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Full Length Research Article

INFLUENCE OF DIETARY SUPPLEMENTATION OF GINGER (*Zingiber officinale* Roscoe) POWDER ON GROWTH PERFORMANCE AND CARCASS YIELD OF BROILER CHICKENS

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ABSTRACT
This experiment was conducted to assess the effect of dried ginger root powder (*Zingiber officinale* Rosc.) as a feed additive in broiler diets. Two hundred and forty unsexed day-old Zam strain broiler chicks were randomly allotted into 16 pens (four groups) of 15 chicks in a pen, using a completely randomized design. Each group was fed diets containing varying levels of ginger (250, 500, and 750 g per 100 kg), in addition to a control diet without ginger inclusion. The control and each level of supplementation were considered as T1, T2, T3, and T4, respectively. All diets were closely designed as iso-nitrogenous and iso-caloric. The broilers were raised for eight weeks, including a one-week adjustment period. Feed consumption, weight gain, and feed conversion ratio were recorded to evaluate the birds' growth performance. At the end of the experimental period, the birds were weighed to obtain live body weight, then slaughtered and weighed to get data for carcass quality (abdominal fat content, gut and liver weight, carcass yield). The data collected were subjected to a one-way analysis of variance (ANOVA) in a Completely Randomized Design (CRD), and Duncan's Multiple Range Test (DMRT) was used to separate the means. The results demonstrated a significant ($p<0.05$) variation in the mean body weight gain (2617.97 - 2696.45 g) and final body weight (2658.67 - 2736.33 g) with T4 recording the highest values among the treatment groups. However, feed consumption (5621.39-5698.54 g) and feed conversion ratios (2.1–2.2) did not differ significantly ($p > 0.05$) across treatments. Similarly, the carcass yield (70.92-79.66as % of live weight) varied significantly ($p<0.05$), with T3 recording the highest value (79.66% of live weight). The study concludes that ginger powder supplementation in the broiler diet increased body weight gain and carcass yield.

Keywords: Broiler, Ginger powder, Growth parameters, Carcass Characteristics

INTRODUCTION

The poultry industry contributes significantly to the provision of animal protein in the human diet. Poultry is a vital component of global meat production, with particular importance in Nigeria and Africa, as it promotes food security, economic growth, and rural livelihoods (Pewan *et al*., 2025). Compared with the beef industry, poultry enjoys a relative advantage in ease of management, higher turnover, quicker returns on capital investment, and broader acceptance of its products for human consumption (Rahman & Bourassa, 2026). In recent times, the experiences of poultry farmers in Nigeria have shown that the industry has suffered setbacks due to rising feed costs, resulting in a significant reduction in net returns (Sowunmi *et al*., 2022). There is also the problem of lower productivity, which has not met the demand for poultry products.

Broiler chicken is one of the most important animal protein sources in the human diet due to its relatively faster growth rate and shorter life cycle compared with other meat-producing livestock. Numerous studies have shown that broiler chicken growth depends on the proper development of their gastrointestinal tract (Juanchich et al., 2021), which enables them to make optimal use of the feed they consume. In addition, the nature of the bird's metabolism and digestive system has necessitated the addition of appropriate supplements to its feed to promote very high, rapid growth and ultimately improve the production performance of the chickens (Obianwuna *et al*., 2024).

As a consequence of the above, chemically based feed additives, such as antibiotics and growth promoters, have been widely used in the broiler industry to improve the health and productivity of chicken flocks (El-Fateh *et al.,* 2015). Furthermore, birds raised with these feed additives have been shown to achieve good performance and produce higher-quality products (Selim *et al*., 2024). However, despite the positive impact of these feed additives on the growth and development of the birds, there are reports that they may remain in broiler products as residues. Consumers perceive that broiler meat may contain residues that could negatively affect their health (Manyi-Loh *et al*., 2024). In addition, there are growing concerns about antibiotic resistance in livestock, necessitating sustainable alternatives to enhance health and productivity in poultry production (Bava *et al*., 2024).

This public health concern has led to the ban on these products and, consequently, to policy restrictions on antibiotic use, which have been effective, prompting the search for alternative feed supplements (Derese *et al.,* 2025). Subsequently, attempts have been made to evaluate the use of naturally available phytobiotics as feed additives in poultry diets to replace the chemical feed additives (Seidavi *et al.,* 2022). Phytogenic or natural feed additives, such as ginger, garlic, and onion, have been reported to have effects similar to those of antibiotics and other chemical feed additives on poultry and swine production performance (Nemati *et al*., 2021).

Ginger (*Zingiber officinale*), a perennial plant, is a natural additive widely used in many countries as a spice or condiment in human food (Yuandani *et al.,* 2025) and as a medicinal herb (Shahrajabian *et al.,* 2019). The main important compounds in Ginger are gingerol, gingerdiol, and gingerdione. These chemicals are reported to have antioxidative activity, the ability to stimulate digestive enzymes, and to affect microbial function (Zhang *et al.,* 2021). When used in broiler diets as a supplement, *Zingiber officinale* was found to improve antioxidant and broiler chickens' blood serum (Mao *et al.*, 2019). As a phytobiotic, ginger is recognized for its diverse health benefits, including promoting growth and improving intestinal function (Duri´c Jari´c *et al.,* 2025).

Academic literature within the last decade has highlighted ginger (*Zingiber officinale*) as a potent natural growth promoter and an effective alternative to antibiotic growth promoters (AGPs) in broiler nutrition. Research consistently indicates that moderate inclusion levels of 0.5% to 1.0% of the diet optimize growth performance, feed efficiency, and carcass yield (Asghara *et al.*, 2021; Rio & Vidyarthi, 2022). Despite the positive results reported for the use of ginger powder in poultry feed, there is variability in the effective dosage across poultry species and production stages, especially in broiler chickens. This study was designed to evaluate the effects of different inclusion levels of ginger powder (250, 500, and 750 g per 100 kg diet) on growth and carcass characteristics of broiler chickens.

MATERIALS AND METHODS

The experiment was carried out in an open-mesh-sided, deep-litter poultry house at the Department of Applied Biology, Kaduna Polytechnic, Kaduna. The house was cleaned, washed, and disinfected using formalin and folic acid. Each pen floor was covered with enough wood shavings, with one tubular feeder and trough, and one round fountain drinker provided. Two hundred and forty unsexed day-old Zam strain broiler chicks were purchased from a local hatchery and randomly assigned to four (4) treatment groups with four (4) replicates in a Completely Randomized Design (CRD). Each replicate contained fifteen (15) day-old chicks.

Fresh ginger rhizome sourced from a local market in the Kaduna metropolis was washed, sliced, sun-dried, ground, and processed into a powder. Ginger powder was then stored in a container at ambient temperature (21-24°C) before being incorporated into the diets. Four diets were formulated for both the starter and finisher phases. The experimental diets were formulated with various inclusion levels of ground ginger root at 0, 250, 500, and 750g per 100 kg diet. The control was the zero ginger inclusion level. Hence, the inclusion levels were considered as T1 (control), T2, T3, and T4, respectively. The experimental diets were made iso-caloric and iso-nitrogenous and formulated to meet the National Research Council (1994) nutrient requirements of broiler chicks.

The diets were also formulated to meet all the birds' dietary nutrient requirements for starter (1 to 28 days) and finisher (29 to 56 days) phases. The composition of experimental diets for starter and finisher is shown in Table 1.

Table 1. Ingredient composition of broiler diets supplemented with varying levels of ginger powder

	Treatment (starter diet)				Treatment (finisher diet)			
Ingredient (%)	T1	T2	T3	T4	T1	T2	T3	T4
Yellow maize	58	58.15	57.9	57.65	67	67.15	66.9	66.65
Soya meal	24	24	24	24	18	17.5	17.5	17.5
Groundnut cake	13	12.5	12.5	12.5	10	10	10	10
Fish meal	1	1	1	1	1	1	1	1
Limestone	1	1	1	1	1	1	1	1
Ginger powder	0	0.25	0.5	0.75	0	0.25	0.5	0.75
Born meal	2	2	2	2	2	2	2	2
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Vitamin premix	0.3	0.25	0.25	0.25	0.3	0.25	0.25	0.25
Methionine	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Enzyme	0.1	0.05	0.05	0.05	0.1	0.05	0.05	0.05
Total	100	100	100	100	100	100	100	100
Calculated analysis								
ME (Kcal/kg)	3,239	3,229	3,219	3,209	3,222	3,211	3,201	3,191
Crude protein	22.5	22.44	22.42	22.39	19.29	19.26	19.24	19.22
Crude fibre	3.62	3.62	3.61	3.61	3.35	3.34	3.34	3.33
Ether extract	4.4	4.39	4.38	4.37	4.33	4.29	4.28	4.27
Calcium	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Phosphorus	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34
Methionine	0.64	0.64	0.64	0.64	0.61	0.61	0.61	0.61
Lysine	1.26	1.26	1.26	1.26	1.06	1.06	1.06	1.06

Vitamin premix 1.25 kg contains vitamin A,10,000,000 IU; Vitamin D3, 2,000,000 IU; Vitamin E,10,000 mg; Vitamin K3,2,000 mg; Folic Acid, 1,000 mg; Niacin, 20,000 mg; Calpan, 8,000 mg; Vitamin B2, 5,000 mg; Vitamin B12,15 mg;Vitamin B1, 1,500 mg; Vitamin B6, 3,000 mg; Biotin, 50 mg; Antioxidant, 125,000 mg. Vitamin premix 1.25 kg contains Cobalt, 200 mg; Selenium, 200 mg; Iodine, 1,000 mg; Iron, 20,000 mg; Manganese, 60.000 mg; Copper, 5000 mg; Zinc, 50,000 mg; Choline Chloride, 100,000 mg. Name of Enzyme: Fullzymes, www.@biofeed.ca Feeding. Direction: 200 - 250g/ton of feed. Manufacturer and E-mail: Biofeed

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Tech Inc, Canada, Info@biofeed.ca. Ingredient Statements: Fungal protease, Alpha amylase, Cellulase, Lipase, β-glucane, Phytase, Pectinase, Lactase, Guaranteed.

The two hundred and forty (240)- day-old Zam strain broiler chicks used for the study were raised in deep litter and brooded for the first (1) week in an electrically heated battery brooder cage. All routine management and vaccine schedules were followed adequately. Water and feed were provided *ad libitum*. Body weight gain (BWG), feed intake (FI), average daily weight gain (ADG), and feed conversion efficiency (FCE) of the chicks were determined as described by Xiong *et al.* (2024).

The experiment lasted seven weeks (8–56 days). During the first week, the chicks were offered a pre-starter diet for five days, followed by a seven-day adaptation period. On the eighth day, all the chickens were moved from the brooding house to the grower house. At the end of the experimental period, all birds were leg-banded, individually weighed, and their live weights recorded. The chickens were then slaughtered manually, scaled using boiling water, washed, and left to drain. In addition, the trachea, esophagus, crop, intestinal tract, giblet (heart and gizzard), spleen, bursa of Fabricius, kidney, and oil glands were completely removed. Then the carcass and liver were weighed. The thighs, breast meat, and wings were excised from the carcass and then weighed. Furthermore, slaughter weight (SW) was obtained to calculate breast meat, thigh, and wing yields using the values of piece weight and SW according to the formula (piece yield = (piece weight/SW) × 100) (Coyne *et al.*, 2019). Mortality was recorded as it occurred.

Proximate analysis of ginger powder (dry matter, crude protein, ether extract, crude fiber, ME, ash, and nitrogen-free extract) was determined according to AOAC (2000) and presented in Table 2.
All collected data were analyzed statistically using one-way Analysis of Variance, following Steel and Towrie (1980). Statistically significant effects were further analyzed, and means were compared using Duncan's multiple-range test as described by Little and Hills (1978). Statistical significance was determined at $P < 0.05$. The analysis was carried out using the Statistical Analysis System (SAS, 2011) program.

Table 2: Nutrient Composition of Dried Ginger Root Powder (dry matter basis)

Parameter	Composition (%)
Dry matter	92.80
Crude protein	7.60
Crude fibre	15.7
Ether extract	2.80
Ash	4.30
Nitrogen-free extract	67.31

RESULTS

Growth Performance

The effect of different ginger supplements on the growth performance of broiler chicks from 8 to 56 days of age is shown in Table 3. The data indicated that the means for final body weight and weight gain of broilers fed with supplementary levels of dried ginger powder differ significantly (p<0.05) among treatment groups. Broilers fed a 750g/kg ginger supplement had a final body weight of 2736.33g, which was significantly higher than that of all other dietary treatments. The control group had the lowest final body weight (2658.67g), which was statistically at par with treatment 2 (250g ginger inclusion) but significantly lower than treatment 3 (750g ginger inclusion), which had final body weights of 2675.33g and 2682.83g, respectively. The recorded weight gain of the birds follows a trend similar to that of the final body weight.

The means of total feed consumed by broiler chicks from 1 to 42 days of age, as influenced by different ginger supplements, showed that the diet had no significant effect on total feed consumption. The data showed no significant difference in the feed conversion ratio of broiler fed graded levels of ginger-supplemented diet from the start to the end of the experiment. However, broiler chickens in treatment groups (T2, T3, and T4) recorded lower FCR than chickens in the control diet.

Table 3. The effect of varying levels of ginger powder supplementation on the growth performance of broiler chickens

Parameters (gram)	Treatment					
	T1	T2	T3	T4	LOS	SEM
Initial body weight	40.70	39.67	39.67	39.88	NS	0.0095
Final body weight	2658.67^{c}	2675.33^{bc}	2682.83^{b}	2736.33^{a}	*	59.39
Gain in body weight	2617.97^{c}	2635.66^{bc}	2643.16^{b}	2696.45^{a}	*	64.83
Feed consumption	5656.16	5621.39	5684.67	5698.54	NS	66.34
Feed conversion ratio	2.20	2.10	2.10	2.10	NS	0.0838
Mortality (%)	0.00	0.00	0.00	0.00	-	-

Means in the same row bearing different superscripts are significantly different (P<0.05): * = significant (P = 0.05); NS = Non-significant.

Carcass Characteristics

The response of the bird's carcass characteristics to the application of dried ginger root-supplemented broiler diet is presented in Table 4. The results showed that the percentages of abdominal fat, gut, and liver relative to live chicken body weight did not differ significantly between the treatment groups from 1 to 42 days of age. In addition, breast, thigh, and wing yields recorded no significant variation in response to the application of ginger supplements. However, the data further revealed statistically significant (p<0.05) differences between treatments in carcass yield at 1 to 42 days of age. The chickens fed with 500g of ginger inclusion per kg of broiler feed had the highest mean carcass yield of 79.66%, which was statistically higher than all other treatment groups and the control, which were statistically similar.

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Table 4. Effect of varying levels of ginger powder supplementation on carcass characteristics (% of live body weight) of broiler chickens at the end of the finisher phase

Parameters	Treatment				LOS	SEM
	T1	T2	T3	T4		
Carcass yield	70.92^{b}	73.44^{b}	79.66^{a}	72.90^{b}	*	1.4217
Breast yield	35.23	35.48	35.39	35.13	NS	0.34
Thigh yield	16.66	17.21	16.78	17.45	NS	0.16
Wing yield	10.65	11.30	11.85	10.70	NS	0.13
Abdominal fat	0.22	0.13	0.31	0.31	NS	0.0759
Gut	7.05	9.07	7.81	8.73	NS	0.6255
Liver	3.24	3.35	3.33	3.52	NS	0.0735

Means in the same row bearing different superscripts are significantly different (P<0.05): * = significant (P = 0.05); NS = Non-significant.

DISCUSSION

The significant increase in broiler body weight with increasing ginger supplement levels observed in this experiment was reported by Ekuagbere et al. (2017), who documented that supplementing the poultry diet with ginger resulted in significant weight gain compared with the control group. A recent study conducted by Yang et al. (2026) reported that the addition of 0.1 % ginger ethanol extract can improve the growth performance, meat quality, lipid and nutrient metabolism of broilers, and protect liver and intestinal health. Previously, the findings of a study conducted by Derese *et al.* (2025) suggest that dietary inclusion of 10 g/kg ginger powder can enhance productivity and physiological health in young laying hens, offering a potential natural alternative to in-feed antibiotics.

However, the results of the experiments conducted by Kehinde et al. (2011) and Rajab et al. (2013) showed no significant difference in body weight gain of broilers fed ginger-supplemented poultry diets. On the contrary, an experiment conducted by Shewita and Taha (2018) observed a significant decrease in body weight gain with the supplementation of 6 g/kg of ginger powder in poultry diets. In line with these findings, an experiment conducted by Al-Mahdawi1 and Al-Hassani (2023) on the effect of ginger powder on the performance of Broiler Chicken has indicated that the control group had higher final body weights and growth weight compared to the other treatments. The authors thus concluded that the use of ginger powder in poultry diet has a detrimental impact on growth.

Numerous studies have documented the effect of optimal supplementation levels of ginger on the growth and other attributes of broiler chickens. For example, the inclusion of 6 g/kg (0.6%) of dried ginger powder has been identified as a "remarkable growth promoter," significantly improving final body weight and FCR (Rio & Vidyarthi, 2022). Other studies found that 1% (10 g/kg) ginger powder significantly improved final body weight (e.g., reaching 3651g vs. control) and yielded the best FCR (Al-Khalaifah *et al.,* 2022). While low-to-moderate doses (2.5–10 g/kg) of ginger often enhance growth performance, excessive levels (above 15–20 g/kg) can sometimes stunt development or reduce feed intake due to the pungent nature of gingerols. In line with previous findings, this result suggests that the growth performance of broilers responds to a ginger-supplemented diet in a dose-dependent manner.

About feed consumption, the non-significant variation observed among treatment groups in this experiment was previously reported by Rajab *et al.* (2013). Previously, Doley *et al.* (2009) found no difference in feed intake in broilers fed with ginger and pepper extract for a period of six weeks. In contrast to these results, however, Najafis and Tehepour (2014) have recorded a significant decrease in feed intake with the supplementation of ginger in poultry diets. Similarly, Al-Mahdawi1 and Al-Hassani (2023) have demonstrated that diets supplemented with 0.5, 1.0, and 2.0g/kg of ginger powder resulted in a significant reduction in feed intake and feed conversion ratio compared with the control group. Contrary to these findings, Shewita and Taha (2018) reported an improvement in total feed intake in a group of birds fed diets supplemented with 2 g/kg or 4 g/kg ginger powder. The absence of significant variation among treatment groups in feed consumption in this experiment may be due to the feed being isocaloric and isonitrogenous.

The insignificant variation in feed conversion ratio observed in this experiment was in line with the report of Rajab *et al.* (2013), who observed that feeding broilers with a ginger-supplemented diet had no significant effect on feed conversion ratio. The result also supports the findings that the addition of garlic and ginger to the broiler diet had no significant effect on feed consumption and feed efficiency in laying hens (Ademola et *al.*, 2009). In contrast to the outcome of this experiment, however, Chaudary *et al.* (2026) have observed a significant (P<0.001) improvement in feed conversion efficiency with increasing levels of ginger extract.

Furthermore, Guntoro *et al.* (2020) reported linear improvements in daily weight gain, feed conversion, carcass yield, and the proportion of thigh meat in the carcass as the level of ginger in the diet was increased from 0 to 0.75%. While these results showed a positive response to ginger with respect to feed conversion ratio, a significant reduction in feed conversion ratio due to the application of ginger in poultry diet was reported by Al-Mahdawi and Al-Hassani (2023). The insignificant effect of ginger inclusion in the poultry diet on feed efficiency may be attributed to other studies indicating that Ginger stimulates the secretion of digestive enzymes (amylase, lipase, and protease) and gastric juices, leading to enhanced nutrient digestion and a lower feed conversion ratio. (Sifiullah *et al.,* 2019; Dosu *et al.,* 2023).

There was no significant variation in carcass characteristics due to the application of ginger in the poultry diet in this trial. This finding was similar to the result reported by Moorthy et al. (2009), who observed no effect of ginger supplementation on carcass characteristics, including New York dressed percentage, eviscerated weight, ready-to-cook percentage, abdominal fat pad, and giblet weight. Similarly, El-Deek *et al.* (2002) have reported no significant difference in dressing percentage between control and ginger-treated broiler birds at six weeks of age. While the addition of ginger (0.25%) in the basal diet of broiler chicks was also

reported to have no significant effect on carcass characteristics (Onu, 2010). In addition, a study conducted by Egenuka *et al.* (2022) found that carcass and meat quality parameters were not significantly affected (P > 0.05) by fresh or dry ginger treatment.
Contrary to the results above, other studies (Ehebha *et al.,* 2018; Al-Khalaifah *et al.,* 2022; Egenuka et al., 2022) have documented that ginger supplementation positively influences meat yield and carcass quality parameters. Duri´c Jari´c *et al.* (2025) reported that dietary ginger inclusion at 5–10 g/kg increased dressing percentage and the proportion of high-value cuts, such as breast and thigh meat. Furthermore, an experiment conducted by Yang *et al.* (2026) has shown that 0.3% ginger ethanol extract (GEE) improved meat pH and color. It also reduces abdominal fat by modulating lipid metabolism. Similarly, 10 g/kg dietary ginger powder supplementation was reported (Derese *et al.*, 2025) to slightly improve the gizzard index and liver morphology, and to enhance intestinal morphology (p < 0.01) linearly.

The insignificant response of carcass yield to the inclusion of ginger powder in broiler diets observed in this experiment could be attributed to the fact that ginger was supplemented at a suboptimal dose. Studies (Ekuagbere *et al.,* 2017; Olumide *et al.*, 2020; Sultan *et al.,* 2024) on the performance of broilers indicate that optimal ginger supplementation has a positive effect on carcass and meat composition, leading to increased dressing percentage, higher proportions of prime cuts, reduced abdominal fat, and enhanced carcass weight (Asghara *et al.,* 2021; Yang et al., 2026). These benefits on carcass and meat quality were primarily attributed to ginger's bioactive compounds, such as gingerols and shogaols, which enhance nutrient metabolism and stimulate digestive enzyme activity. (Shewita and Taha, 2018; Rio and Vidyarthi, 2022; Duri´c Jari´c *et al.*, 2025). In addition, the performance gains have also been reported to be driven by several physiological improvements, such as nutrient digestibility and gut health. and antioxidant status of the birds (Shewita & Taha, 2018; Al-Khalaifah *et al.,* 2022; Durić Jarić *et al.,* 2025).

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REFERENCES

Ademola S.G., Farinu G.O., & Babatunde G.M. (2009). Serum lipid, growth, and hematological parameters of broilers fed garlic, ginger, and their mixtures. *World Journal of Agricultural Research*, 5(1): 99–104.

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* 2022, 12, 901.

Al-Mahdawi R. S., and Al-Hassani A. S. (2023). Effect of Ginger Powder Addition in Broiler Chicken Diets on Productive Performance. *Fifth International Conference for Agricultural and Environmental Sciences IOP Conf. Series: Earth and Environmental Science* 1158 (2023) 052028 doi:10.1088/1755-1315/1158/5/052028.

AOAC. (2000). Official Methods of Analysis. 17th Edition, Association of Official Analytical Chemists, International Gaithersburg, MD.

Asghara M. U., Rahmana A., Hayata Z., Rafiquec M. K., Badard I. H., Yara M. K., & Ijaza M. (2021). Exploration of Zingiber officinale effects on growth performance, immunity, and gut morphology in broilers—Brazilian *Journal of Biology*, 2023, vol. 83, e250296 https://doi.org/10.1590/1519-6984.250296.

Asghara M. U.; Rahmana A.; Hayata,b Z.; Rafiquec M. K.: Badard I. H.; Yara M. K. and Ijaza M. (2021): Exploration of Zingiber officinale effects on growth performance, immunity, and gut morphology in broilers. Brazilian. *Journal of Biology,* vol. 83, e250296 https://doi.org/10.1590/1519-6984.250296.

Bamidele, O. & Adejumo, I. O. (2012). Effect of garlic (*Allium sativum* L.) and ginger (*Zingiber officinale* Roscoe) mixtures on performance characteristics and cholesterol profile of growing pullets. International Journal of Poultry Science 11 (3): 217-220

Bansal, G. R., Singh, V. P., & Sachan, N. (2011). Effect of probiotic supplementation on the performance of broilers. *Asian Journal of Animal Sciences* 5 (4): 277–284,

Chaudhary J. D.; Patil S. S.; Pawar M. M.; Mohapatra S. K.; Srivastava A. K. and Modi C. P. (2026): Effect of Aqueous Ginger (Zingiber officinale) Extract Supplementation on Growth Performance and Production Efficiency in Broiler Chickens. *Uttar Pradesh Journal of Zoology*. Vol. 47, Issue 2, Page 193–201, Article no.UPJOZ.5731.

Derese, D. B.; Sun, H.; Xiong, X.; Li, Z.; Malyar, R. M.; Lu, L.; and Shi, F. (2025): Effects of Dietary Ginger (Zingiber officinale) Rhizome Powder Supplementation on Productive Performance, Egg Quality, Antioxidant Capacity, and Hepato-Intestinal Morphology in Pre-Peak Xiaoshan Laying Hens. *Animals* 15, 2315. https://doi.org/10.3390/ani15152315.

Dibner, J.J., & Richards, J.D. (2005). Antibiotic growth promoters in agriculture: history and mode of action. *Poultry Science* 84:634–43. doi:10.1093/ps/84.4.634 2.

Doley S., Gupta J.J., & Reddy P.B. (2009). Effect of supplementation of ginger, garlic, and turmeric in broiler chicken. *Indian Veterinary Journal*, 86(6): 644–645.

Dosu G.; Obanla T. O.; Zhang S.; Sang S. Adetunji A. O.; Fahrenholz A. C.; Ferket P R.; Nagabhushanam K.; and Fasina Y. O. (2023): Supplementation of ginger root extract into broiler chicken diet: effects on growth performance and immunocompetence. *Poultry Science* 102:102897 https://doi.org/10.1016/j.psj.2023.102897.

Duri´c Jari´c, M.; Gottstein, Ž.; Vince, S.; Žura Žaja, I.; Brus, M.; Duriˇci´c, D.; Samardžija, M.; Valpoti´c, H. (2025): Effect of Standardized Ginger (Zingiber officinale Roscoe) Extract on Gut Morphology, Microbiota Composition, and Growth Performance in Broiler Chickens**.** *Agriculture* 15 (13), 1448; https://doi.org/10.3390/agriculture15131448.

Egenuka F. C.; Okeudo N. J.; Otti M. I.; Obikaonu H. O. and Aladi N. O. (2022): Comparative effects of fresh and dry ginger as nutritional supplements on live-weight gain, carcass characteristics and meat quality of broiler chicken. *Research Square* https://orcid.org/0000-0002-1871-1789 DOI: https://doi.org/10.21203/rs.3.rs-1707401/v1.

Ehebha, E.T. E; Okosun, S.E, Adomeh, E.E, and Eguaoje, S.A (2018): Growth performance, carcass characteristics and organoleptic properties of broiler finisher fed graded levels of ginger root meal (grm) basal diets. *Sustainability, Agri, Food and Environmental Research*, (ISSN: 0719–3726), 6(4), 2018: 86-98 http://dx.doi.org/10.7770/safer-V0N0-art1544.

Ekuagbere, C. E.; Igene, F. U. and Aikpitanyi, K. U. (2017): Effect of dietary supplementation of ginger (zingiber officinale) as feed additive on broiler chicken performance. *The Nigerian Journal of Agriculture and Forestry*. Pp 80–91.

El-Deek, A. A., Y.A. Attea, M. Maysa, & M. Hannfy (2002). Effect of anise (Pimpinella anisum), ginger (Zingiber officinale Roscoe), and fennel (Foeniculum vulgare) and their mixture on the performance of broilers. *Arch Geflugelkd*, 67: 92–96.

Guntoro B, Thai Hung L, Thu Lan L T, & Hoang Qui N. (2020). Supplementation with ginger (*Zingiber officinale*) improved growth performance and carcass traits of Dong Tao chickens. *Livestock Research for Rural Development. Volume 32, Article #140.* Retrieved April 15, 2026, from http://www.lrrd.org/lrrd32/9/nguye32140.html.

Haruna U., Hamidu B. M. (2004). Economic analysis of turkey production in the western agricultural zone of Bauchi State, Nigeria. *Proceedings 9th Annual Conference, Animal Science Association of Nigeria. September13th-16th. Abakaliki: Ebonyi State University*. https://doi.org/10.1080/09712119.2019.1608211. https://doi.org/10.3390/ani12070901.

Kehinde, A.S., Obun C.O., Inuwa, M., & Bobadoye, O. (2011). Growth performance, haematological and serum biochemical Indices of cockerel chicks fed ginger (zingiber officinale) additive in diets. *Animal Research International*. 8(2): 1398 – 1404

Larsen, K., Ibrahim, H., Khaw, S. H. & Saw, L. G. (1999). Gingers of Peninsular Malaysia and Singapore: natural *History Publications (Borneo), Kota Kinabalu, Malaysia*.

Little, T.M. and Hills, F.J. (1978). Agricultural Experimentation. John Wiley & Sons Limited.

Manyi-Loh, C.; Mamphweli, S.; Meyer, E.; Okoh, A. (2018): Antibiotic Use in Agriculture and Its Consequential Resistance in Environmental Sources: Potential Public Health Implications. *Molecules.* 23, 795.

Mao, Q.-Q.; Xu, X.-Y.; Cao, S.-Y.; Gan, R.-Y.; Corke, H.; Beta, T.; Li, H.-B. (2019): Bioactive Compounds and Bioactivities of Ginger (Zingiber officinale Roscoe). *Foods* 8, 185.

Moorthy M., Ravi S., Ravikumar M., Viswanathan K., & Edwin S.C. (2009). Ginger, pepper, and curry leaf powder as feed additives in the broiler diet. *International Journal of Poultry Science*, 8(8): 779–782.

Murugesan, G.R., Syed, B., Halder, S., & Pender, C. (2015). Phytogenic feed additives as an alternative to antibiotic growth promoters in broiler chickens. *Frontiers in Veterinary Science* 2:21

Najafi S. & Taherpour K. (2014). Effects of dietary ginger (Zingiber Ofjicinale), cinnamon (Cinnamomum), synbiotic, and antibiotic supplementation on the performance of broilers. *J Anim Sci Adv* 2014, 4(1): 658-667

National Research Council, NRC (1994). Nutrient Requirements of Poultry 9th Ed. National Academy Press. Washington, DC. Of Alletchs 10th Annual Symposium. *Nottingham University Press. Nottingham, UK. Philadelphia,* pp 512–514.

Nemati, Z.; Moradi, Z.; Alirezalu, K.; Besharati, M.; Raposo, A. (2021): Impact of Ginger Root Powder Dietary Supplement on Productive Performance, Egg Quality, Antioxidant Status and Blood Parameters in Laying Japanese Quails. *Int. J. Environ. Res. Public Health* 18, 2995.

NOAH (National Office of Animal Health) (2001). Antibiotics for animals. www.noah.co.uk

Olumide, M. D.; Oladejo. S.O Ayo-Bello. T. A and Akinboye O.E. (2020): Effect of ginger (Zingiber officinale) supplementation on performance, meat quality, and blood profile of broiler chicken. *Journal of Life &Physical Sciences. Acta SATECH* 12 (1):1 – 13.

Onu, P.N. (2010). Evaluation of two herbal spices as feed additives for finisher broilers. *Biotechnology in Animal Husbandry* 26: 383–392.

Oyetunde, O.O. (2003). Appraisal of small and medium scale performance in egg production in Ijebu North Local Government Area of Ogun State: unpublished *B. Tech Thesis, Ladoke Akintola University of Technology, Ogbomoso*.

Pewan, S.B.; Kabantiyok, D.; Emennaa, P.E.; Dawurung, J.S.; Dawurung, C.J.; Duwil, R.K.; Olorundare, O.O.; Ngukat, H.Y.; Umaru, M.G.; Ugwuoke, G.M.; et al. Advancing Nigerian Indigenous Poultry Health and Production, Use of Probiotics as Viable Alternatives to Antibiotics: A Review. Antibiotics **2025**, 14, 846. https://doi.org/10.3390/antibiotics14080846

Rajab F. R., Ebrahimnezhad Y., Seyedabadi H. R., & Vahdatpour, T. (2013). Effect of different concentrations of aqueous extract of ginger (*Zingiber officinale*) on performance and carcass characteristics of male broiler chickens in wheat-soybean meal-based diets. *J. BioSci. Biotech.* 2(2): 95-99

Rio T. & Vidyarthi V. K. (2022). Performance of Broiler Chicken on Diet Supplemented with Ginger Powder -A Review. *Livestock Research International* Vol. 08 | Issue 03 | 117-124 https://www.researchgate.net/publication/358022227.

Safiullah M., Chand N., Khan R U., Naz S., Ahmad M., & Gul S. (2019). Effect of ginger (Zingiber officinale Roscoe) and organic selenium on growth dynamics, blood malondialdehyde, and paraoxonase in broilers exposed to heat stress. Journal of Applied *Animal Research.* VOL. 47, NO. 1, 212–216

SAS Institute (2000). Users Guide. Release 8.1 ed. SAS Institute Inc., Cary, NC.

Seidavi, A.; Tavakoli, M.; Asroosh, F.; Scanes, C.G.; Abd El-Hack, M.E.; Naiel, M.A.E.; Taha, A.E.; Aleya, L.; El-Tarabily, K.A.; Swelum, A.A. (2022): Antioxidant and Antimicrobial Activities of Phytonutrients as Antibiotic Substitutes in Poultry Feed. *Environ. Sci. Pollut. Res.* 29, 5006–5031.

Shahrajabian, M.H.; Sun, W.; Cheng, Q. (2019): Clinical Aspects and Health Benefits of Ginger (Zingiber officinale) in

Both Traditional Chinese Medicine and Modern Industry. *Acta Agric. Scand. Sect. B Soil Plant Sci.* 69, 546–556.

Shewita R.S.; and Taha A.E. (2018): Influence of dietary supplementation of ginger powder at different levels on growth performance, haematological profiles, slaughter traits and gut morphometry of broiler chickens. *South African Journal of Animal Science* 48 (No. 6) Journal homepage: http://www.sasas.co.za/journals.

Steel R.G.D. & J. H. Torrie (1981). Principles and procedures of statistics. 2nd Edition *McGraw-Hill Co., New York. USA.* pp. 137–171.

Sultan, A., Aziz, T., Islam, Z., Uzair, M. S., Alhindary, I. A., Khan, R. U., and Tiwari, R.: (2024): Effect of ginger-based zingibain enzyme on growth and intestinal health in Japanese quails, *Arch. Anim. Breed.*, 67, 571–581, https://doi.org/10.5194/aab-67-571-2024, 2024.

Suresh, G.; Das, R.K.; Kaur Brar, S.; Rouissi, T.; Avalos Ramirez, A.; Chorfi, Y.; Godbout, S. (2018) Alternatives to antibiotics in poultry feed: Molecular perspectives. *Crit. Rev. Microbiol.* 4, 318–335.

Yang K.; Gao F.; Shi J.; Yue Z.; Jin S.; Wang W.; Liu C.; Yin Q.; Dang X.; Guo H.; and Chang J. (2026): Effects of ginger ethanol extract on growth performance, antioxidant capacity, and intestinal microbiota of broilers. *Poultry Science*. Vol. 105, Issue 1, 106139.

Zhang, M.; Zhao, R.; Wang, D.; Wang, L.; Zhang, Q.; Wei, S.; Lu, F.; Peng, W.; Wu, C. (2021) Ginger (Zingiber officinale Rosc.) and Its Bioact. Compon. Are Potential Resources for Health Beneficial Agents? *Phytother. Res.* 35, 711–742.

Pewan, S.B.; Kabantiyok, D.; Emennaa, P.E.; Dawurung, J.S.; Dawurung, C.J.; Duwil, R.K.; Olorundare, O.O.; Ngukat, H.Y.; Umaru, M.G.; Ugwuoke, G.M.; et al. Advancing Nigerian Indigenous Poultry Health and Production, Use of Probiotics as Viable Alternatives to Antibiotics: A Review. Antibiotics **2025**, 14, 846. https://doi.org/10.3390/antibiotics14080846