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Original Article

Effect of Diet Supplemented with Graded Levels of Ginger (*Zingiber officinale*) Powder on Growth Performance, Hematological Parameters, and Serum Lipids of Broiler Chickens

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Abstract

The present study was conducted at the Poultry Research Center, Faculty of Agriculture; Sebha University, Libya. The feeding trial lasted 42 days in total. A local hatchery provided 240 unsexed one-day-old broiler chicks (Ross 308). The birds were randomly distributed into four groups, and each group was then divided into four replicates, with 15 birds in each group. The objective of the current study was to examine the impact of ginger powder as a natural feed supplement on broiler chickens' growth performance, hematological parameters, and serum lipids. Four dietary treatments were formulated and supplemented with ginger powder at levels 0%, 0.2%, 0.4% and 0.6%. The findings exhibited substantial differences in body weight and weight gain across the experimental groups. Birds fed ginger-enriched diets had higher feed conversion and lower feed intake than control birds (P<0.05). Birds fed a 0.6% ginger powder diet compared to the control group had considerably superior productive performance (P<0.05), while feed consumption was lowered. Dietary ginger powder supplementation improved hematological parameters; white blood cells, lymphocytes, heterophils, and the lymphocyte to heterophil ratio were improved with dietary ginger powder supplementation (P<0.05). Additionally, as compared to the control group, ginger powder groups significantly (P<0.05) lowered serum triglycerides, total cholesterol, and very low-density lipoprotein. While supplementation of dietary ginger powder significantly increased (P<0.05), the levels of high-density lipoprotein against the control group. In conclusion, ginger supplementation had a positive effect on the performance of chickens when supplemented on broiler ration and can be considered an alternative growth promoter in feeding broiler ration.

Keywords: Ginger, Growth performance, Broilers, hematological parameters

1. Introduction

Because of the significant proportion of the population in developing nations, especially in rural regions, the impact of insufficient animal protein intake is expected to be high (1). Poultry meat is a better source of animal protein and can significantly contribute to increasing animal protein.

In poultry production, additives are utilized as natural feed additives to improve growth rate and productivity. Herbs in poultry feed have beneficial effects such as improving feed intake and appetite, energizing secretion of digestive enzymes, stimulating immunological response, antioxidant, antimicrobial, anthelminthic, antiviral properties, and anti-heat stress modulators.

The poultry sector has recently become one of the fastest expanding segments of the agricultural industry. The major goal of adding additives to poultry feed is to improve the nutritional value of ingredients and enhance performance by raising growth rate and feed conversion efficiency (2, 3).

Feed additives are nutritive and non-nutritive substances added to chicken feed to increase birds' performance (4). The most often utilized feed additives in the past were antibiotics. On the other hand, antibiotics are forbidden in many nations because of their impact on normal gut microbiota and human drug resistance. Therefore, natural growth promoters such as probiotics, herbs, and spices can be applied to replace them without harming the health and performance of birds (5). Herbs are utilized around the world to prevent diseases and enhance general health. Herbs and spices, as well as their constituents, are widely recognized as safe and a rich source of secondary bioactive compounds with significant pharmacological effects (2).

Many phytochemical-rich medicinal herbs are now evaluated as potential antimicrobial and growth promoter alternatives (2). Aromatic herbs have been successfully used in the poultry sector to increase antioxidant capacity (6).

Ginger is a spice, food, and medicinal plant. Gingerdione, gingerdiol, and gingerol are the most significant components in ginger, and when added to broiler diets, they can activate digestive enzymes and influence microbial activity (7). Antioxidant, antibacterial, Immuno-modulatory, anti-tumorigenic, anti-inflammatory, anti-apoptotic, anti-hyperglycemic, anti-lipidemic, and antiemetic characteristics have been found for the active chemicals in ginger (8). In addition to its antioxidant properties, ginger powder supplementation in chicken diets has been shown to improve broiler performance in various trials. Ginger can be used as a phytobiotic to enhance the performance of broilers. This improvement could be attributed to two types of digestive enzymes; protease and lipase, which are part of the plant's natural content (9). Consequently, the current study was carried out to investigate the response of broilers fed ginger Powder on Growth Performance, hematological parameters, and serum lipids.

2. Materials and Methods

2.1. Birds Management

The current feeding trial was conducted at the Poultry Research Center, Faculty of Agriculture, Sebha University, Libya. The experiment was carried out at the broiler Production Unit. The ginger used in the experiment was purchased raw from a local market. It was then chopped into smaller pieces and allowed to dry in the sun. To dry the required amount of ginger, fine grinding was used.

During the experiment, the in-house mean temperature ranged from 18.3 to 32.8°C, with a relative humidity of 26 to 81%.

A total of 240 one-day-old broiler chicks (Ross308) were provided from a local hatchery and randomly divided into four dietary groups. Each group was then split into four replicates, with 15 birds in each group. Ginger powder was supplemented to the diet as follows: 0.0%, 0.2%, 0.4% and 0. 6%. The chicks were raised in 1.5 x 1.5-meter ground pens with wood shavings mulch. According to NRC (10), all mixes were formulated to meet the nutritional requirements (Table 1). The feed and water were provided *ad libitum*. Vaccines against the prevalent infectious diseases were provided to all chicks (11, 12). The body weight (BW) was weighed individually, and feed consumption was documented weekly for each replicate. The body weight gain (BWG) and feed conversion ratio (FCR) were estimated accordingly.

Table 1. Ingredients and chemical composition of broiler diets (% as fed)

Ingredient (%)	Starter 0–21 Day	Finisher 22–42 Day
Corn	55.00	61.00
Soybean	40.00	32.39
oil	1.35	3.35
Limestone	1.45	1.3
Dicalcium Phosphate	1.4	1.2
Salt	0.21	0.20
L-Lysine	0.12	0.1
DL-Methionine	0.27	0.26
Premix *	0.2	0.2
Total%	100	100
Calculated Analysis		
Crude Protein (CP) (%)	22	18
Metabolizable Energy (kcal/kg)	2975	3150
C/P	135	175
Fat (g/kg)	3.86	6
Lysine	1.22	0.97
Methionine %	0.46	0.40
Phosphorus	0.45	0.38
Calcium	0.9	0.76
Crude fiber	3.0	3.0

*Premix each kg contain Vit A 8,25,000 IU, Vit D3 1,20,000 IU/, Vit K 100 mg, Riboflavin 500 mg, Thiamine 80 mg, Pyridoxine 160 mg, Vit E 800 mg, Cyanocobalamine 100 mcg, Niacin 1200 mg, Calcium pantothenate 80 mg, Manganese sulphate 25 g, Ferrous sulphate 10 g, Copper sulphate 500mg, Zinc oxide 8g Potassium Iodide 100 mg, Coccidiostat 60g

2.2. Hematological and Biochemical Parameters

On day 42, blood samples were taken from four birds of each treatment group (one bird per replicate).

2.2.1. Blood Sampling

The blood samples were collected from the wing vein using a sterilized injector. The samples were then transferred into a vacuum tube or K3EDTA vacuum tube. An automatic blood analyzer (BC 3200, Nanshan, Shenzhen 518057, PR China) was used to determine the concentrations of white blood cells (WBC), red blood cells (RBC), and lymphocytes in whole blood samples.

2.3. Statistical Analysis

Statistical analysis was done using the GLM procedure of Statistical Analysis Software of SAS Institute (13). One-way analysis of variance applied to the following formula: $y_{ijk} = \mu + \tau_j + \varepsilon_{ijk}$, where μ=general mean, τ= treatment effect, and ε= experimental random error. Arcsine transformation was used to normalize data distribution before analysis. Tukey's HSD test tested the mean difference at $P<0.05$.

3. Results and Discussion

3.1. Broiler Performance

Table 2 exhibits the impact of ginger supplementation on broiler performance during 42 days of age. The high levels of ginger powder (0.4% and 0.6%) had significant effects ($P<0.05$) in enhancing final BW, BWG, and FCR compared to the control group. Compared to the control, the birds fed ginger powder with 0.6% had considerably lower feed intake ($P<0.05$). Furthermore, compared to the control, chickens fed ginger powder (0.4% and 0.6%) exhibited a higher FCR**.** The increased BW was expected in birds-fed diets supplemented with ginger because the active components in ginger stimulate the digestive enzymes, improving overall digestion and nutrient absorption. Consequently, boosting the BWG. Due to its productivity, palatability, appetite stimulation, and nutrient utilization in chicken, ginger has lately been a substitute for antibiotic growth promoters (14). Ademola, Farinu (15) found that including ginger in the chicken feed has a significant effect ($P<0.05$) on the birds' BW. The enzymes protease and lipase contained in ginger may be responsible for the better performance reported in birds fed ginger (16).

Table 2. Effect of Ginger supplementation on broiler performance during 42 days of age

Traits	Control	GingerpowderLevel			*P*-value
		0.2g/kg	0.4g/kg	0.6g/kg	
initial body weight (g)	40.41±0.27	40.36±0.46	40.39±0.36	40.43±0.27	40.85±0.37	0.978
Live Body weight (g)	1915±14.6^{b}	1945±14.4^{ab}	1987±22.9^{ab}	1999±22.3^{a}	0.028
Body weight gain (g)	1874.47±14.1^{b}	1904.61±15.7^{ab}	1946.57±22.3^{ab}	1958.15±23.5^{a}	0.035
FeedConsumption(g)	3250±17.9^{a}	3133±37.1^{ab}	3096±42.6^{ab}	3021±50.6^{b}	0.007
FeedConversionratio	1.73±0.022^{a}	1.64±0.015^{ab}	1.60±0.019^{b}	1.54±0.038^{b}	0.001

$^{a, b}$ Means within the same row with different superscript letters are significantly different at ($P\leq0.05$)

The significant improvement in BWG found in the current feeding trial is consistent with other previous studies (16). These findings are in line with those of Ademola, Farinu (15), who discovered that ginger supplementation in diets could enhance BW when supplemented up to 2%. Al-Homidan (17) observed similar results, claiming that pigeons fed a diet supplemented with ginger had better BWG.

According to Herawati (16), chickens fed 2% red ginger had higher BW than chickens fed a control diet. Ginger supplementation in poultry feed has been shown to offer antioxidant properties, reduce heat stress, boost immunity, improve growth performance, and minimize coccidiosis and infectious bursa disease in chickens. Additionally, recent research on ginger as a feed additive has yielded promising results in terms of growth performance. However, Ademola, Farinu (15) found that adding ginger to broiler diets reduced BWG.

The findings contradict those of Ademola, Farinu (15), who observed that birds fed a ginger-supplemented diet consumed considerably more feed than those in the control group.

The findings were inconsistent with those of (18), who found no variations in feed intake in broilers fed ginger extract for six weeks.

Ginger has a number of active compounds that may stimulate feed digestion and digestive enzymes. Thus, feed intake and FCR could be increased (19). Ginger's potential to enhance the digestive and absorptive efficiency of the small intestine by improving gut morphology may account for the improvement in FCR (5). The FCR results are consistent with those of Herawati (16), (20), who claimed that ginger supplementation had a positive role in FCR. According to these investigators, this result could be attributed to the enhanced gut microbiota, which restricted microbial fermentation and increased feed efficiency.

3.2. Hematological Parameters

The impact of ginger powder supplementation on blood hematological parameters in broiler chickens at day 42 is shown in table 3. Chickens fed a 0.6% basal diet had higher red blood cell (RBC) counts than those fed 0.2% or control groups. The hemoglobin concentration of chickens fed a basal meal supplemented with high doses of ginger powder was considerably greater (P<0.05) than that of 0.2% treatment and the control group. When compared to the control group, feeding a diet high in ginger powder significantly (P<0.05) increased packed cell volume (PCV), whereas birds fed on 0.4% ginger powder exhibited higher mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) than that of the basal diet and 0.2% ginger powder. Birds fed the basal diet showed lower white blood cell (WBC) counts than the 0.6% group. Moreover, birds fed the basal diet showed a lower lymphocyte (P<0.05) than those fed 0.4%. The chickens on the control diet had a higher heterophil and L/H ratio than those on the high-ginger powder diet (Table 3).

The relationship between hematological factors and health status is clear. These variables serve as crucial diagnostic markers during the clinical assessment of the state of the animal's health. It is interesting to note that different studies disagree about how ginger affects lipid profiles and blood measurements. This might be explained by variations in strain, age, ginger content, genetics, and experiment conditions. The lack of a discernible impact on RBC counts and hemoglobin concentration proved that including ginger in the broiler feed did not result in anemia in the broilers (21).

3.3. Serum Biochemical Parameters

The effect of ginger supplementation on serum lipids of broiler chickens is shown in table 4. When compared to the control group, the chickens fed 0.6% ginger powder had significantly (P<0.05) lower triglyceride levels. Compared to the control and 0.2% ginger powder groups, there was a 0.6% reduction in total cholesterol. While, birds fed the basal diet represented lower high-density lipoprotein (HDL) than the other dietary treatments. Feeding 0.6% of ginger powder significantly (P<0.05) decreased very low-density lipoprotein (VLDL) compared to the control and 0.2% groups.

Table 3. Effect of Ginger supplementation on hematological parameters at 42 days of age.

Parameters	Control	Ginger powder Level			*P*-value
		0.2 g/kg	0.4 g/kg	0.6 g/kg	
Hemoglobin,g/dL	10.2±0.22[b]	10.3±0.44[b]	12.4±0.27[a]	12.1±0.42[a]	0.0001
PCV,%	32.3±0.68[c]	32.1±0.45[bc]	34.8±0.61[ab]	35.3±0.53[a]	0.006
MCV,fL	84.74±2.29	86.14±3.10	88.53±2.52	87.57±1.25	0.367
MCH,pg	26.58±0.81[b]	26.71±2.34[b]	31.39±0.87[a]	29.86±1.32[ab]	0.011
MCHC,g/ dL	31.5±0.17[b]	31.2±1.22[b]	35.5±0.94[a]	34.1±0.94[ab]	0.012
WBCs,$10^3/mm^3$	26.7±0.32[b]	27.7±0.65[ab]	27.9±0.37[ab]	28.8±0.46[a]	0. 037
Lymphocytes,%	42.5±0.90[b]	44.4±0.54[ab]	46.4±0.97[a]	45.2±1.08[ab]	0.046
Monocytes,%	6.08±0.44	6.71±0.35	7.80±0.41	6.93±0.85	0.139
Basophils,%	0.641±0.019	0.645±0.032	0.655±0.023	0.661±0.025	0.984
Eosinophils,%	11.1±0.37	11.8±0.59	11.5±0.64	11.4±0.17	0.908
Heterophils,%	24.5±0.33[a]	23.4±0.32[ab]	23.2±0.32[b]	23.1±0.26[b]	0.018
L/Hratio	0.575±0.016[a]	0.526±0.007[ab]	0.498±0.015[b]	0.509±0.015[b]	0.006

[a, b, c]Means in the same row having different letters are significantly different at ($P \leq 0.05$)

Table 4. Effect of ginger supplementation on serum lipids of broiler chickens at 42 days of age

Parameters	Control	Ginger powder Level			*P*-value
		0.2 g/kg	0.4 g/kg	0.6 g/kg	
Triglycerides mg/dl	80.5±6.25[a]	58.0±6.39[ab]	66.7±7.30[ab]	41.1±2.76[b]	0.003
Cholesterol mg/dl	132.0±2.49[a]	126.9±3.06[a]	121.0±2.22[ab]	116.4±4.06[b]	0.004
HDL mg/dl	53.2±0.44[b]	55.4±0.42[a]	55.3±0.39[a]	56.0±0.51[a]	0.0001
LDL mg/dl	63.5±2.66	60.7±3.72	53.1±2.86	53.1±4.05	0.191
VLDL mg/dl	16.11±0.94[a]	11.61±1.05[bc]	13.35±0.97[b]	8.23±0.63[c]	0.001

[a,b,c]Means in the same row having different letters are significantly different at ($P \leq 0.05$)

The results agree with Shewita and Taha (22), who found those lipid profile parameters were significantly modulated in ginger-supplemented birds. This might be related to ginger's anti-hypercholesterolemia and hypolipidemic activity. Dietary ginger lowers cholesterol by inhibiting hydroxymethyl-glutaryl-coenzyme-A reductase (HMG-CoA) or boosting bile acid production. Ginger-supplemented diets given over a short period and in small quantities have been linked to decreased cholesterol levels. Similarly, Barazesh, Boujar Pour (23) investigated ginger powder's influence on broilers' blood parameters. They discovered that ginger considerably impacts blood parameters, as well as cholesterol and triglyceride levels.

Similarly, Zhang, Yang (9) reported that adding ginger to broiler feed increased total protein concentration and reduced broilers' cholesterol levels.

In conclusion, ginger (*Zingiber officinale*) powder may improve broiler chicken productivity and hematological and blood lipid profile without side effects on birds' health. In addition, more investigations are needed to evaluate higher ratios of ginger in poultry feed.

Authors' Contribution

Study concept and design: M. A. K. and A. A. A.
Acquisition of data: M. A. K.
Analysis and interpretation of data: M. A. K.
Drafting of the manuscript: M. A. K. and M. I. A.
Critical revision of the manuscript for important intellectual content: M. A. K., A. A. A. and M. I. A.
Statistical analysis: M. A. K.
Administrative, technical, and material support: M. A. K., A. A. A. and M. I. A.

Ethics

All ethical standards related to animal care and husbandries were applied in the current study and approved by the ethics committee of the Faculty of Agriculture, University of Sebha.

Conflict of Interest

The authors declare that they have no conflict of interest.

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