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EFFECT OF MODE OF ADMINISTRATION OF PHYTOGENIC FEED ADDITIVE ON GROWTH PERFORMANCE AND HEALTH PROFILE OF BROILER CHICKEN

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ABSTRACT

Phytogenic feed additives, particularly turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), and garlic (*Allium sativum*), have gained increasing attention as natural alternatives to antibiotic growth promoters in broiler production. However, evidence remains limited regarding the influence of administration route on their physiological effectiveness. This study evaluated the effects of feed-based and water-based administration route of a phytogenic blend on growth performance, hematological indices, and serum biochemical characteristics of broiler chickens. A total of 540-day-old Arbor Acres broilers were randomly assigned to nine treatment groups in a 2 × 4 + 1 factorial arrangement, using varying combinations of turmeric, ginger, and garlic administered via feed or water. Growth indices, blood parameters, and serum biochemistry were measured over six weeks. Administration route significantly influenced performance ($p<.05$) with water-based supplementation improving hematological markers, including packed cell volume, hemoglobin, and white blood cell count. Combination effects showed that the triple blend (turmeric-ginger-garlic) enhanced weight gain, feed conversion efficiency, immune response, and gut health more effectively than dual combinations. The feed-based triple blend yielded the greatest final weight (1993.25 g) while water-based administration produced superior hematological values. Overall, both administration modes improved broiler performance compared to the control, but with differing physiological strengths. These findings highlight the strategic value of optimizing phytogenic delivery for sustainable broiler production.

Keywords: Phytogenic additives; broiler chickens; ginger; garlic; turmeric; administration route; hematology; performance.

INTRODUCTION

The global rise in demand for poultry protein has necessitated the exploration of safe and sustainable strategies that enhance broiler performance without relying on Antibiotic Growth Promoters (AGPs). While AGPs historically improved feed efficiency and growth rate, their use has become increasingly restricted due to antimicrobial resistance and food safety concerns (Gadde *et al*., 2017; Sugiharto, 2016). This shift has intensified research on phytogenic feed additives, bioactive herbal substances derived from plants such as turmeric, ginger, and garlic, known for their antimicrobial, antioxidant, anti-inflammatory, and digestibility-enhancing properties (Alagawany *et al*., 2015; Wang *et al*., 2024).

Individually, ginger offers potent antioxidant and digestive-stimulatory effects (Malekizadeh *et al*., 2012; Ooi *et al*., 2022), garlic provides lipid-lowering, antimicrobial, and immunomodulatory functions (Sahidur *et al*., 2023; Ashour *et al*., 2025), while turmeric improves digestive enzyme activity, gut morphology, and meat quality through curcumin's anti-inflammatory actions (Aderemi and Alabi, 2023; Sharifi-Rad *et al*., 2020a). Although these phytogenic plants have well-documented benefits, the mode of administration may substantially affect bioavailability, stability, and physiological response (Hashemi and Davoodi, 2011; Rehman *et al*., 2020).

Given the limited comparative research on whether feed-based or water-based delivery is more effective, this study evaluated the effects of different administration modes and phytogenic combinations on broiler performance, blood indices, gut morphology, and carcass quality.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at a commercial poultry farm in Idi-Ayunre, Oluyole Local Government Area, Ibadan, Nigeria.

Experimental Birds

A total of 540-day-old Arbor Acres broilers were procured, weighed (~40 g), vaccinated, and reared for six weeks under standard management and biosecurity.

Preparation of Phytogenic Additives

Turmeric, ginger, and garlic bulbs were cleaned, peeled, sun-dried, milled into powder, and subjected to proximate analysis following AOAC (2005) guidelines.

Experimental Design

A 2 × 4 + 1 factorial arrangement in a Completely Randomized Design (CRD) was used. Nine treatments were created: four phytogenic combinations in water, four in feed, and one control with five replicates per treatment.

Treatment Structure

Treatment Code	Description
T1	Water-based: Turmeric, Ginger, and Garlic (2g/kg water, 1:1:1 ratio)
T2	Water-based: Ginger and Garlic (2g/kg water, 1:1 ratio)
T3	Water-based: Turmeric and Ginger (2g/kg water, 1:1 ratio)
T4	Water-based: Turmeric and Garlic (2g/kg water, 1:1 ratio)
T5	Feed-based: Turmeric, Ginger, and Garlic (2g/kg feed, 1:1:1 ratio)
T6	Feed-based Ginger and Garlic (2g/kg feed, 1:1 ratio)
T7	Feed-based Turmeric and Ginger (2g/kg feed, 1:1 ratio)
T8	Feed-based Turmeric and Garlic (2g/kg feed, 1:1ratio)
T9	Control (no phytogenic additive)

Parameters Measured

Growth Performance: Initial body weight (IBW), final body weight (FBW), body weight gain (BWG), daily feed intake (DFI), and feed conversion ratio (FCR) were calculated following standard methods (Raj, 2025).

IBW=Average weight of birds per treatment group at Day 0 (g)

FBW=Average weight of birds per treatment group at the end of the trial (g)

BWG = FBW – IBW

DFI =Total amount of feed intake (g) / Total birds weight gain (g)

FCR =feed intake (g) / weight gain (g)

Hematological and Biochemical Indices: Blood samples were analyzed for PCV, Hb, RBC, WBC, differential leukocyte counts, platelets, serum protein, albumin, cholesterol, and liver enzymes (ALT, AST).

PCV (%) = $\frac{Height\ of\ red\ blood\ cell\ column}{Total\ blood\ column\ height}\ X\ 100$

WBC count: Blood was diluted (1: 20) with Turk solution. Cells were enumerated and denoted in cells/ u L.

Statistical Analysis

Data were analyzed using ANOVA (GLM procedure, SAS, 2010). Means were separated using Duncan's Multiple Range Test at α = .05.

RESULTS

Growth Parameters

The results from Table 1 showed that the route of administration had a significant effect on broiler performance. Initial weights differed (P<0.05), with feed-administered birds recording higher baseline weights (166.89 g) compared with water (156.68 g) and control (137.03 g). Weight gain was significantly highest in the control group (1766.23 g), but this was coupled with the highest feed intake (2848.00 g) and a poor FCR (1.61).

Table 1: Main Effect of Routes of Administration of Phytogenic Plants on the Growth Performance of Broiler Chickens

Parameters (g)	Water	Feed	Control	SEM	P-Value
Initial weight	156.68^{b}	166.89^{a}	137.03^{c}	0.1	0.0001
Final weight	1871.69	1906.25	1903.25	0.88	0.0454
Average weight gain	1715.00^{b}	1739.36^{ab}	1766.23^{a}	0.81	0.0024
Feed intake	2655.25^{c}	2700.75^{b}	2848.00^{a}	0.99	0.0001
Feed Conversion Ratio	1.55^{b}	1.55^{b}	1.61^{a}	0.00	0.0001

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

Table 2 with the triple blend (turmeric+ginger+garlic) showed significant difference in final weight (1,953.13g) and average weight gain (1,788.46g). Lowest feed intake was observed in ginger/garlic (2,627.50g),

Table 2: Effect of Different Combination of Phytogenic Plants on the Growth Performance of Broiler Chickens

Turmeric/Ginger/	Ginger/	Ginger/	Garlic/	Control	SE	P-

	Garlic	Garlic	Turmeric	Turmeric		M	Value
IW	164.67[a]	153.55[b]	160.70[ab]	168.24[a]	137.03[c]	0.18	0.0001
FW	1953.13[a]	1852.63[c]	1891.75[bc]	1858.38[bc]	1903.25[b]	0.82	0.0001
AWG	1788.46[a]	1699.08[cd]	1731.05[bc]	1690.13[d]	1766.23[ab]	0.66	0.0001
FI	2764.00[b]	2627.50[d]	2644.50[cd]	2676.00[c]	2848.00[a]	0.72	0.0001
FCR	1.55[c]	1.55[c]	1.53[d]	1.58[b]	1.61[a]	0.00	0.0001

[abcd] Means on the same row with different superscripts are significantly (P<0.05) different

IW: Initial weight, FW: Final weight, AWG: Average weight gain. FI: Feed intake and FCR: Feed conversion intake

Table 3 showed the interaction of phytogenic with feed and water feed-based triple blends (T5) produced the highest final weight (1993.25 g) and weight gain (1817.13 g), followed closely by birds on treatment 9 (control group) and treatment 1 (water-based turmeric + ginger + garlic) group. In contrast, the lowest final weight and weight gain were observed in birds on treatment 3 (water-based garlic + turmeric) group. Feed intake was highest in the control group (2,848 g) and lowest in treatment 4 (2623 g). Feed conversion ratio was most efficient (lowest) in treatment 7 (feed-based ginger + turmeric) group (1.52), while the least efficient conversion was recorded in T9 (1.61).

Table 3: Interactive Effect of the Combination of Different Phytogenic Plants Administered Through Different Routes on the Growth Performance of Broiler Chickens

	Water				**Feed**				Control		
amete)	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**SEM**	**PV**
	153.21[g]	153.31[g]	161.10[c]	159.11[e]	176.12[b]	153.78[f]	160.31[d]	177.38[a]	137.03[h]	0.01	0.0001
	1913.00	1873.75	1891.50	1808.50	1993.25	1831.50	1892.00	1908.25	1903.25[b]	0.15	0.000

	b	d	c	f	a	e	c	b	c		1
G	1759.79 b	1720.44 c	1730.40 c	1649.39 e	1817.13 a	1677.72 d	1731.70 c	1730.88 c	1766.23[b]	0.15	0.0001
	2739.00 c	2628.00 g	2631.00 f	2623.00 i	2789.00 b	2627.00 h	2658.00 e	2729.00 d	2848.00[a]	0.00	0.0001
R	1.56[d]	1.53[e]	1.52[f]	1.59[b]	1.53[e]	1.57[cd]	1.53[e]	1.58[c]	1.61[a]	0.00	0.0001

[abcd] Means on the same row with different superscripts are significantly (P<0.05) different

T1: Water-based Turmeric, Ginger, and Garlic; T2: Water-based Ginger and Garlic; T3: Water-based Turmeric and Ginger; T4: Water-based Turmeric and Garlic; T5: Feed-based Turmeric, Ginger, and Garlic; T6: Feed-based Ginger and Garlic; T7: Feed-based Turmeric and Ginger; T8: Feed-based Turmeric and Garlic; T9: Control (no phytogenic additive)

Hematological Parameters

Notably, water-based T9 (turmeric–ginger–garlic) recorded the highest PCV (32.67%), Hb (10.67 g/dL), RBC (3.29 ×10^6/µL), WBC (22,316/µL), and lymphocytes (66%). Lower heterophil counts (26.33%) in T1 reflect reduced stress.

In Table 4, Packed Cell Volume (PCV), Haemoglobin (Hb), and RBC counts were significantly higher in birds administered phytogenic through water, while feed and control groups had lower values. White Blood Cells and platelet counts followed the same trend, with water-based administration producing significantly higher counts compared to feed and control. Lymphocyte percentage was significantly higher in the water group (61.42%) than in feed (57.75%), with control (60.00%) being intermediate. Heterophil percentage was highest in the feed group (35.25%) and significantly lower in both water and control groups.

Table 4: Main Effect of Routes of Administration of Phytogenic Plants on the Haematology of Broiler Chickens

	Water	Feed	Control	SEM	P-Value
PCV (%)	29.75[a]	26.83[b]	28.00[b]	0.04	0.0002

Hb (g/dL)	9.64[a]	8.63[b]	8.93[b]	0.01	0.0002
RBC (×10^6/µL)	2.93[a]	2.66[b]	2.77[ab]	0.01	0.0047
WBC (/µL)	18500.00[a]	15995.80[b]	14566.70[b]	56.69	0.0002
Platelet (/µL)	170417.00[a]	146917.00[b]	127667.00[b]	0.00	0.0001
Lymphocytes (%)	61.42[a]	57.75[b]	60.00[ab]	0.06	0.0020
Heterophils (%)	31.00[b]	35.25[a]	33.00[b]	0.06	0.0002
Monocytes (%)	3.08	2.75	3.00	0.01	0.2051
Eosinophils (%)	4.25	4.08	3.67	0.02	0.1205
Basophils (%)	0.17	0.25	0.33	0.01	0.6620

[abcd] Means on the same row with different superscripts are significantly (P<0.05) different

Table 5 revealed significant differences (P < 0.05) in most haematological parameters across the different phytogenic plant combinations. Packed cell volume (PCV) was highest in birds fed the turmeric + ginger + garlic combination (30.33%), followed by ginger + garlic (29.00%) and control (28.00%), while the lowest values were recorded in the ginger + turmeric (27.17%) and garlic + turmeric (26.67%) groups. A similar trend was observed for haemoglobin concentration (Hb) and red blood cell (RBC). White blood cell (WBC) counts were significantly elevated in the turmeric–ginger–garlic group (19,283/µL) compared to the garlic + turmeric (14,942/µL) and control (14,567/µL). Platelet counts were highest in birds given the ginger–turmeric mixture (170,333/µL). Leukocyte differentials were highest in the turmeric + ginger + garlic group (63.17%), while Heterophils, were lowest in turmeric + ginger + garlic (29.83%) and highest in garlic + turmeric (35.33%). Monocyte values ranged from 2.33% in turmeric + ginger + garlic to 3.17% in both ginger + garlic and ginger + turmeric groups, with significant differences among treatments. Eosinophil and basophil counts did not differ significantly (P > 0.05) across treatments, with values ranging from 3.67% to 4.50% for eosinophils and 0.00% to 0.33% for basophils.

Table 5: Effect of Different Combination of Phytogenic Plants on the Haematology of Broiler Chickens

	Turmeric/ Ginger/ Garlic	Ginger/ Garlic	Ginger/ Turmeric	Garlic/ Turmeric	Control	SE M	P Value

PCV (%)	30.33[a]	29.00ab	27.17[b]	26.67[b]	28.00ab	0.06	0.0088
Hb (g/dL)	9.77[a]	9.55[ab]	8.73[bc]	8.50[c]	8.93[abc]	0.02	0.0037
RBC ((×10^6/µL)	3.04[a]	2.88[ab]	2.58[c]	2.68[bc]	2.77[abc]	0.01	0.0014
WBC (/µL)	19283.00[a]	16500.00[abc]	18267.00[ab]	14942.00[bc]	14567[c]	69.25	0.0018
Platelet (/µL)	159667.00[ab]	152833.00[ab]	170333.00[a]	151833.00[ab]	127667.00[b]	0.00	0.0688
Lymphocytes (%)	63.17[a]	58.83[b]	58.67[b]	57.67[b]	60.00[ab]	0.08	0.0066
Heterophils (%)	29.83[b]	33.33[ab]	34.00[ab]	35.33[a]	33.00[ab]	0.08	0.0137
Monocytes (%)	2.33[b]	3.17[a]	3.17[a]	3.00[ab]	3.00[ab]	0.01	0.0193
Eosinophils (%)	4.50	4.33	4.17	3.67	3.67	0.02	0.1623
Basophils (%)	0.33	0.17	0.00	0.33	0.33	0.01	0.6060

[abcd] Means on the same row with different superscripts are significantly (P<0.05) different

Table 6 presents the interactive effects of different phytogenic plant combinations administered through drinking water, feed, and the control treatment on the haematological characteristics of broiler chickens. Significant differences ($P < 0.05$) were observed for all measured haematological indices except eosinophils and basophils, indicating that both the type of phytogenic combination and the route of administration influenced the blood profile of the birds.

Packed cell volume (PCV) was significantly ($P < 0.0001$) affected by the treatments. Birds in T1 recorded the highest PCV value (32.67%), which was statistically similar to T2 (31.00%) but significantly higher than the remaining treatments. The lowest PCV was observed in T7 (26.00%). Haemoglobin (HB) concentration followed a similar trend ($P < 0.0001$), with T1 recording the highest value (10.67 g/dL), followed by T2 (10.13 g/dL), while the lowest values occurred in T7 (8.30 g/dL) and T8 (8.40 g/dL). Red blood cell (RBC) count differed significantly ($P < 0.0001$) among treatments. The highest RBC count was obtained in T1 (3.29×10^6/µL), followed by T2 (2.98×10^6/µL), whereas T7 recorded the lowest value (2.40×10^6/µL). White blood cell (WBC) count also varied significantly ($P < 0.0001$). Birds in T1 had the highest WBC count (22.32×10^3/µL), followed by T2, T3, and T7, while T6 recorded the lowest value (13.82×10^3/µL).

Platelet count showed significant variation ($P < 0.0001$), with T1 recording the highest value ($20.70 \times 10^4/\mu L$), whereas T5 recorded the lowest value ($11.23 \times 10^4/\mu L$). Lymphocyte percentage was significantly affected ($P < 0.0001$). Birds in T1 recorded the highest lymphocyte percentage (66.00%), while all other treatments ranged between 56.33 and 61.00%. Conversely, heterophil percentage increased significantly ($P < 0.0001$) in treatments with reduced lymphocyte counts. The highest heterophil percentages were observed in T7 (36.67%) and T8 (36.33%), whereas T1 recorded the lowest value (26.33%). Monocyte counts differed significantly ($P = 0.0005$), with T5 recording the lowest value (1.67%), while all other treatments ranged from 3.00 to 3.33%. Eosinophil ($P = 0.4374$) and basophil ($P = 0.9203$) percentages were not significantly influenced by the treatments.

Table 6: Interactive Effect of the Combination of Different Phytogenic Plants Administered Through Different Routes on the Haematology of Broiler Chickens

	Water			Feed					control		
	T1	T2	T3	T4	T5	T6	T7	T8	T9	SEM	PValue
PCV (%)	32.67^{a}	31.00^{a}	28.33^{b}	27.00bc	28.00bc	27.00bc	26.00^{c}	26.33bc	28.00bc	0.03	0.0001
HB (g/dL)	10.67^{a}	10.13^{b}	9.17^{c}	8.60de	8.87cd	8.97cd	8.30^{e}	8.40^{e}	8.93cd	0.01	0.0001
RBC	3.29^{a}	2.98^{b}	2.75^{bc}	2.69^{c}	2.78^{bc}	2.79^{bc}	2.40^{d}	2.68^{c}	2.77^{bc}	0.00	0.0001
WBC (x10^3	22.32^{a}	19.18^{b}	18.25^{b}	14.25^{de}	16.25^{c}	13.82^{e}	18.28^{b}	15.63^{cd}	14.57^{de}	0.21	0.0001
Platelet (x10^4	20.70^{a}	15.73^{bc}	16.33^{bc}	15.40^{c}	11.23^{e}	14.83^{cd}	17.73^{b}	14.97^{c}	12.77^{de}	0.26	0.0001
Lymphocytes	66.00^{a}	60.00^{b}	61.00^{b}	58.67^{b}	60.33^{b}	57.67^{b}	56.33^{b}	56.67^{b}	60.00^{b}	0.06	0.0001
Heterophils	26.3	32.00	31.33^{c}	34.33^{ab}	33.33^{a}	34.67^{ab}	36.6	36.33^{a}	33.00^{bc}	0.04	0.000

	3[d]	[c]		[c]	[bc]	[c]	7[a]	[b]			1
Monocytes	3.00[a]	3.33[a]	3.00[a]	3.00[a]	1.67[b]	3.00[a]	3.33[a]	3.00[a]	3.00[a]	0.01	0.0005
Eosinophils	4.33	4.33	4.67	3.67	4.67	4.33	3.67	3.67	3.67	0.03	0.4374
Basophils	0.33	0.00	0.00	0.33	0.33	0.33	0.00	0.33	0.33	0.02	0.9203

[abcd] Means on the same row with different superscripts are significantly (P<0.05) different

T1: Water-based Turmeric, Ginger, and Garlic; T2: Water-based Ginger and Garlic; T3: Water-based Turmeric and Ginger; T4: Water-based Turmeric and Garlic; T5: Feed-based Turmeric, Ginger, and Garlic; T6: Feed-based Ginger and Garlic; T7: Feed-based Turmeric and Ginger; T8: Feed-based Turmeric and Garlic; T9: Control (no phytogenic additive)

DISCUSSION

The results of the growth study demonstrated that both feed-based and water-based administration of phytogenic plants significantly influenced the growth performance of broiler chickens. Feed-based administration was associated with higher initial body weight and improved feed conversion ratio (FCR), whereas water-based administration resulted in comparable final body weight and average weight gain. These findings are consistent with previous reports that phytogenic feed additives enhance nutrient digestibility, improve feed palatability, and stimulate the secretion of digestive enzymes, thereby promoting better growth performance (Sharifi-Rad *et al*., 2020; Al-Abdullatif *et al*., 2025). Although the control group recorded the highest weight gain, this was accompanied by the highest feed intake and the poorest FCR, indicating lower feed utilization efficiency. This suggests that while broilers can achieve substantial growth without phytogenic supplementation, the inclusion of phytogenic additives improves nutrient utilization and feed efficiency, thereby reducing production costs (Abdelli *et al*., 2021). The different phytogenic combinations further highlighted the synergistic effects of combining medicinal plants; the turmeric–ginger–garlic blend produced significantly higher final body weight and average weight gain than the other combinations. However, the ginger–turmeric combination has the best feed conversion ratio (1.53), indicating efficient feed utilization. This agrees with the finding of Rajput *et al*. (2013), who attributed the improved feed efficiency of these phytogenic plants to their ability to stimulate bile secretion and digestive enzyme activity, thereby enhancing nutrient digestion and absorption.

Haematological parameters are reliable indicators of physiological health, immune status, and overall well-being of poultry. The water-based administration of phytogenic plants significantly increased packed cell volume (PCV), haemoglobin (Hb) concentration, red blood cell (RBC), and white blood cell (WBC) counts compared with feed-based administration and control. Furthermore, birds receiving the combination of turmeric + ginger + garlic (T1) exhibited increased lymphocyte counts and reduced heterophil levels, suggesting enhanced immune competence and lower physiological stress. These observations are consistent with reports that aqueous supplementation with phytogenic plants strengthens immune function and improves stress tolerance in poultry, particularly under heat stress conditions (Mao *et al*., 2019; Lentfer *et al*., 2015; Mutibvu *et al*., 2017; Thiam *et al*., 2022). In contrast, feed-based administration of the ginger + turmeric combination resulted in elevated heterophil counts, an indicator of stress-induced leukocytosis (Rahimi *et al*., 2011). These findings suggest that water-based administration of phytogenic blends may provide a faster and more effective means of enhancing immune responsiveness, alleviating physiological stress, and improving haematological profiles in broiler chickens.

The serum biochemical parameters further confirmed the beneficial effects of phytogenic supplementation on the health and metabolic status of broiler chickens. Water-based administration significantly increased globulin concentrations, indicating enhanced synthesis of immune-related proteins. In particular, the water-based combination of turmeric + ginger + garlic (T1) recorded the highest total protein and globulin levels, reflecting improved protein metabolism and immune function. Although liver enzyme activities (AST, ALT, and ALP) differed among treatments, all values remained within normal physiological ranges, indicating no hepatotoxic effects. This observation supports previous reports that turmeric and garlic possess hepatoprotective properties by protecting liver tissues against oxidative stress (Abdulkareem *et al*., 2023).

Phytogenic supplementation significantly influenced lipid metabolism by reducing serum cholesterol and triglyceride concentrations compared with the control group. Birds receiving ginger + garlic and ginger + turmeric combinations exhibited markedly lower lipid levels, confirming the hypolipidemic properties of these phytogenic plants. The lowest cholesterol (125.67 mg/dL) and triglyceride (63.33 mg/dL) concentrations were recorded in T7, demonstrating the strong lipid-lowering potential of phytobiotics (Wei Wang, 2012). These effects are attributed to the ability of garlic-derived organosulfur compounds to inhibit hepatic cholesterol synthesis, while gingerols and curcumin enhance lipid metabolism and bile secretion, thereby promoting lipid breakdown and reducing cholesterol production (Ogbuewu *et al*., 2019; Abdulkareem *et al*., 2023; Jimoh *et al*., 2024). Improved serum lipid profiles may reduce fat

deposition, enhance carcass quality, and produce healthier, lower-cholesterol meat that is more desirable to consumers.

Conclusion

The research compared the impact of various forms and modes of administration of phytogenic plants, namely turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), and garlic (*Allium sativum*), on the growth performance and haematological profile of broiler chickens. The results are good proof that phytogenic supplementation has considerable and positive effects on broiler productivity and health, and the results depend on the type of plant blends and the route of administration.

Administration through feed, especially when using a combination of turmeric, ginger, and garlic, stimulated the best growth rate and increased feed conversion ratio. This implies that phytogenic blends may be used as an effective growth promoter, which can increase nutrient usage and aid in carcass production. The triple blend of the drug was more effective in water-based administration, particularly in enhancing the haematological and immunological indices. Groups of birds had greater packed cell volume, haemoglobin concentration, red and white blood cell counts and lymphocyte proportions, which indicated improved oxygen-carrying capacity, immunity, and physiological stress.

In general, the findings demonstrate that phytogenic plants are safe, sustainable and effective alternatives to antibiotic growth promoters in raising poultry. Their application not only increases growth efficiency and feed consumption but also boosts their immune status and health in general, leading to the production of high-quality, residue-free poultry meat.

REFERENCES

Abdelli, N., Solà-Oriol, D., & Pérez, J. F. (2021). Phytogenic feed additives in poultry: Achievements, prospects, and challenges. *Animals, 11*(12), 3471. https://doi.org/10.3390/ani11123471

Abdulkareem, Z. A., Mohammed, N. I., Abdollahi, A., Ahmed, O. R., Ghaffar, O. R., Khdir, H. A., Salam, D. A., Aziz, S. A., Mustafa, M. M., Mustafa, W. M., Abas, Z. A., & Abid, O. I. (2023). Effects of garlic, onion, and apple cider vinegar as a herbal mixture on performance and blood traits of broilers inoculated with chicken infectious anemia virus. *Heliyon, 9*(7), e17768. https://doi.org/10.1016/j.heliyon.2023.e17768

Al-Abdullatif, A. A., Al-Garadi, M. A., Qaid, M. M., Matar, A. M., Alobre, M. M., Al-Badwi, M. A., Hussein, E. O., & Suliman, G. M. (2025). Effects of water- and feed-based RISCO-NUTRIFOUR probiotic supplementation on the technological and physicochemical quality of broiler breast meat. *Frontiers in Veterinary Science, 12*, 1517078. https://doi.org/10.3389/fvets.2025.1517078

Aderemi, F. A., & Alabi, O. M. (2023). Turmeric (*Curcuma longa*): An alternative to antibiotics in poultry nutrition. *Translational Animal Science, 7*(1), txad133. https://doi.org/10.1093/tas/txad133

AOAC International. (2005). *Official methods of analysis of AOAC International* (18th ed.). AOAC International.

Ashour, E. A., Aldhalmi, A. K., Elolimy, A. A., Madkour, M., Elsherbeni, A. I., Alqhtani, A. H., Khan, I. M., & Swelum, A. A. (2025). Optimizing broiler performance, carcass traits, and health: Evaluating thyme and/or garlic powders as natural growth promoters in antibiotic-free diets. *Poultry Science, 104*(2), 104689. https://doi.org/10.1016/j.psj.2024.104689

Banerjee, S., Mukherjee, P. K., & Maulik, S. (2003). Garlic as an antioxidant: The good, the bad and the ugly. *Phytotherapy Research, 17*(2), 97–106. https://doi.org/10.1002/ptr.1281

Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics, 11*(1), 1–42.

Etim, N. N. (2014). Haematological parameters and factors affecting their values. *Agricultural Science, 2*(1), 37–47. https://doi.org/10.12735/as.v2i1p37

Gadde, U., Kim, W. H., Oh, S. T., & Lillehoj, H. S. (2017). Alternatives to antibiotics for maximizing growth performance and feed efficiency in poultry: A review. *Animal Health Research Reviews, 18*(1), 26–45.

Hashemi, S. R., & Davoodi, H. (2011). Herbal plants and their derivatives as growth and health promoters in animal nutrition. *Veterinary Research Communications, 35*(3), 169–180.

Jimoh, O. A., Ayodele, A. D., Ojo, O. A., Okin-Aminu, H. O., & Olarotimi, O. J. (2024). Effects of turmeric, ginger, cinnamon, and garlic essential oils on HSP70, NF-κB, oxidative DNA damage, inflammatory cytokines, and oxidative markers in broiler chickens. *Translational Animal Science, 8*, txae127. https://doi.org/10.1093/tas/txae127

Lentfer, T. L., Pendl, H., Gebhardt-Henrich, S. G., Fröhlich, E. K. F., & von Borell, E. (2015). H/L ratio as a measurement of stress in laying hens: Methodology and reliability. *British Poultry Science, 56*(2), 157–163. https://doi.org/10.1080/00071668.2015.1008993

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*(6), 185. https://doi.org/10.3390/foods8060185

Malekizadeh, M., Moeini, M. M., & Ghazi, S. (2012). The effects of different levels of ginger powder on performance and carcass characteristics of broiler chickens. *Poultry Science Journal*, *1*(1), 17–23.

Mutibvu, T., Chimonyo, M., & Halimani, T. E. (2017). Tonic immobility, heterophil to lymphocyte ratio, and organ weights in slow-growing chickens. *Journal of Applied Poultry Research, 26*(2), 226–235. https://doi.org/10.3382/japr/pfw066

Murugesan, G. R., Syed, B., Haldar, S., & Pender, C. (2015). Phytogenic feed additives as an alternative to antibiotic growth promoters in broiler chickens. *Frontiers in Veterinary Science, 2*, Article 21. https://doi.org/10.3389/fvets.2015.00021

Ogbuewu, I. P., Mbajiorgu, E. F., & Mbajiorgu, C. A. (2019). Efficacy of garlic (*Allium sativum* L.) on performance, gut microbiota, blood biochemistry, and carcass traits of broilers: A review. *Livestock Research for Rural Development, 31*(3), Article 44.

Ooi, S. L., Pak, S. C., Campbell, R., & Manoharan, A. (2022). Polyphenol-rich ginger (*Zingiber officinale*) for iron deficiency anaemia and other clinical entities associated with altered iron metabolism. *Molecules, 27*(19), 6417. https://doi.org/10.3390/molecules27196417

Platel, K., & Srinivasan, K. (2004). Digestive stimulant action of spices: A myth or reality? *Indian Journal of Medical Research, 119*, 167–179.

Prasad, S., & Aggarwal, B. B. (2011). Turmeric, the golden spice: From traditional medicine to modern medicine. In I. F. F. Benzie & S. Wachtel-Galor (Eds.), *Herbal medicine: Biomolecular and clinical aspects* (2nd ed.). CRC Press.

Rahimi, S., Teymouri Zadeh, Z., Karimi Torshizi, M. A., Omidbaigi, R., & Rokni, H. (2011). Effect of three herbal extracts on growth performance, immune system, blood factors and intestinal selected bacterial population in broiler chickens. *Journal of Agricultural Science and Technology*, *13*, 527–539.

Raj, S. (2025). Importance of feed conversion ratio (FCR) in poultry farming. *Livine*. https://www.livine.io/blogs/importance-feed-conversion-ratio-fcr-poultry-farming

Rajput, N., Naeem, M., Ali, S., Zhang, J. F., Zhang, L., & Wang, T. (2013). The effect of dietary supplementation with the natural carotenoids curcumin and lutein on broiler pigmentation and immunity. *Poultry Science, 92*(5), 1177–1185. https://doi.org/10.3382/ps.2012-02853

Rehman, Z. U., Abbas, G., & Sohail, M. U. (2020). Bioavailability and stability concerns of phytogenic feed additives in poultry. *World's Poultry Science Journal*, *76*(3), 482–496.

Sharifi-Rad, J. (2020). Turmeric and its major compound curcumin on health: Bioactive effects and safety profiles for food, pharmaceutical, biotechnological, and medicinal applications. *Frontiers in Pharmacology*, *11*, 1021. https://doi.org/10.3389/fphar.2020.01021

Sahidur, M. R., Islam, S., & Jahurul, M. H. A. (2023). Garlic (*Allium sativum*) as a natural antidote or protective agent against diseases and toxicities: A critical review. *Food Chemistry Advances*, *3*, 100353.

SAS Institute Inc. (2010). *SAS/STAT® 9.3 user's guide*. SAS Institute Inc.

Spence, C. (2023). Ginger: The pungent spice. *International Journal of Gastronomy and Food Science*, *33*, 100793. https://doi.org/10.1016/j.ijgfs.2023.100793

Thiam, M., Wang, Q., Barreto Sánchez, A. L., Zhang, J., Ding, J., Wang, H., Zhang, Q., Zhang, N., Wang, J., Li, Q., Wen, J., & Zhao, G. (2022). Heterophil/lymphocyte ratio level modulates *Salmonella* resistance, cecal microbiota composition and functional capacity in infected chicken. *Frontiers in Immunology*, *13*, 816689. https://doi.org/10.3389/fimmu.2022.816689

Toghyani, M., Tohidi, M., Gheisari, A., & Tabeidian, S. A. (2011). Performance, immunity, serum biochemical, and hematological parameters in broiler chicks fed dietary thyme as an alternative for an antibiotic growth promoter. *African Journal of Biotechnology*, *10*(40), 8618–8624.

Wang, J., Deng, L., Chen, M., Che, Y., Li,L., Zhu, L., Chen, G., & Feng, T. (2024). Phytogenic feed additives as natural antibiotic alternatives in animal health and production: A review of the last decade. *Animal Nutrition*, *17*, 244–264. https://doi.org/10.1016/j.aninu.2024.01.012

Wang, W. (2012). Chemical composition and *in vitro* antioxidant and cytotoxicity activities of *Zingiber officinale* Roscoe essential oil. *African Journal of Biochemistry Research*, *6*(6). https://doi.org/10.5897/AJBR11.122

Windisch, W., Schedle, K., Plitzner, C., & Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science, 86*(Suppl. 14), E140–E148. https://doi.org/10.2527/jas.2007-0459