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Effects of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) powders on the growth performance and haematology of broiler chickens

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***Target Audience:** Animal scientists, Pharmacists, Poultry farmers, Researchers and Veterinarians.*

Abstract

Antibiotics have been in use as growth promoters and chemotherapeutics over the years in poultry production. This leaves antibiotic resistance in the microorganisms which invariably is transferred to animal and human end users of poultry. However, medicinal plants can substitute the orthodox antibiotics since they are less likely to constitute antibiotic resistance. Therefore, eight-week study was carried out to assess the effects of garlic and ginger on the growth and haematology of broilers. Ninety-nine day-old Abor-acre chicks were allotted in completely randomized design to three treatments of T_1 (control), T_2 (1% garlic) and T_3 (1% ginger). Each treatment was replicated thrice with 11 chicks per replicate. Acclimatization to the environment lasted for 2 weeks. The birds received the experimental diets for 8 weeks during which growth performance parameters were measured and blood was collected from any three birds per replicate for haematology. The data were subjected to analysis of variance and means separated with Duncan's New Multiple Range Test. The results showed weight gain, FCR and mortality being significant ($p>0.05$) in T_3 and T_2 but differed ($p<0.05$) from T_1. There was no significant difference ($p>0.05$) in feed intake. The T_3 and T_2 were statistically similar ($p>0.05$) but differed ($p<0.05$) from T_1 with respect to PCV, Hb, TWBC, neutrophil and MCHC. They were significant differences ($p<0.05$) in RBC. Generally, the T_3 outperformed the rest of the groups in growth and haematology. It can be concluded that garlic and ginger at inclusion levels of 1 % apiece enhanced the growth and haematology.

***Keywords**: Broiler chickens, garlic, ginger, growth, haematology*

Description of Problem

For many years, antibiotic growth promoters (AGP) have been incorporated into poultry diets because of their favourable effects on growth rate, feed consumption, and feed efficiency, however, they are notorious for bacterial resistance and their negative impacts on the consumers' health (1). With the growing public concern of bacterial resistance to orthodox antibiotics, poultry production industries are looking at AGP alternatives that could maintain intestinal health, have antimicrobial properties, and serve as growth enhancer. Many types and forms of herbal feed supplements have been used to maintain and improve the health of chickens (2). The beneficial effects of natural products are greater than those observed with antibiotics (3), including a lower cost of production and reduced toxicity hazards (4).

Garlic and ginger as natural growth promoters can be potential alternatives for AGP (5). Ginger and garlic supplements in broiler chicken diets have been recognized for their strong stimulating effects on the immune and digestive systems in birds (6), acting as a prebiotic with positive effects on the immune response (7). Recent research works on ginger and garlic formulations as feed additives have shown encouraging results with regards to weight gain, feed efficiency, lowered mortality and increased liveability in poultry birds (8; 9).

Different supplemental levels of garlic and ginger have been tried in the diets of birds and the most consistent results were obtained at about 1% level (10; 11).

It is reported that ginger possesses useful pharmacological potent chemical substances for use in poultry due to its antioxidants, antibacterial, anti-inflammatory, antiseptic, anti-parasitic and immune-modulatory properties (12). Since, ginger contains several compounds such as gingerol, shogaols, gingerdiol, and gingerdione (13), that possess antioxidant and pharmacological effects, the addition of ginger to feed might help to promote performance and health status. (14) suggested that ginger had a positive effect on growth performance parameters in broiler chicks. Ginger extract given in broiler diets had significant ($p<0.05$) influence on body weight gains especially after 14 to 35 days of age (15). In the contrary, (16) and (17) concluded that ginger powder in broilers did not improve growth performance. (18) and (19) observed improved growth, FCR and feed intake in broilers fed diet containing garlic powder. Garlic powder can eliminate pathogenic microbes and improve body health which can finally increase the feed intake and growth (20).

It is also possible that the end product of garlic metabolism in the body stimulates the kidney directly to cause formation and secretion of erythropoietin (21). (22) opined that inhibiting the transformation of arachidonic acid to thromboxane and decreasing the sensitivity of platelets to aggregating agents may be possible with the administration of ginger in fatty diets. This implies that ginger could be potentially useful in improving blood circulation on account of its inhibitory effects on platelet aggregation (22; 23). Ginger at a 1% inclusion level, in the diet of broilers, significantly ($p<0.05$) improved the haematological values (24). This study was designed to compare the effects of garlic and ginger as phytobiotics on growth and haematology of broiler chickens

Materials and Methods

Experimental site and ethical consideration

The experiment was carried out at the poultry unit of the student's project site of the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, Oyo State, Nigeria. Ibadan is located approximately on longitude 3° 5' to 4° 36' E and latitude 7° 23' to 7° 55' N (25). Ibadan has a tropical wet and dry climate, with a lengthy wet season. It has mean total rainfall of 9,233.60 mm, mean maximum and minimum temperatures of 39.82 °C and 22.5 °C respectively (26) and relative humidity of 74.55%. Ethical conditions governing the conduct of experiments with live animals were strictly observed as stipulated by (27). The experimental protocol was approved by the institution's ethical committee for the use of animals for experiment.

Test ingredients and the preparation

Ginger and garlic were purchased fresh from Oja-Oba market in Ibadan. Their rinds and husks were peeled off, washed, cut into smaller pieces and sun-dried. They were ground with domestic electric grinding machine (Sonik® Model SB-464) to fine powder and sieved by 1 mm sieve for feed compounding.

Birds, management, design and duration

Ninety-nine day-old unsexed Arbor acre broiler chicks were purchase from a CHIMERO Farm LTD in Ibadan for the study. Prior to the arrival of the birds, the pens were cleaned and washed with detergent solutions. Disinfection of the pen was done using saponated cresol (Lysol®), and the pen was left without stocking for one week and the floor litter laid to $5cm^3$ with wood shavings. On arrival of the chicks, anti-stress solution (mixture of water, glucose and vitalyte® vitamins premix) was served as well as control diet and borehole water *ad libitum* for the 14-day acclimatization period. Routine

vaccinations (Newcastle disease vaccine (NDV) intra-ocular, Lasota and Infectious bursal disease (IBD)) were administered accordingly during the two weeks of acclimatization. IBD vaccine was repeated on day fourteen. After acclimatization, the birds were allocated to three treatments in a completely randomized design. Each treatment was replicated three times with eleven chicks each. The treatments were identified as T_1 (control, no garlic or ginger), T_2 (1% garlic in the diet) and T_3 (1% ginger in the diet). They were fed with the treatment diets *ad libitum* throughout the experimental duration of 8 weeks under standard environmental conditions (a 12 h/12 h light/dark cycle). A switch from starter to finisher feeds took place after 4 weeks of age. The care and handling of the chickens were in accordance with international accepted guidelines for use of animals (28).

Table 1: Composition of starter diets

Ingredient	T_1(control)	T_2(garlic)	T_3(ginger)
Maize	53.15	52.50	52.50
Fish meal	3.00	3.00	3.00
Soy bean meal	30.00	30.00	30.00
GNC	4.70	4.70	4.70
Wheat offal	5.00	5.00	5.00
Garlic	0.00	1.00	0.00
Ginger	0.00	0.00	1.00
Bone meal	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50
Lysine	0.10	0.10	0.10
Methionine	0.20	0.20	0.20
Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total (%)	100	100	100
Proximate analysis			
Dry matter (%)	90.39	90.30	90.40
Moisture (%)	5.50	5.45	5.50
Crude protein (%)	22.25	23.15	22.45
Crude fiber (%)	4.35	4.67	4.71
Ash (%)	10.70	10.45	10.74
Ether extract (%)	8.65	8.75	8.70
NFE (%)	42.70	43.65	43.15
Energy (Kcal/kg)	2845	2825	2820

Data collection

Weekly weight gain and daily feed intake data were collected by subtracting the lastly measured weights from the present weights. On the last day of the study, three birds from each replicate were randomly selected for aseptical bleeding via the wing veins. Three millilitres (3 mL) of blood from each bird was deposited in ethylene diamine tetra-acetic acid (EDTA) sample bottle for haematological analysis. Red blood cell (RBC) count, white blood cell (WBC) count and the differentials (monocytes, lymphocytes, neutrophils, basophils and eosinophils), packed cell volume (PCV) and haemoglobin (Hb) concentration were determined by the process described by (29). Others such as mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated according to standard formula (30).

Table 2: Composition of finisher diets

Ingredient	T_1(control)	T_2(garlic)	T_3(ginger)
Maize	57.00	56.00	56.00
Fish meal	1.00	1.00	1.00
Soy bean meal	20.00	20.00	20.00
GNC	10.00	10.00	10.00
Wheat offal	8.00	8.00	8.00
Garlic	0.00	1.00	0.00
Ginger	0.00	0.00	1.00
Bone meal	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50
Lysine	0.10	0.10	0.10
Methionine	0.25	0.25	0.25
Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total (%)	100	100	100
Proximate analysis			
Dry matter (%)	93.00	94.20	94.40
Moisture (%)	7.00	6.45	6.50
Crude protein (%)	20.20	20.75	20.45
Crude fiber (%)	3.20	3.65	3.74
Ash (%)	6.60	7.40	7.10
Ether extract (%)	5.00	5.70	5.60
NFE (%)	56.20	53.60	54.25
Energy (Kcal/kg)	3000.50	2992.50	2962.00

Table 3: Phytochemical analysis of garlic and ginger

Items (mg/100 g)	Garlic	Ginger
Tannins	0.90	1.70
Polyphenols	69.13	118.04
Terpenes	1.80	3.90
Saponins	86.15	157.05
Flavonoids	2.10	3.30
Alkaloids	128.11	327.00
Glycosides	39.00	112.85

Oni *et al*. (72)

Statistical analysis

All data obtained were subjected to analysis of variance (ANOVA) using a Statistical Package for Social Sciences *(SPSS) version 20.0*. Significantly different means were separated using Duncan's New Multiple Range Test as described by (31).

Results

Performance characteristics of broiler chickens

Table 4 shows the performance characteristics of broiler chickens on diets compounded with garlic and ginger. The results showed that the initial weights were not significantly different ($p>0.05$). With respect

to total weight gain and feed conversion ratio (FCR), ginger (T_3) outperformed garlic (T_2) though statistically similar ($p<0.05$) but differed significantly ($p>0.05$) from T_1. It then means that there are possible pharmacological constituents in the test ingredients responsible for the significant growth and FCR. Though there was no significant difference in feed intake, the T_2 (7356.45±0.69 g) consumed more feed than T_1 (7239.26±0.43 g) and T_3 (7348.54±1.14 g). For the fact that T_3 consumed less and had better FCR than T_2 might be pointing to intrinsic factor(s) in ginger that enhanced feed utilization independent of the amount of feed consumed. The T_1 group recorded 6.06 % mortality which significantly differed ($p>0.05$) from T_2 and T_3 that had zero mortalities. The zero mortality in the phytobiotic-fortified groups could be a lead to hidden potentials of antimicrobial principles in these test ingredients.

Table 4: Performance characteristics of broiler chickens on diets compounded with garlic and ginger

Parameters	T_1(control)	T_2(garlic)	T_3(ginger)	±SEM
Initial weight (g)	76.15±1.22	76.23±1.43	76.17±0.96	0.02
Final weight (g)	3061.64±2.33^b	3272.13±1.74^a	3291.76±83^a	46.15
Weight gain (g)	2985.49±1.57^b	3195.90±3.11^a	3215.59±32^a	39.15
Daily weight gain (g)	53.31±0.76^b	57.07±1.06^a	57.42±0.76^a	3.02
Feed intake (g)	7239.26±0.43	7356.45±0.69	7348.54±1.14	52.10
Daily feed intake (g)	129.27±0.62	131.37±0.41	131.22±0.83	8.01
Feed conversion ratio	2.42^a	2.30^b	2.29^b	0.47
Mortality (%)	6.06^a	00.00^b	00.00^b	3.07

ab: means along the same row with different superscripts are significantly different ($p<0.05$)

Haematology

Table 5 shows the haematology of broiler chickens on diets compounded with garlic and ginger. The results showed that there were significant differences ($p<0.05$) in PCV, Hb, RBC, TWBC, neutrophil, basophil and MCHC across the treatment groups. Ginger (T_3) numerically improved haematological parameters above garlic (T_2) in all the major haematological parameters of PCV, Hb and RBC except TWBC, basophil and MCHC though they were both statistically the same ($p<0.05$). This trend could point to some erythropoietic, and haematinic potentials in ginger. There were no significant differences ($p>0.05$) among the groups in platelet, lymphocyte, monocyte and eosinophil counts, MCV and MCH. However, with respect to MCHC, the T_2 and T_3 ($p>0.05$) were significantly different ($p<0.05$) from T_1. The Hb, RBC, TWBC, neutrophil, basophil and MCHC of T_2 significantly differed ($p<0.05$) from those of T_1 but not PCV that though was numerically higher but statistically similar ($p>0.05$) with T_1. It could be that ginger has more principles that aid greater absorption of haematinic elements/compounds than garlic weight for weight. The WBC differentials did not show a particular order of interpretation but suggested increase in the ability to ward off bacteria and parasites by the treated groups of T_2 and T_3 since they significantly ($p<0.05$) enhanced TWBC, neutrophil and basophil counts in comparison to T_1.

Table 5: Haematology of broiler chickens on diets compounded with garlic and ginger

Parameter	T_1(control)	T_2(garlic)	T_3(ginger)	±SEM
PCV (%)	22.33±1.32^{b}	23.00±2.48^{ab}	26.00±2.44^{a}	0.74
Hb (g/dL^{-1})	7.23±1.64^{b}	9.57±3.21^{a}	10.27±2.06^{a}	0.22
RBC (x 10^{12}/L)	1.95±2.18^{c}	2.12±1.23^{b}	2.20±2.43^{a}	0.29
TWBC (x 10^{3}/µL)	14.62±1.87^{b}	22.66±1.42^{a}	17.23±1.51^{ab}	4.56
Platelet (x 10^{5}/µL)	2.17±2.48	2.08±1.72	2.34±1.72	0.24
Lymphocyte (%)	61.33±3.01	71.00±2.62	61.67±1.32	3.43
Neutrophil (%)	22.67±2.22^{b}	31.33±1.12^{a}	31.33±3.62^{a}	6.44
Monocyte (%)	3.33±3.12	3.67±2.33	2.67±3.31	0.22
Eosinophil (%)	3.00±2.22	3.00±1.53	4.00±1.03	0.47
Basophil (%)	0.00±0.00^{c}	0.67±0.07^{a}	0.33±0.18^{b}	3.17
MCV (fL)	114.51±0.45	108.49±1.87	118.18±2.63	7.43
MCH (pg)	37.08±1.67	45.14±0.37	46.68±0.86	4.47
MCHC (g/dL)	32.38±2.01^{b}	41.61±0.23^{a}	39.50±1.04^{a}	3.32

abc: means along the same row with different superscripts are significantly different ($p<0.05$)

Discussion

Phytogenic substances are known to increase performance of birds by stimulating secretion of digestive enzymes, leading to enhanced digestion and absorption (32). Similar to the present study, (18) and (33) got increased body weight gain in broiler fed garlic contained feed. This could be attributed to the possibility that garlic enhances villus and goblet cell numbers in the duodenum, jejunum and ileum of birds (34). In this way nutrient absorption is enhanced with the resultant growth promoting effect (35; 36). Garlic powder can eliminate pathogenic microbes and improve body health which can finally increase the growth and feed intake (20). Also garlic powder can promote several body systems including enzyme secretion, absorption and immunity (37) which can help the body gain weight. (18) and (38) recorded increased feed intake in birds that received garlic contrary to the studies of some other authors (39: 40). The improved performance traits in respect of feed consumption, body weight gain and FCR in garlic treated groups might be due to the fact that garlic contained high levels of allicin, diallyl disulfide and S-methylcysteine sulfoxide (41; 42). Sulphur is an essential nutrient required for normal growth and reproduction of bacteria in the rumen of cattle. Sulphur is essential for rumen microbial synthesis of certain amino acids (cysteine, cystine and methionine), vitamins (thiamin and biotin) and enzymes (43).

The present study had ginger outperformed garlic groups in growth performance. This is corroborated by (15) and (44) reports that ginger had a positive effect on growth performance parameters in broiler chicks. Too, (45) observed a significant increase in final body weight, higher feed intake and better FCR of birds fed 2% supplemented red ginger in their diet. It appears that ginger in the feed acts as a growth stimulant independent of effects on feed intake (46). It is suggested that the mode of action of the ginger is through improvements in digestibility and nutrient absorption as indicated in the reports of (47) and (48). In the same vein, a protein digesting enzyme (zingibain) found in ginger is believed to improve digestion as well as kill parasites and their eggs (45) which results in better feed utilization and weight gain. In the contrary, (16) and (17) concluded that ginger powder in broilers did not improve growth performance just like (49) performed a study to assess the impact of ginger oil on the growth performance of broilers and it showed no clear variations in feed intake, FCR and BWG among the treated birds.

Similar to the present study, (24), (44), (50), and (51) got increase in feed intake as gradation of ginger increased. (44) equally reported that final body weight, total body

gain, total feed intake and FCR improved after supplementation of ginger at levels of 2 and 4 but not 6 g/kg in the diets. This indicates that ginger increases appetite and digestion by stimulating digestive juice such as bile, saliva, gastric, pancreatic and intestinal secretion (52). In contrary to the present observation, (17) noted no significant differences in feed intake between the control and treated groups of broiler chickens on ginger contained diets.

Like in the present study, the significant effect of garlic on FCR of broiler was in close agreement with (33), (44), and (51). The better FCR can be attributed to the anti-bacterial properties of the garlic powder which resulted in better absorption of the nutrients in the gut and finally leading to improvement in FCR. Similar observations were reported in broiler chicken by other workers (11; 38) who found significantly ($p<0.05$) improved FCR due to supplementation of garlic powder at various levels. Contrary to the present findings, (53) and (54) found no significant differences in FCR due to supplementation of garlic powder in feed of broiler chickens probably due to lower dosages (0.2 and 0.4 %) of garlic used in these previous studies. According to (55) and (56) the FCR of broiler with ginger supplementation was significantly good. Birds fed diets with ginger root meal had a significantly better ($p<0.05$) FCR than those on the control diet (24).

The zero mortality in T_2 and T_3 in the present experiment is in tandem with the study result of (35) who reported that garlic-derived products showed broad antibiotic properties against gram-positive and gram-negative bacteria and were effective against many common pathogenic intestinal bacteria. This is also similar to the report of (33), where lowest mortality was recorded with 3% garlic powder in the diet. According to (57), such improved health benefits could be due to the immuno-modulating effect of garlic. A protein digesting enzyme (zingibain) found in ginger is believed to improve digestion as well as kill parasites and their eggs (45) which could have resulted to improved health no wonder zero mortality in the present study.

Haematology

The result of the present study which had T_3 (ginger) as the best in terms of major haematological parameters is in tandem with the result of (24) that reported significant differences ($p<0.05$) across all haematological indices with 1% ginger group showing the highest level of significance across the treatment groups. (45) equally got significant increase ($p< 0.05$) in the PCV, Hb, RBC, and WBC of birds on the ginger and garlic infusion than those on control treatment. This shows that birds fed ginger at 1.0 % had more RBC, which could imply that ginger have some innate quality to stimulate the production of RBC through vitamin synthesis (24). Unlike the present study, (58) reported that the inclusion of ginger in broiler diets did not affect the haematological parameters of the chickens except for the WBC where there was a significant increase as the ginger levels increased in the diet through 5, 10 and 15 g/kg of feed. These high quantities of ginger could have resulted to no effect on haematology. Equally, in contradiction to the present study, (44) and (59) observed that ginger did not affect differential leukocytic counts, RBC, Hb and PCV. According to (60), RBC is involved in the transport of oxygen and carbon dioxide in the body. Thus, a reduced red blood cell count implies a reduction in the level of oxygen that would be carried to the tissues as well as the level of carbon dioxide returned to the lungs and vice versa when RBC count increases (60). Haematological indices for PCV in the present study, though significantly different ($p<0.05$) among treatments, are within the range of 21.90 – 30.20 % reported by (60) but differed from 29.56 - 32 and 28.75 -29.33 % reported by (62) and (63) respectively. The Hb concentration in the present study is also in tandem with the ranges of 7.26 – 10.03 and 9.85 – 10.66 g/dL^{-1} reported by (61) and (62) respectively whereas

according to (61) study, RBC count range of 3.74 – 5.14 differed from 1.95 – 2.20 x 10^{12}/L got in the present study. Unlike the present study, (45) reported that sole administration of ginger and garlic numerically reduced the platelets in the blood. In contradiction of the present findings, hematological analysis reported by (64) demonstrated that intake of garlic oil reduced RBC counts, Hb, PCV and MCH values in rats. All haematological values fell within normal ranges reported by (61). This suggests that garlic and ginger might not compromise the health of animal. Meanwhile, similar to the present study, when garlic was used in diet of fish at high doses of 20, 30, and 40 g/kg, it increased the RBC (65). The scientists reported that hematocrit values reached a significant increase in fish fed on 20 g garlic but no significant differences in MCH concentration. It is also possible that the end product of garlic metabolism in the body of the fish stimulates the kidney directly to cause formation and secretion of erythropoietin (21). Similar to the present study, (66) concluded that garlic supplementation increases the WBC and lymphocyte counts in broilers whereas (67) reported that garlic did not affect leukocyte numbers in broilers. Like in this study, with regards to WBC counts, it was reported that dietary addition of garlic increased lymphocyte concentration in peripheral blood of pigs. The enhanced lymphocyte proliferation by garlic treatment along with the possible protection of the cells from oxidative stress seemed to contribute to the increased WBC count (68; 69). Animals with low WBC count are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases (70) and enhance adaptability to local prevalent disease conditions (71).

Conclusion and Applications

1. Garlic and ginger enhanced growth performance and haematological values relative to the control.
2. Ginger outperformed garlic in these respects.
3. Therefore, ginger and garlic can be used in lieu of orthodox antibiotics as growth promoters which will not have deleterious effect on the haematological parameters of the birds.

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