kilogram of feed had same value of ₦1,600 and ₦980 respectively among the groups studied.

The cost of feed consumed had the highest value of ₦1,560.17 in treatment 1 which was significantly ($P < 0.05$) different from the value observed in treatment 2 (₦1,468.38). Treatment 4 had the least value with ₦1,299.83 which differed significantly ($P < 0.05$) from the value obtained in treatment 3 (₦1,397.38). Managerial cost of 700 was the same for all treatments.

The total cost of production was highest in treatment 1 with a value of ₦3,860.17, while the lowest value of ₦3,599.83 was observed in treatment 4. Moreover, ₦3768.38 and ₦3697.38 was recorded as the total cost of production in treatment 2 and 3 respectively. The revenue generated from the sales of the birds was highest in treatment 4 with a value of ₦6118.20 and differed significantly among other treatments ($P < 0.05$). Following treatment 4, treatment 3 generated a revenue of ₦5,626.58 while the lowest revenue was obtained in treatment 1 (₦4,484.48). Moreover, non-significant differences were observed among treatment 1 and treatment 2 ($P > 0.05$).

Table 4. Growth performance and cost benefit analysis of starter broiler chickens.

Parameters	Treatments				
	T1 (Control)	T2 (5ml/L)	T3 (10ml/L)	T4 (15ml/L)	SEM
Initial body weight (g)	180.50	180.25	180.50	179.10	-
Final body weight (g)	996.55^{c}	1060.10^{c}	1250.35^{b}	1359.60^{a}	39.52
Body weight gain (g)	816.05^{d}	879.85^{c}	1070.35^{b}	1180.50^{a}	26.14
Daily weight gain (g)	38.86^{c}	41.90^{c}	50.97^{b}	56.21^{a}	6.54
Feed intake (g)	1592.01^{a}	1498.35^{b}	1425.90^{c}	1326.36^{d}	33.76
Daily feed intake (g)	75.80^{a}	71.35^{b}	67.90^{c}	63.16^{d}	9.11
Feed conversion ratio	1.95^{a}	1.70^{b}	1.33^{c}	1.12^{d}	0.48
Cost of day-old chicks (₦)	1600.00	1600.00	1600.00	1600.00	-
Cost of kg of feed (₦)	980.00	980.00	980.00	980.00	-
Cost of feed consumed (₦)	1560.17^{a}	1468.38^{b}	1397.38^{c}	1299.83^{d}	28.40
Managerial cost (₦)	700.00	700.00	700.00	700.00	-
Total cost of production (₦)	3860.17^{a}	3768.38^{b}	3697.38^{c}	3599.83^{d}	62.76
Revenue (₦)	4484.48^{c}	4770.45^{c}	5626.58^{b}	6118.20^{a}	84.10
Benefit/Net profit (₦)	624.31^{d}	1002.07^{c}	1929.20^{b}	2518.37^{a}	45.31
Cost-benefit ratio	6.18^{a}	3.76^{b}	1.92^{c}	1.43^{d}	0.89

Note: ^{abcd}Means on the same row with different superscripts are significantly ($P < 0.05$) different.

Abbreviation: SEM = Standard Error of Mean

The net profit among all treatments was significantly different ($P < 0.05$). Treatment 4 provided the highest net profit of ₦2,518.37 which was followed by ₦1,929.20 in treatment 3. The least net profit value recorded was found in treatment 1 ₦624.31, while the net profit of treatment 2 was recorded as ₦1002.07. The cost-benefit ratio was measured with superior performance in treatment 4 with value of 1.43, while the least performed treatment was reported in treatment 1 with a value of 6.18. Moreover, the cost-benefit ratio was obtained as 3.76 and 1.92 in treatment 2 and 3 respectively.

4. DISCUSSION

This study evaluated the performance characteristics of starter broiler chickens administered leaf meal extracts of neem, moringa, and lemongrass.

The final body weight exhibited an increasing trend among all treatment groups (treatment 1 to 4) with different leaf meal extracts of neem, moringa and lemongrass in the diets of chicken. This suggests that the birds efficiently utilize the nutrients in the extracts of the leaf minerals and vitamins. The rich protein store in the leaves of, especially, moringa, played a vital role as observed in the body weight of the birds administered with the leaf extract. (Zanu & Asiedu, 2012) reported the presence of essential nutrients which include vitamins, minerals and protein found in phytogenic extract. Moreover, plant leaf extracts contain antifungal, antimicrobial, antiviral and immune-modulatory properties and can reduce competition in the animal host to allow more nutrients for growth and development (Mishael *et al*., 2024). Our results are in positive agreement with the study conducted by (Azodo *et al.,* 2023) where they observed improved final body weight in broiler chicken when administered with extracts of *Costus afer*. (El-Hussein *et al.,* 2008) observed increased growth performance in the treatments where herbs were used to replace synthetic growth promoters and medical herbs in broiler birds. (Oloruntola *et al.,* 2018) report dietary supplementation with neem, pawpaw and bamboo leaf meals improved the growth performance of broiler chickens with birds receiving higher levels of leaf meals attaining significantly greater final body weights.

The decrease in feed intake across the treatment group could be due to the presence of bitter and unpalatable substances in

the leaf extract, especially neem (*nimbidine*). The presence of anti-nutritional factors and bitter compounds such as *nimbidine* in the extract could be a regulating the feed intake in treatments fortified with the leaf extracts. Also, the high crude fiber could be another factor responsible for decreased feed intake across the treatment groups. This agrees with the findings of (Oloruntola *et al.,* 2018; and Azodo *et al.,* 2023) where they reported high fiber in the diet of broiler birds usually leads to the decline in their feed intake. (Onyimonyi & Ernest, 2009) also reported low level of feed intake when neem leaf was used in the diet of broiler birds. Our study obtained superior performance for feed conversion ratio in treatment 4. This indicates that the inclusion of leaf meal extracts was able to improve feed efficiency and weight gain in relation to the quantity and quality of feed consumed. This is also in agreement with the result obtained by (Azodo *et al.,* 2023) where ginger lily extract improved weight gain in relation to feed consumed in finisher broiler birds.

Our results for cost-benefit analysis were best in treatment 4. This was observed as cost of production was lowest, while revenue, net profit and cost-benefit ratio were higher than the rest of the treatment groups. This result agrees with the report of (Azodo *et al*, 2023) where they obtained superior revenue, net profit and cost-benefit ratio. Also, (Onyimonyi & Ernest, 2009; Olabode *et al.,* 2022; and Mishael *et al.,* 2024) reported in their studies, a better revenue and net profit when phytogenic plants were used to fortify diets given to broiler birds.

LIMITATIONS OF THE STUDY

Anti-Nutritional Factors: Leaf extracts often contain tannins, phytates and oxalates that bind to proteins and minerals, thereby lowering the nutrient use in young birds.

Digestive Sensitivity: Chicks have delicate, immature intestines during the starter phase and the bitter taste of leaf extracts like neem can cause reduced feed consumption.

Variable Potency: The concentration of active ingredients in fresh leaf extracts changes based on plant age, soil quality and storage time, making precise dosage difficult.

Drug or Vaccine Replacement: While some leaves offer mild support, they cannot prevent major poultry diseases or replace proper medical treatment and vaccination.

CONCLUSION

It can be concluded that extracts from neem, moringa and lemongrass leaf meal were rich sources of bioactive nutrients and phytochemicals which facilitated the growth of the administered birds. The administration of leaf meal extracts of neem, moringa and lemongrass is recommended up-to the rate of 15 mL/liter. Moreover, cost-benefit (revenue, net profit and cost-benefit ratio) was better in the treatment administered with 15 mL/liter of the leaf extract.

LIST OF ABBREVIATIONS

ANOVA	=	Analysis of Variance
CRD	=	Completely Randomized Design
DMRT	=	Duncan Multiple Range Test
FCAI	=	Federal College of Agriculture
NIAS	=	National Institute of Animal Science
SEM	=	Standard Error of Mean
WHO	=	World Health Organization

AUTHORS' CONTRIBUTIONS

O.A.D. conceptualized the study, collected and interpreted the data and helped with manuscript writing. N.C. helped with study design and collection of data. A.M. and O.A. designed the study, collected the data and wrote the manuscript.

ETHICAL APPROVAL & INFORMED CONSENT

The experiment was conducted using broiler chickens in accordance with guidelines for care and use of animals for research (National Research Council., 2011) and ARRIVE 2.0 Guidelines for reporting research on animals. The study was approved by Animal Ethics Committee of the Federal College of Agriculture (FCAI), Ishiagu, Nigeria. Moreover, field inspections of the experimental facility were carried out by members of National Institute of Animal Science (NIAS), South-East zone, Nigeria. Informed consent was not applicable to this study because it involved animal subjects and did not involve human participants.

AVAILABILITY OF DATA AND MATERIALS

Data supporting findings of the study will be made available from the corresponding author upon request [O.A.D.].

FUNDING

This research was funded by the authors, O.A.D., N.C., and A.M.

CONFLICT OF INTEREST

Olabode Adeyemi David is an Editorial Board Member of Majestic Journal of Zoology but was not involved in the editorial decision-making or peer-review process for this manuscript. No other conflicts of interest are declared.

ACKNOWLEDGEMENTS

Declared none.

DECLARATION OF AI

The authors agree to the usage of AI to improve the grammar of the final manuscript.

REFERENCES

Alagbe, J. O. (2017). Effect of dietary inclusion of Polyalthia longifolia leaf meal as phytobiotic compared with antibiotics on the nutrient retention, immune response and serum biochemistry of broiler chicken. *Greener Journal of Agricultural Sciences*, *7*(3), 74-81. https://doi.org/10.15580/GJAS.2017.3.052217067

Azodo, L. N., Bamidele, A. J., Irelen, T. U., Uzoma, C., Olabode, A. D. & Aniebo, A. O. (2023). Impact of ginger lily (Costus afer) extract on the growth performance and cost benefit analysis of finisher broiler birds. *Journal of Animal Science and Veterinary Medicine*, *8*(4), 95-98. https://doi.org/10.31248/JASVM2023.372

Benhammouche, T., Melo, A., Martins, Z., Faria, M. A., Pinho, S. C. M., Ferreira, I. M. L. P. V. O, & Zaidi, F. (2021). Nutritional quality of protein concentrates from Moringa Oleifera leaves and in vitro digestibility. *Food Chemistry*, *348*, 128858. https://doi.org/10.1016/j.foodchem.2020.128858

Bonsu, F. R. K., Kagya-Agyemang, J.K., Kwenin, W.K.J. & Zanu, H.K. (2012). Medicinal response of broiler chickens to diets containing neem (Azadirachta indica) leaf meal on haematology and meat sensory analysis. *World Applied Science Journal*, *19*(6), 800-805. Available from: https://idosi.org/wasj/wasj19(6)12/7.pdf

David, O.A., Christiana, N., Emmanuel, O.O., Noah O., & Chibuzo, A. (2024). Growth performance and haematological profile of broiler chickens fed graded levels of lemon grass leaf meal. *Current Research in Poultry Science*, *14*(1), 21-26. https://doi.org/10.3923/crps.2024.21.26

El-Husseiny, O. M., Abdallah, A. G., & Abdel-Latif, K. O. (2008). The influence of biological feed additives on broiler performance. *International Journal of Poultry Science*, *7*(9), 862-871. Available from: https://ijpsjournal.org/ijps/article/view/1042/1025

Hafeez, A., Manner, K., Schieder, C. & Zentek, J. (2016). Effect of supplementation of phytogenic feed additives (powdered vs. encapsulated) on performance and nutrient digestibility in broiler chickens. *Poultry Science*, *95*(3), 622–629. https://doi.org/10.3382/ps/pev368

Horwitz, W., & Latimer, G. W. (2005). Official methods of analysis of AOAC International. *1*, (46-50). Gaithersburg: AOAC International.

Macambira, G. M., Rabello, C. B-V., Navarro, M. I. V., Lopes, C. C., Lopes, E. C., Nascimento, G. R., Oliveira, H. S. H., & Silva, J. C. R. (2022). Effects of Moringa oleifera leaf meal on the growth performance and carcass characteristics of broiler birds. *Revista Brasileira de Zootecnia*, *51*, e20210203. https://doi.org/10.37496/rbz5120210203

Mahfuz, S., & Piao, X. S. (2019). Application of Moringa (Moringa oleifera) as natural feed supplement in poultry diets. *Animals*, *9*(7), 431. https://doi.org/10.3390/ani9070431

Mishael, A., David, O. A., Christiana, N., & Noah, O. (2024). Effect of black plum leaf meal on the growth performance characteristics, cost benefit evaluation and serum biochemical indices of finisher broiler birds. *Current Research in Poultry Science*, *14*(1), 10-15. https://doi.org/10.3923/crps.2024.10.15

National Research Council. (2011). Guide for the care and use of laboratory animals (8th ed.). National Academies Press. https://doi.org/10.17226/12910

Obun, C. O., Ukim, C. I., Olatunji, E. A. & Kehinde, A. S. (2013). Health and carcass implications of dietary inclusion of graded level of sun-cured neem (Azadirachta indica) leaf for broilers. *Greener Journal of Agricultural Science*, *3*(1), 48-54. https://doi.org/10.15580/GJAS.2013.1.110512219

Ogbonna, C.G., Akintunde, A.O., Dupe, O.M., Arinola, A.O., Chidinma, N-O.L., Emmanuel, A. J. A., Taofeek, A-B & John, A. O. (2017). Carcass and performance characteristics of broiler chickens fed with Cymbopogon citratus leaf meal as alternative to Mycotoxin binder. *International Journal of Agricultural Science and Research*, *6*(4), 18-23. Available from: https://www.scribd.com/document/537660108/2051

Olabode, A. D., Amos, M. & Nduka, C. E. (2023). Impact of phytobiotics on growth performance and cost analysis of starter broiler birds. *Acta Scientific Veterinary Sciences*, *5*(9), 100-103. https://doi.org/10.31080/ASVS.2023.05.0746

Olabode, A. D., Azodo, L., Okelola, O. E., Olorunfumilola, N. A. & Onyishi, P. (2022). Growth response and cost benefit analysis of starter broiler birds fed supplemental levels of black plum leaf meal (A case study in Ishiagu, Ivo Local Government Area of Ebonyi State). *International Journal of Environmental and Agricultural Research*, *8*(7), 38-41. https://doi.org/10.5281/zenodo.6944803

Oloruntola, O. D., Agbede, J. O., Ayodele, S. O. & Oloruntola, D. A. (2018). Neem, pawpaw and bamboo leaf meal dietary supplementation in broiler chickens: Effect on performance and health status. *Journal of Food Biochemistry*, *43*(2), e12723. https://doi.org/10.1111/jfbc.12723

Onyimonyi, A. E., & Ernest, O. (2009). An assessment of pawpaw leaf meal as protein ingredient for finishing broiler. *International Journal of Poultry Science*, *8*(10), 995-998. https://doi.org/10.3923/ijps.2009.995.998

Percie du Sert, N., Hurst, V., Ahluwalia, A., Alam, S., Avey, M. T., Baker, M., Browne, W. J., Clark, A., Cuthill, I. C., Dirnagl, U., Emerson, M., Garner, P., Holgate, S. T., Howells, D. W., Karp, N. A., Lazic, S. E., Lidster, K., MacCallum, C. J., Macleod, M., Pearl, E. J., Petersen, O. H., Rawle, F., Reynolds, P., Rooney, K., Sena, E. S., Silberberg, S. D., Steckler, T., & Würbel, H. (2020). The ARRIVE guidelines 2.0: Updated guidelines for reporting animal research. *PLoS Biology*, *18*(7), e3000410. https://doi.org/10.1371/journal.pbio.3000410

Sadid, M. M., & Anam, M. S. (2025). Dietary effect of Moringa oleifera leaf meal on growth performance, blood lipids, and haematological parameters in broiler chickens: A meta-analysis. *World's Poultry Science Journal*, *81*(1), 205-226. https://doi.org/10.1080/00439339.2024.2427696

Sariözkan, S., Y. Konca, B.K. Güçlü, E. Aktuğ, M. Kaliber, Ş. Özkan and S.T. Ay, (2016). The effect of dietary supplementation of lemon grass (Cymbopogon citratus) on performance, carcass quality, and marketing of quail (Coturnix coturnix japonica). *Scientific Works. C Series. Veterinary Medicine*, *62*(1), 98-103. Available from: https://www.cabidigitallibrary.org/doi/pdf/10.5555/20163346113

Shankar, B. P., Gowda, R. N. S., Pattnaik, B., Prabhu, B. H. M., Patil, S. S., & Pradhan, H. K. (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. https://doi.org/10.3923/ijps.2009.256.259

Tesfaye, E., Animut, G., Urge, M. & Dessie, T. (2013). Moringa oleifera leaf meal as an alternative protein feed ingredient in broiler ration. *International Journal of Poultry Science*, *12*(5), 289-297. https://doi.org/10.3923/ijps.2013.289.297

Ubua, J. A., Ozung, P. O. & Inagu, P. G. (2019). Dietary inclusion of neem (Azadirachta indica) leaf meal can influence growth performance and carcass characteristics of broiler chickens. *Asian Journal of Biological Sciences*, *12*(2), 180-186. https://doi.org/10.3923/ajbs.2019.180.186

Zanu, H. K., Asiedu, P., Tampuori, M., Abada, M., & Asante, I. (2012). Possibilities of using Moringa (Moringa oleifera) leaf meal as a partial substitute for fishmeal in broiler chickens' diets. *Online Journal of Animal and Feed Research*, *2*(1), 70-75. Available from: https://www.cabidigitallibrary.org/doi/pdf/10.5555/20123130680

Zhang, Y. N., Wang, J., Qi, B., Wu, S. G., Chen, H. R., Luo, H. Y., Yin, D. J., Lü, F. J., Zhang, H. J., & Qi, G. H. (2017). Evaluation of mango saponin in broilers: Effects on growth performance, carcass characteristics, meat quality and plasma biochemical indices. *Asian-Australasian Journal of Animal Science, 30*(8), 1143-1149. https://doi.org/10.5713/ajas.16.0847