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Growth response, carcass characteristics and economic returns of broiler chickens fed diets containing graded levels of ginger (*Zingiber officinale*) rhizome meal as a feed additive.

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***Target Audience:** Poultry farmers, nutritionists, feed millers, extension officers*

Abstract

The study investigated the performance, carcass characteristics, and feed cost-benefit analysis (FCBA) of broiler chickens fed diets containing ginger rhizome meal (GRM) as a feed additive. A total of 150-day-old chicks (Ross 308) purchased from reputable source at Ibadan were divided into five dietary groups after one week of acclimatization. There were five treatments, each replicated three times in a CRD over 49 days, with each treatment comprising 30 birds. Diet 1 (0.0% ginger) served as the control, while Diets 2, 3, 4, and 5 contained 0.10%, 0.15%, 0.20%, and 0.25% ginger, respectively. Feed and water were provided ad libitum throughout the study. Performance results showed no significant differences (P>0.05) between dietary treatments. However, significant (p<0.05) differences in carcass yield were observed in breast weight (34.67%, Diet 2) and shank weight (4.39%, Diet 1) showing the highest values. Though significant (P>0.05) differences were not observed in the FCBA, the best cost was observed in birds fed Diet 2, with a production cost of ₦1058.86, revenue of ₦3065.00, and a gross margin of ₦1098.50. This study indicated that incorporating GRM into broiler feed is a profitable venture for African poultry producers and nutritionists considering the highest profit index values (revenue and gross margin) observed in all the ginger treatment groups, especially at a 0.10% inclusion level. Therefore, GRM can be used as an alternative growth promoter without any negatively affecting overall performance. It was concluded that the inclusion of 0.10% GRM in the diet of broiler chickens can improve breast yield.

Keywords: *Ginger, carcass characteristics, growth performance, cost-benefit, broiler chickens, feed additive*

Description of problem

Poultry production plays an important role in food security and poverty alleviation worldwide because of its ability to provide

nutrition (meat and egg), high market value, job opportunities, and contribution to economic growth. The growth of broiler chickens is relatively quicker in terms of generation interval when compared with other meat-producing animals. At the age of 6-8 weeks, the broiler can reach a slaughter weight of 2.2 - 2.5 kg (1). In terms of quantity of production, broilers can be raised intensively in large numbers from hundreds to hundreds of thousands per farm per year. Thus, broiler production is capable of meeting the demands for meat which is expected to continuously increase among the increasing populace. The importance of animal protein in man's nutrition cannot be over-emphasized due to its balanced amino acid profile and relatively high level of availability (2).

Recently, research has become more focused on the use of naturally occurring phytobiotics in replacing chemically based feed additives (1). This is due to the ban on the use of antibiotic products for poultry in many countries because of the deposit of undesirable residues in the poultry products which may be harmful to man when consumed (3). This has led to growing interest in the use of natural herbs and medicinal plants such as ginger, garlic, turmeric, clove, onion etc as additives in poultry diets in order to maximize their potential output (4).

Zingiber officinale is a perennial flowering plant commonly known as ginger. It belongs to the family of Zingiberacae whose rhizome serves as a storage organ. The plant is a knotted, thick and binge underground stem (Rhizome). The important compounds in *Zingiber officinale* are gingerol, gingerdiol and gingerdione which can stimulate digestive enzymes, affect the microbial activity and have an antioxidative capacity (5). When used in broiler diets, ginger supplementation improves antiemetic, antiulcer, antipyretic, and cardio depressant among others, antioxidant and reducing free radicals damage, increases production and reproduction and improves animal health generally (6).

Additionally, it has been reported that ginger has some active properties which play a vital role in the prevention of diseases (7). Its application would hinder the growth of harmful bacteria within the gut of broiler chickens with no disastrous effect on man. It will also serve as a growth promoter. Therefore, this study was aimed at investigating the growth response, carcass characteristics and economic returns of broiler chickens fed diets containing graded levels of *Zingiber officinale* rhizome meal as an additive.

Materials and Methods

This study was carried out at the Poultry Section of the Teaching and Research Farm of the College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. It is located at Latitude 5°28' North and Longitude 7°32' East; and at an altitude of 122 meters above sea level. It lies within the tropical rainforest zone of South Eastern Nigeria, and is characterized by average annual rainfall of about 2,177mm in 148- 155 rain days, and average relative humidity during the rainy season ranges from 57-91%. It has an environmental temperature range of 22 - 30°C (8).

Preparation of ginger rhizome meal

Fresh ginger rhizome was procured from commercial dealers. The back of the ginger

rhizome was properly washed in running tap water to remove sand and other adhering debris. The sliced ginger rhizome was dried to 10% moisture content in an open ventilated space away from sunlight. The essence of air drying was to preserve the aromatic compounds, vitamins and mineral elements. The air-dried ginger was milled into fine particles using a mechanical grinding machine to produce ginger powder of 2 mm particle size. The grounded samples were preserved in an air-tight container, stored at room temperature and used as the test ingredients for the experiment and subsequent laboratory analysis.

Experimental Design and Birds Management

A total of 150-day old broiler chicks purchased from a reputable farm at Ibadan were randomly assigned to five treatment diets designated as D_1, D_2, D_3, D_4 and D_5 containing ginger meal as an additive at 0.00 (control), 0.10, 0.15, 0.20, and 0.25% levels, respectively in a completely randomized design after acclimatization period of 7 days. Each treatment comprised 30 birds and was randomly subdivided into three (3) replicates with ten (10) birds per replicate. Feed and water were given *ad libitum* while necessary vaccines and other medications were administered as at when due. The experiment lasted for 49 days. The chemical composition of the diet is presented in Table 1.

Growth performance

A known quantity of feed was supplied *ad - libitum* to the birds and the leftover was removed and weighed to determine the actual feed consumed daily. The daily feed consumption was added together over 7 days to obtain the feed consumption per week. The initial body weights of the experimental animals were measured using a digital weighing balance before stocking and on a weekly basis subsequently. The difference between mean weights for two successive weeks was taken in order to obtain the average weight gain of birds per week. Feed conversion ratio was calculated as a ratio of feed consumption and body weight gain.

Carcass quality

At the end of the experiment, two (2) birds from each replicate were randomly selected, starved overnight, weighed and slaughtered by severing the jugular vein. The birds were de-feathered and eviscerated and all cut parts (breast, drumstick, thigh, back-cut, wings, neck) were weighed and expressed as a percentage of the dressed weight. The procedure described by (2; 9) was adopted in calculating the cut-up parts of the slaughtered birds.

Cost-benefit analysis

Feed cost-benefit was computed in the 8^{th} week of the experiment to evaluate the profitability of the experiment. The current market price of the various feed ingredients was used to compute the total cost of feed that was consumed during the feeding trial. Total feed intake, Average weight gain, cost of feed per kilogram, feed cost per kilogram weight gain, total weight gain, and cost of one kilogram of meat were used to determine how profitable or otherwise it was to feed broiler chickens with graded levels of ginger (*Zingiber officinale*) rhizome meal. The feed cost-benefit parameters were carried out as described by (10).

Cost/kg of feed = (Total cost of producing 100Kg of feed)/100

Cost of feed consumed = Cost/Kg of feed × Total feed consumed
Cost/kg weight gain = FCR × Cost/kg of feed
Cost of production = Cost/kg weight gain × Mean weight gain
Revenue = Price of 1 kg of meat × Mean weight gain
Gross margin = Revenue - Cost of production

Statistical analysis

All data collected at the end of the experiment were subjected to one-way analysis of variance (ANOVA) in a completely randomized design using the general linear model procedure in Statistical Package for Social Science software (Version 23) (11). Significant differences between treatment means were separated using Duncan's Multiple Range Test at $P \leq 0.05$ (12).

The following linear model was used to analyse the data:

$$Y_{ij} = \mu + T_i + E_{ij}$$

Where:
Y_{ij}: The observation
μ: The overall mean
T_i: The treatment effect
E_{ij}: The random error

Table 1: Ingredients and chemical composition of experimental straight diet containing varying levels of Zingiber officinale rhizome meal

Ingredients	**Composition**
Maize	60.00
Soyabean meal	30.00
Palm kernel cake	3.50
Foreign Danish fish meal (72.6%)	3.00
Bone meal	3.00
Common salt	0.25
Broiler premix	0.25
Total (%)	**100**
Calculated values:	
Metabolisable Energy (Kcal/Kg)	3021.24
Crude protein (%)	21.36

Broiler premix declaration 0.25kg of premix contains: Vitamin A: 2400000 IU, vitamin D: 1000000 IU, vitamin E: 16000 IU, vitamin K: 800mg, vitamin B6: 1000 mg, vitamin B12: 6mg, Niacin: 8000mg, folic acid: 400mg, pantothenic acid: 3000mg, Biotin: 40mg, antioxidant: 3000mg, Cobalt: 80mg, copper: 2000mg, Iodine: 400mg, iron: 1200mg, Manganese: 1800mg, Selenium: 60mg, and Zinc: 14000mg.

Results and Discussion

The proximate composition of *Zingiber officinale* and experimental diet is presented in Table 2. The proximate composition of *Zingiber officinale* showed that the dry matter, moisture content, ash, crude protein, ether extract, crude fibre, nitrogen-free extract and Metabolisable energy were

92.75%, 7.25%, 6.35%, 8.75%, 4.60%, 0.83%, 72.22% and 3358.40 Kcal/Kg, respectively. This indicated that the plant rhizome contains some significant nutrients other than their phytogenic values which may improve the nutrient level of the diet when incorporated at a moderate dose. The values obtained in this study for *Zingiber officinale* were lower than 9.17 %, 13.5 % and 6.40 % for crude protein, crude fibre and ether extract reported by (13). The ash content was similar to 6.17 % reported by (13) but lower than 12.60 % and 10.41 % reported by (14; 15), respectively. The NFE obtained in this study is higher than the value (64.80 %; 38.83 % and 36.02 %) of (13; 14; 16), respectively. The results obtained indicate that *Zingiber officinale* rhizome meal could be used as a dietary nutrient source in animal nutrition.

Table 2: Proximate composition of Zingiber officinale rhizome meal

Parameters	***Zingiber officinale***
Dry matter	92.75
Moisture content	7.25
Ash	6.35
Crude protein	8.75
Ether extract	4.60
Crude fibre	0.83
Nitrogen free extract	72.22
Metabolizable energy (Kcal/Kg)	3358.40

The growth performance of broiler finisher chickens fed diets containing graded levels of *Zingiber officinale* rhizome meal is presented in Table 3. All parameters measured were not significantly (P>0.05) influenced by the dietary treatments.

In TFI, the lowest value was observed in D_1 while D_2 has the highest value. (17) reported that feed intake is the single most important factor in determining the growth rate of commercial broilers.

ADFI followed the same trend as in TFI and the values obtained in this study are lower than the values reported by (18) of 156.51 – 170.36 who fed Ross 308 broiler chickens for 49 days with 4.0% inclusion levels of raw and cooked *Curcuma longa* rhizome meal each. Growth rate is measured as the increase in body weight with time and is dependent on the amount of nutrients supplied coupled with time as well as the physiological and metabolic demands of specific tissues (19).

Final body, Average weight gain and Average daily weight gain numerically increased among all the birds on dietary inclusion of *Zingiber officinale* rhizome meal although not significant (P>0.05). The higher feed intake which resulted in higher weight gain could be attributed to the presence of phytogenic substances that may have improved the efficiency of absorption of the feed ingredients resulting in higher weight gains (20). The results obtained in this study tarried with the reports of (21; 22) who stated that *Zingiber officinale* rhizome meal *and Aframomum melegueta seed meal* improved body weight gain in Cobb-500 and Funaab Alpha broiler chickens at the rate of 120, 240,

360 ppm and 0.5, 1.0, 1.5, 2.0 g/kg for 49 and 56-days of studies, respectively.

All birds had similar feed efficiency during the entire period of the experiment. However, birds in the ginger-supplemented groups especially D_3 0.15% had the lowest value of FCR which indicates better efficiency of feed utilization. This is in agreement with the works of (18; 22) who reported improvements in feed efficiency in broiler birds fed turmeric and ginger-supplemented diets respectively.

The non-significant differences observed in the performance parameters measured in this study indicated that *Zingiber officinale* rhizome meal has no negative effect on the birds and this is in agreement with the report of (22) who supplemented the diet of Arbor Acres broiler chickens with *Zingiber officinale* rhizome meal at the level of 5 g/kg for 42 days. (23) also reported that *Petiveria alliacaea* root meal has no negative effect on the performance and carcass traits of broiler chicken of Cobb strain after feeding for 49 days at 500, 1000, 1500, 2000 and 2500 g/kg. However, the result obtained in this study contradicts the report of (24) who observed a reduced growth rate when *Zingiber officinale* rhizome meal was fed to Ross 308 for 42 days at the rate of 60 g/kg, (22; 25; 26) claimed such outcome may be due to the toxic effect of this compound. The different results on the growth performance of broilers may be ascribed to the different doses used in the experiments as well as the different environmental conditions where the experiment was carried.

Table 3: The growth performance of broilers fed diets containing graded levels of Zingiber officinale rhizome meal

Parameters	$D_1$0.00%	$D_2$0.10%	$D_3$0.15%	$D_4$0.20%	$D_5$0.25%	SEM	P-values
TFI (g)	5056.03	5919.46	5375.93	5650.29	5785.49	172.96	0.082
ADFI (g)	106.88	131.54	119.45	125.56	128.57	3.86	0.077
IBW (g)	167.67	169.00	166.67	169.67	170.00	0.70	0.380
FBW (g)	1586.33	2100.00	2011.33	1905.67	1888.00	81.98	0.091
AWG (g)	1418.67	1931.00	1844.67	1736.00	1718.00	81.99	0.092
ADWG (g)	31.52	42.91	40.99	38.58	38.18	1.82	0.092
FCR	3.56	3.07	2.91	3.25	3.36	0.11	0.228

SEM=Standard error of mean. IBW=Initial body weight, FBW=Final body weight, AWG=Average weight gain, ADWG=Average daily weight gain, TFI=Total feed intake, ADFI=Average daily feed intake, FCR=Feed conversion ratio, D_{1-5}=Diets

Table 4 shows the results of carcass characteristics of broiler finisher chickens fed diets containing graded levels of ginger rhizome meal. Significant ($P<0.05$) differences were recorded in mean values obtained for breast yield while all other parameters were not significant ($P>0.05$).

The values obtained in this study for dressing percentage were lower than the report of (27) who recorded a dressing percentage of 79 – 87% for broiler chickens fed diet supplemented with bionic prebiotic (hilyses) and hardcore yeast cell wall for the period of 56 days but higher than the report of (28) who reported that dressing percentage of 60 - 65% for Anak titan strains of broiler chicken reared up to 56days.

The carcass and cut parts obtained in this

study can be compared with the results of (29) who obtained the following results for male and female Marshall broilers after 56 days of live weight (2320 g and 2310 g), dressed weight (2200 g and 2140 g), dressed percent (94.6% and 92.6%) and other parts expressed as a percentage of live weight, including breast muscle (23.69-21.30), back cut (14.36 and 14.14), thigh weight (11.09 and 10.87), drumsticks 10.72-9.73), wings (8.19 and 7.80) but higher with the result of (30) obtained the following results in Marshall broiler strains at 56 days of age. Live weight 1780-2100 g, dressed weight 1230-1400 g, another part expressed as percentage live weight which includes back cut 13.4, breast 13.92, wing 13.4, thigh 10.82, drumsticks 9.79.

However, this result of carcass yield and cut parts corroborates with the report of (22) who observed that Arbor Acres broiler birds fed ginger rhizome meal at the level of 5 g/kg for 42 days produced higher carcass weights compared to untreated birds. Dressing percentage, breast weight and leg weights increased significantly in response to an aqueous extract of a plant mixture containing ginger (25). (22) suggested that improved carcass quality of broilers may be associated with the antioxidant effect of ginger which enhances protein and fat metabolism. In contrast, (31) reported no effect of ginger supplementation on carcass characteristics which contradicted the report of this study. This result also contradicted the report of (32) who found that the dressing percentage did not differ between control and ginger-treated Hubbard broilers up to the sixth week of age, likewise, (33) affirmed that the addition of ginger (0.25%) in the basal diet of broiler chicks did not result in significant differences in carcass characteristics.

Table 4: The carcass characteristics of broiler chickens fed diets containing graded levels of ginger rhizome meal.

Parameters	$D_1$0.00%	$D_2$0.10%	$D_3$0.15%	$D_4$0.20%	$D_5$0.25%	SEM	P-values
LW (g)	1586.33	2100.00	2011.33	1905.67	1888.00	82.02	0.091
DFW (g)	1400.00	1698.33	1876.67	1800.00	1540.00	78.88	0.103
DW (g)	1181.67	1333.33	1416.67	1116.67	1248.33	51.96	0.112
DP (%)	76.51	63.70	70.46	59.94	66.50	2.41	0.147
Thigh (%)	14.58	17.05	15.75	17.29	16.94	0.38	0.078
Breast (%)	27.21^{b}	34.67^{a}	31.84^{ab}	27.76^{b}	28.66^{b}	0.85	0.050
Drumstick (%)	14.72	16.60	14.71	15.85	15.73	0.37	0.215
Wing (%)	11.27	12.46	11.21	12.10	12.19	0.27	0.226
Back cut (%)	19.30	23.27	21.64	20.32	21.30	0.66	0.169
Shank (%)	4.39	3.26	3.44	3.77	4.04	0.16	0.146
Head (%)	2.53	2.18	2.35	2.37	2.36	0.08	0.298
Neck (%)	4.19	4.44	4.87	4.59	5.00	0.66	0.166

^{a,b,c} Means with different super scripts in the same row are significant different (p? 0.05)
SEM=Standard error of mean, LW= Live weight, DFW= Defeathered weight, DP= Dressed percentage, DW= Dressed weight, D_{1-5}=Diets

Table 5 shows the results of the **feed cost-benefit** analysis of broiler chickens fed diets containing graded levels of *Zingiber officinale* rhizome meal. There were no significant (P>0.05) differences observed in all the parameters measured such as total feed intake, average weight gain, cost per kg of feed, cost of feed consumed, cost per kg weight gain, cost of production, revenue and gross margin. In all the parameters except in cost/kg weight gain, numerically, D_1 has the least values while higher values were observed in D_2.

A great concern in poultry enterprise is to lower feed cost and consumption while increasing the feed efficiency of birds at the same time. Feed alone accounts for up to 70-80% of the total cost of broiler production (34).

The feed cost-benefit result showed that total feed intake per bird and the cost per 100 kg of feed were higher in the ginger groups than in D_1 (control). This is contrary to the result of (35) who reported higher values in the control group than in ginger-supplemented groups. However, the weight gain per kg per bird, the revenue generated, and the gross margin realized from the sale of these broilers at the end of the feeding trial were higher in D_2 than in D_3, D_4, and D_5. This suggests that the inclusion of ginger at 0.10% of diet was significantly more productive and efficient with higher returns than inclusion at 0.15 %, 0.20%, and 0.25%. (36) reported that the recommended dose of ginger in the diets for chickens was found to be about 1% level while increasing the dose over 1% can increase the cost of feeding.

From this study, there is an indication that the cost of supplementing feed components with 0.10% can considerably decrease the cost of production of broilers while yielding higher growth performance, revenue generation and gross margin. A similar study reported by (36) supported this finding. (37) reported that when the gross margin is greater than ₦1 it indicates profitability, but less shows the unprofitability of the venture. Since the gross margin values obtained in ginger treatment groups were greater than ₦1, therefore it is considered that the incorporation of *Zingiber officinale* rhizome meal as an additive into broiler feed is a profitable venture, especially at 0.10%/. These findings agreed with the report of (38) who showed a reduction in production cost per kg weight gain, increased live weight, better feed conversion efficiency and higher net revenue in ginger-treated groups as compared to the untreated group.

Conclusion and Applications

From the result obtained, it can be concluded that:

1. The inclusion of *Zingiber officinale* rhizome meal as a phytobiotics in broiler chicken diets did not negatively influence the performance of the birds.
2. The carcass characteristics (breast yield) of broiler chicken were positively influenced by the dietary treatments at 0.10% supplementation.
3. The moderate inclusion level of *Zingiber officinale* rhizome meal at 0.10%/100kg generated better economic benefits with higher revenue and gross margin profit as a result of the significantly higher weight gain per kg. Therefore, it is recommended that ginger rhizome meal be included in their diets at 0.10 %.
4. More research is required since water intake, meat qualities, microbial load and gut development were not considered and the test ingredient might influence results.

Table 5: The feed cost -benefit analysis of broiler chickens fed diets containing graded levels of ginger (Zingiber officinale) rhizome meal.

Parameters	$D_1$0.00%	$D_2$0.10%	$D_3$0.15%	$D_4$0.20%	$D_5$0.25%	SEM	P-values
Total feed intake (g)	5056.03	5919.46	5375.93	5650.29	5785.49	172.96	0.082
Average weight gain (g)	1418.67	1931.00	1844.67	1736.00	1718.00	81.99	0.092
Cost/kg feed (?)	331.55	332.18	332.49	332.80	333.11	0.30	0.180
Cost of feed consumed	1676.54	1966.50	1787.69	1880.32	1926.49	57.75	0.400
Cost/weight gain (?)	1220.88	1058.86	967.57	1090.25	1121.35	51.43	0.840
Cost of production (?)	1670.68	1966.50	1787.87	1880.33	1926.49	58.08	0.380
Revenue (?)	2418.33	3065.00	2770.00	2600.00	2580.00	110.68	0.900
Gross margin (?)	747.65	1098.50	982.13	719.67	653.51	78.70	0.830

SEM=Standard error of mean, D_{1-5}=Diets

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References

1. Herawati, H. and Marjuki, H. (2011). The effect of feeding Red Ginger (Zingiber officinale Rosc) as phytobiotic on broiler slaughter weight and meat quality. *International Journal of Poultry Science, 10(12): 983-985.*
2. Kuka, T.T., Batomayena B., Kuka, F. C a**nd** Adjei-Mensah, B. (2023). *In ovo* effect of Soursop (*Annona muricata* L.) leaf extract on hatching and post-hatch performance of Noiler chickens. *Nigeria. Journal of Biotechnolgy,* 39:1-24.
3. Diarra, S. S., Kwari, I. D., Girigigi, Y. A., Saleh, B. and Igwebuike, J. U. (2011). The use of Sorrel (Hibiscuss sabdariffa) seed as a Feed Ingredient for Poultry: A Review. *Research Opinions in Animal and Veterinary Science* 1: 573-577.
4. Ewa, U. E., Essen, P. O. and Innocent, M. K. (2023). Organs Weight and Blood Profile of Broiler Chickens Fed Diets Containing Graded Levels of Ginger (*Zingiber officinale*) Rhizome Meal as Additive. *Nigeria Journal of Animal Science and Technology,* 6 (1):100 – 106.
5. Dieumou, F. E., Teguia, A., Kuiate, J. R., Tamokou, J. D., Fonge, N. B. and Dongmo, M. C. (2019). Effects of Ginger (Zingiber officinale) and garlic (Allium sativum), essential oils on growth performance and gut microbial population of broiler chickens. *Livestock Research for Rural Development, 21: 25-34.*
6. Jana, U., Chattopadhyay, R. N., and Shaw, B. P. (2019). Preliminary studies on anti-inflammatory activity of Zingiber officinale Rosc., Vitex negundo Linn and Tinospora cordifolia (Willie's) Miers in albino rats. *International Journal of Pharmacology*, 31(6):232-233.

7. Al-Khalaifah, H., Al-Nasser, A., Al-Surrayai, T., Sultan, H., Al-Attal, D., Al-Kandari, R., Al-Saleem, H., Al-Holi, A., and Dashti, F. (2022). Effect of Ginger Powder on Production Performance, Antioxidant Status, Hematological Parameters, Digestibility, and Plasma Cholesterol Content in Broiler Chickens. *Animals,* 12(7) 901.
8. National Roots and Crops Research Institute (NRCRI) Umudike Umuahia, Nigeria. (2019). Agro-meteorological station Data.
9. Leeson, S. (2008). Predictions for commercial Poultry Nutrition *Journal of Applied Poultry Research,* 17:315-322.
10. Ojewola, G. S., Abasiekong, S. F., and Ukachukwu, S. N. (2005). Methionine supplementation in the productive efficiency, carcass characteristics and Economics of growing indigenous Turkey. *Tropical of Animal Science 4(2): 161-170.*
11. SPSS (2004): Statistical software package for social Scientists. SPSS, Inc., Chicago, IL, USA.
12. **Duncan, D.B. (1955). Multiple Range and Multiple F-Tests. Biometrics, 11,1-45. http://dx.doi.org/10.2307/3001478**
13. Suliman, M. A. E., Ahmed, F. G., El-Kholy, K. H. F., Mohamed, R. A. E. and Abdel-Mawla, L. F. (2023). Effects of clove (*Syzygium aromaticum*) on productive performance, nutrients value and digestibility, blood lipid profile, antioxidant status and immune response of growing rabbits. *Online Journal of Animal and Feed Res*ource, 13(1): 01-09.
14. Sulaiman, A. and Anas, M.S. (2017). Quantitative determination of nutritional and anti-nutritional composition of cloves. *Journal of Dairy and Veterinary Sciences*, 3(2): 1-3
15. Aliyu, A. M., Bawa, G. S., Abdu, S. B. Afolayan, M., Musa, A. and Abubakar, M. (2024). Evaluation of proximate and phytochemical composition of *Syzygium aromaticum* and *trigonella foenum graecum* asphytogenic feed additives. *Proceedings of 49th Conference Nigeria Society for Animal Production, 24 – 27 March, 2024, University of Ibadan, Nigeria.* Pp. 1597-1600
16. Gamaliel, S. T. J. L., Josiah, W. T. and Stephen, A. (2023). Nutritional composition of cinnamon and clove powder and the evaluation of the antimicrobial properties of their extract: A comparison between Ghana and other countries. *African Journal of Plant Science*, 17(2): 11-17.
17. Adams, C. A. (2019): *Nutricines: Food components in health and nutrition*. Nottingham University press. Nottingham, UK. Pp. 3-10.
18. Anyanwu, N. J., Anyanwu, G.A., Omumuabunike, C. S., Okonkwo, Z.C and Nwasike, H. U. (2021). Growth performance of broiler chickens fed raw and cooked turmeric rhizome *(curcuma longa)* supplemented diets. *Nigerian Journal of Agriculture, Food and Environment.* 17(4): 69-77
19. Usama, A. (2019). Energy and amino acid requirements of broiler chickens: keeping pace with the genetic progress. *World's Poultry Science Journal.*75(4):1-8
20. Tekeli, A., Kutlu, H.R. and Celik, L. (2011) Effect of *Zingiber officinale and Propalis* Extracts on the Performance, Carcass and Some Blood Parameters of Broiler Chicks. *Current Research in Poultry Science.* 1:12-23.

21. Onogwu, L. O, Njoku, C. P., Adeyeye, E. A and Sobayo R. A. (2024). Growth response of funaab alpha broiler chickens to diets containing varying levels of alligator pepper (*Aframomum melegueta*) seed meal. *Proceedings of 49th Conference Nigeria Society for Animal Production, 24 – 27 March, 2024, University of Ibadan, Nigeria.* Pp. 1334-1337.
22. Zhang, G.F., Yang, Z.B., Wang, Y., Yang, W.R., Jiang, S.Z. And Gai, G.S. (2009). Effects of ginger root (Zingiber officinale) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poultry Science,* 88:2159-2166.
23. Odetola, O. M. (2016). Growth Response, Haematology and Carcass Characteristics of Broiler Chickens fed Diets Supplemented with *Petiveria alliacea* Root Meal. *Nigerian Journal of Animal Science.* 2016 (2):370 – 379.
24. Al-Homidan, A.A. (2005) Efficacy of using Different Sources and Levels of Allium cepa**,** Allium Sativum and Zingiber officinale on Broiler Chicks Performance. *Saudi Journal of Biological Sciences,* 12: 96–102.
25. Moorthy, M., Ravi, S., Ravikumar, M., Viswanathan, K. and Edwin, S.C. (2009) Ginger, Pepper and Curry Leaf Powder as Feed Additives in Broiler Diet. *International Journal of Poultry Science,* 8:779-782.
26. Onunkwo, D. N., Nwaokeke, C. I., Wogu, K. R., Ndukwe, O. and Ezenyilimba, B. N. (2024). Carcass characteristics and organ weight of broiler chickens fed diet supplemented with bionic prebiotic (hilyses) and hardcore yeast cell wall. *Nigerian Journal of Animal Production*, 1485–1489.
27. Sogunle, O. M., Egbuyale, L. T., Bajomo, T. T., Bamigboje, O. V. and Fanimo, A. O. (2008). Comparison of the performance, carcass characteristics, and Haematological parameters of broiler chicken reared in cages and floor. *Pakistan Journal of Biological sciences.* 11(3): 480-483.
28. Olawumi, S. O., Fajemilehin, S. O. and Fagbuaro, S. S. (2012). Genotype and sex interaction effects on carcass traits of three strain of commercial broiler chickens. *Journal of World's Poultry Research.* 2(1): 21-24.
29. Asafa, A. R., Ologhobo, A. D., and Adejumo, I. O. (2016). Performance and carcass characteristics of broiler finisher fed different levels of poultry offal and crayfish waste meal as replacement for fish meal. *American Journal of experimental Agriculture, 2(4): 690-699.*
30. Javed, M., Durrani, F., Hafeez, A., Khan, R.U. and Ahmad, I. (2009) Effect of aqueous extract of plant mixture on carcass quality of broiler chicks. *ARPN Journal of Agricultural and Biological Science,* 4: 37-40.
31. El-Deek, A. A., Attia, Y. A., Maysa, M. and Hannfy, M. (2002). Effect of anise (Pimpinella anisum), ginger (Zingiber officinale Roscoe) and fennel (Foeniculum vulgare) and their mixture on performance of broilers. *Archv fur Geflugelkunde, 67: 92-96.*
32. Onu, P.N. (2010). Evaluation of two herbal spices as feed additives for finisher broilers. *Biotechnology in Animal Husbandry,* 26: 383-392.
33. Kamran, M. M. A., Haq, A. U. and

Mahmood, S. (2014). Effect of Decreasing dietary Protein levels with optimum Amino acids profile on the performance of broilers. *Pakistan Veterinary Journal. 24: 165-168*.

34. Akdeniz, R. C a**nd** IAK Boyar, S. (2016). Feed Industry and Problems in Turkey, Turkish Agricultural Engineering VI. *Technical Congress Proceedings Ankara. 2:(37): 935960*.
35. Mba I. K, Onunkwo D. N., Ekwe, C. and Asemota, O. D. (2024). Impact of ginger meal as an alternative/supplement to synthetic premix on growth performance and economic returns of broiler chickens. *Proc. 49th Conf., Nig. Soc. for Anim. Prod*. 24 – 27 March, 2024, Univ. of Ibadan, Nigeria 1464
36. Attia, Y. A., Abd Al-Hamid, A. E., Ibrahim, M. S., Al-Harthi, M. A., Bovera, F. and El-Naggar, A. (2014a). Productive Performance, Biochemical and Hematological Traits of Broiler Chicks Supplemented with Propolis, Bee Pollen, and Mannanoligosaccharides Continuously or Intermittently. *Livestock Science*, 164: 87–95.
37. Babale, M. Y. (2016). Growth performance at various growth stages of *Clarias gariepinus* (Burchell, 1822) fed various inclusion levels of processed water melon (*Citrullus lanatus,* mansf.) seed cake diets. Published Ph.D. Thesis, Department of Biological Sciences, Ahmadu Bello University Zaria, Zaria, Nigeria. Pp. 164.
38. Kassu, Y., Berhan T., and Etalem T., (2016). Effect of Supplementing Natural Additives: Black Cumin, Fenugreek and Turmeric on the Growth Performance and Economic Efficiency of Broiler Chickens. *Advances in Biological Research* 10(5):335-344.