Effect of garlic powder on growth performance and immune response for newcastle and avian influenza virus diseases in broiler of chickens

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Abstract

The aim of the present study was to investigate the effect of garlic powder on performance of broilers (e.g. growth rate, cumulative feed intake and feed conversion rate) and immune response for Newcastle virus (NVD) disease at 7, 14 and 21 days post vaccination and avian influenza virus (AIV) disease at 22, 29 and 36 days post vaccination. One hundred and sixty Hubbard chicks at one-day-old were chosen randomly and divided into four groups (40 birds in each group). The chicks in the first group were fed on control diet free of garlic, (GP0), but the 2nd, 3rd and 4th groups received diet supplemented with 100 (GP100), 150 (GP150) and 200 (GP200) g garlic powder/tonne, respectively. Results showed that the diets containing feed additives of garlic powder had a highly significant effect on broilers' performance ($P<0.0001$). It was improved live body weights, LBW and increased feed conversation rate (FCR); decreased cumulative feed intake (CFI); and mortality rate (MR). In general, it showed that birds fed on diet supplemented with garlic showed a highly significant effect ($P<0.001$) on antibodies titers for NVD and AIV diseases. Birds fed on diet supplemented with garlic showed a positive significant effect ($P<0.05$) on blood hematology (red blood cell "RBC", white blood cell "WBC", lymphocytes "L", heterophyles "H" and H/L ratio and hemoglobin HP). Chicks which received diet supplemented with 200 g garlic powder /tonne were affected more postively compared to the other groups. Sex effect was significant ($P<0.05$) for LBW, CFI, FCR, WBC, RBC and H; but not for MR, NVD and AIV diseases as well as for L, H/L ratio and Hp traits.

Keywords: *Broilers, garlic powder, growth performance, immune response, blood hematology.*

Introduction

Feed represents the major part of cost in poultry production. Efforts have been made since beginning the poultry industry to increase the efficiency of feed utilization and to minimize the cost of production per unit. In spite of the ban of using antibiotics, most developing countries are using them as growth promoters. Poultry scientists today are challenged to find out new alternatives to these synthetic growth promoters that could be as or more effective to keep the poultry gut healthy and well balanced with normal micro flora. Garlic is as a spice and herbal medicine for prevention and treatment of a variety of diseases (Adibmoradi *et al.,* 2006). Recently, Salah (2012) reported that garlic (Allium sativum) contains 17% protein, 0.8% fat, 3% minerals, with varying amounts of vitamins (thiamine, riboflavin, and niacin) and enzymes (allinase, peroxidase, and myrosinase). It also contains 0.2% volatile oils, which are particularly released when the plant is processed into powder. The herbal extracts are either used alone as drugs or constitute a part of the drug. Chemical composition and concentration of compounds for these herbal extracts are variable. These components have many effects as antimicrobial, stimulating animal digestive systems, antioxidants, anticoccidial, increase production of digestive enzymes and improve utilization of digestive products by enhancing liver functions (Corzo-Martinez *et al.,* 2007 and Hernandez *et al.,* 2009). An EU-wide ban on the use of *antibiotics* as growth promoters in animal *feed* entered *into effect* on January 1, 2006; thus, all the antibiotics used at sub-therapeutic doses for growth promotion were withdrawn (Nollet, 2005; Cervantes, 2006; Michard, 2008 and Toghyani *et al.,* 2010). Antibody production against Newcastle disease virus (NDV) in a group of broiler chicks treated with probiotic (garlic) has been reported to be significantly higher 10 days post immunization (Khaksefidi and Ghoorchi, 2006). Garlic demonstrates antimicrobial activity (Adibmoradi *et al.,* 2006), and improved productive performance of broiler chicks (Demir *et al.,* 2003). The purpose of the present study was to investigate the effect of garlic powder on performance of broilers (regarding. growth rate, cumulative feed intake and feed conversion rate) and immune response for Newcastle virus and avian influenza virus diseases at different periods post vaccination.

Materials and Methods

Birds and treatments

This experiment was carried out at a Private Poultry Farm in Toukh, Qalyubia, Egypt. One hundred and sixty Hubbard day-old broiler chicks were chosen randomly and distributed into four dietary treatments; each dietary treatment contains forty birds (20 males and 20 females). The first treatment was a control group fed without any garlic

supplementation (0 garlic powder, diet 1, GP0). The other three treatments were supplemented with garlic powder by 100 (diet 2, GP100), 150 (diet 3, GP150) and 200 (diet 4, GP200) g/tone of feed. The basal starter, grower and finisher diets contains 23% CP and 3000 kcal/kg ME, 20% CP and 3150 kcal/kg ME and 18% CP and 2500 kcal/kg ME, respectively. The starter, grower and finisher diets were supplied to chicks from the 1st to 21th day, 22th to 29th day and 30th to 49th day, respectively. The commercial name of garlic is Garllicin (the composition per kg: 250 g of Garlic Extract (Allicin $C_6 H_{10}S_3$) active and 750 g of Carrier (Silicon Dioxide). This product was produced by Gloryvet Company (Gloryvet.com 2011). Dosages recommended by the company range from 50 to 200 g/tonne. The garlic powder was added on additives and mixed used a mixer of machine. Feed and water were provided to chicks *ad libitum*. Ambient temperature ranged from 24 to 33°C, lighting duration 24 hours, humidity ranged from 35 to 75%; ventilation and other environmental conditions fully met the requirements laid down in the technical instructions of strain for broiler breeding. All groups of birds were subjected to the same managerial and environmental conditions during the experiment.

Vaccination program

Vaccination program for Hubbard strain was applied as the following:

N	Age (day)	Name of vaccine+	Method of vaccine
1	7	Clone + IB	Eye drop
2	9	AI (dead) + IBD (live)	Injection 0.5 / B sub cut + eye drop
3	17	Clone (live)	Eye drop
4	22	IBVD (live)	Eye drop
5	29	Clone (live)	Drinking water

+IB = Infectious Bronchitis, IBD = Infectious Bursal Disease, AI = Avian Influenza, Clone = strain of Newcastle Disease.

Experimental parameters

Performance of broilers was evaluated by recording body weight, cumulative feed intake and feed conversion ratio during the experimental period. Individual body weight (BW) of birds was recorded at hatch, 1, 2, 3, 4, 5, 6 and 7 weeks of age in each group. Traits of cumulative feed intake (CFI), feed conversion ratio (FCR) and mortality rate (MR) in each group were recorded per week and then calculated during the whole experimental period (7 weeks).

Samples of blood were collected from all birds via wing veins in each group at 7 week of age to study the hematological parameters. About 5 ml of blood were taken into sets of sterilized glass tubes/bottles. For hematology, blood samples were collected into plain vacationers (i.e. without anticoagulant) to study hematology traits in serum. Serum samples were separated using the standard Microhematocrit method by centrifuge at 12,000 x g for 5 min and stored in freezer at -10°C until analysis.

Analysis of blood samples

Blood samples of each bird were taken by puncture of the brachial vein to measure antibody titers against Newcastle virus (NVD) and avian influenza virus (AIV) diseases. The antibody titers for NVD and AIV were measured at 14, 21 and 28 days and 22, 29 and 36 days post vaccination, respectively using ELISA method. Hematological traits such as count of total red blood cells (RBC) and white blood cells (WBC), heterophyles (H), lymphocytes (L), as well as H/L ratio were measured by the Natt-Herrick Procedure (1:200 dilution) and Neubauer hemocytometer (Campbell, 1988).

Analysis of Data

The data collected for all traits were analyzed using PROC GLM of SAS (2004) package and the differences between means were tested using Duncan's multiple range test of the same software at ($p<0.05$). The following model was used to analyse the data:

$$X_{ijk}= \mu+\alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijk}$$

Where:

X_{ijk}= the observation of trait on bird; μ= the overall mean; α_i= the effect of diet; β_j= the effect of sex; $(\alpha\beta)_{ij}$ = the effect of interaction between diet and sex; and e_{ijk}= the random error.

Results and discussion

Growth performance

Results presented in Table 1 show that highly significant effect of garlic powder ($P< 0.0001$) on live body weight at different ages. The group which received 200 g garlic per *tone (GP 200)* had significantly greater live body weight than the other three groups (GP0, GP100 and GP150) at different ages. The mean live body weight at marketing age (49 days) was 2248 g in the group which received GP200 diet, while it was 2165, 2114 and 2139 g in the groups which received GP0, GP100 and GP150 diets, respectively. One could conclude that diet supplemented with 200 g garlic powder/tonne

increased the growth rate in broilers. These results are in agreement with Raeesi *et al.* (2010) who found the birds which received 3% garlic powder had greater live body weight than those groups fed on diet contains 0.5% garlic powder and the birds received garlic in their finisher diet only. They added that Garlic manifests hypocholesterolemic effects on chickens through inhibition of the most important enzymes that participate in the synthesis of cholesterol and lipids (trihydroxy-tri-methyl-glutaril coenzyme, reduced cholesterol-7-hydroxylase and the synthesis of fatty acids). Salah (2012) found that the weight gain was better for the garlic-fed chickens, suggesting higher feed efficiency and utilization. Amagase *et al.* (2001) reported that medicinal effect of garlic improved intestinal disorders, abdominal distension and treatment of intestinal worms and respiratory infections.

Sex effect was highly significant (P<0.0001) on live body weight of broiler chickens (Table 1). Males recorded greater live body weight (2294 g) than females (2179 g) at different ages. This may be due to sex-linked effect on live body weight. These results are similar to those reported by Eid (2010), who showed a highly significant effect of sex on live body weight.

Feed intake

Results in Table 2 show that diets supplemented with different levels of garlic powder/tonne were highly significant (P<0.0001) on cumulative feed intake (CFI). Mean of CFI at 49 days was the highest (3958 g) for the control group, followed by (3903 g) and (3827 g) for groups received 100 and 150 g garlic powder/tonne, respectively. But it was the lowest (3768 g) for group which received 200 g garlic powder/tonne. Feed intake decreased gradually with increasing level of garlic, probably due to the associated flavor factor, and the need of chickens to get adapted to the supplement during the first few weeks of feeding (Salah 2012). Since garlic has a pungent smell, it may have lead to lower diet palatability. In this concern, Raeesi *et al.* (2010) and Salah (2012) found that feed intake was significantly higher for the control group (p<0.01) compared to other groups fed on diets containing garlic. Conversely, results of current study disagree with those reported by Chowdhury *et al.* (2002) who observed no significant effect of garlic on feed intake in layers of chickens.

Regarding the sex effect, significant effect (p<0.01) of sex was observed for CFI traits in Hubbard broilers (Table 2). The mean of CFI was higher in males (3871 g) than in females (3858 g). An opposite response was reported by Rahimi *et al.* (2011) found that males of Ross 308 fed on herbal extract consumed lower feed compared with females during the first 42 days.

Table 1. Effect of Garlic powder and sex on live body weight (g) at different ages in Hubbard chickens.

Trait[+]	Diet[++]					Sex		
	GP0	GP100	GP150	GP200	Prob.<	Male	Female	Prob.<
BW0	35±0.42a	35±0.42a	36±0.42a	36±0.42a	0.31	37±0.29a	34±0.30b	0.26
BW1	149±0.40d	158±0.40c	163±0.40b	167±0.40a	0.00011	161±0.28a	158±0.28b	0.0001
2	428±1.16a	451±1.16b	467±1.16c	479±1.14d	0.0001	464±0.8a	449±0.8b	0.0001
BW3	677±1.9d	718±1.85c	751±1.85b	780±1.82a	0.0001	737±1.30a	726±1.3b	0.0001
BW4	961±15.1d	1048±14.9c	1095±14.6b	1164±14.8a	0.0001	1106±10.6a	1027±10.5b	0.0001
BW5	1505±4.3d	1563±4.1c	1643±4.09b	1713±4.02a	0.0001	1625±2.9a	1587±2.9b	0.0001
BW6	1951±15.3d	2052±14.6c	2101±14.4b	2154±14.2a	0.0001	2097±10.4a	2032±10.2b	0.0001
BW7	2165±8.3d	2114±7.9c	2139±7.7b	2248±7.5a	0.0001	2294±5.7a	2179±5.4b	0.0001

[+]BW0, BW1, BW2, BW3, BW4, BW5,BW6 and BW7= body weight at 0, 1, 2, 3, 4, 5, 6 and 7 week of age, respectively
Means with the same letters within each column are not- significantly difference (p<0.05).
[++]GP0, GP100, GP150 and GP200 = diets contains 0, 100, 150 and 200 g garlic powder/tonne, respectively.

Feed Conversion Rate (FCR)

Results in Table 2 show that the group fed on GP200 diet increased significantly (p<0.05) feed conversion rate (FCR) compared to other groups fed on GP0, GP100 and GP150 diets. Means of FCR were 1.58, 1.66, 1.71 and 1.79 for groups fed on GP200, GP150, GP100 and GP0, respectively. This indicates that feed conversion rate was improved with increasing level of garlic powder on diets. Amagase *et al.* (2001) suggested that garlic could act as remedy for intestinal disorders, flatulence, worms and respiratory infections. Such positive effect in the digestive tract might be one of the reasons for increased digestibility. The current results agree with those reported by Raeesi *et al.* (2010), who found the birds which received 3% garlic powder had a higher feed conversion rate than those fed on diet containing 0.5% garlic powder or those of the control group. Salah (2012) showed feed conversion ratio was better for the garlic-fed chickens, suggesting higher feed efficiency and utilization. However, these results disagree with those of Demir *et al.* (2003) who added thyme and garlic powder on broilers' diet, with no effect on FCR. Hernandez *et al.* (2009) stated that most essential oils consist of mixtures of compounds such as phenolics and polyphenols, terpenoides, saponins, quinines, esters, flavones, flavonoids, tannins, alkaloids and nonvolatile residues; and their

chemical composition and concentration of compounds are variable. These components have many effects such as antimicrobial, stimulating animal digestive systems, antioxidants, anticoccidial, increase production of digestive enzymes and improve utilization of digestive products by enhancing liver functions, all the last options may be tended to improve feed conversion rate.

Significant effect ($p<0.001$) was observed for sex on FCR (Table 2). Males were higher FCR than females. This results is opposite to that of Rahimi *et al.* (2011) **who** found that males of Ross 308 fed on herbal extract had lower FCR than females during the first 42 days of age.

Mortality rate

Results in Table 2 show that effect of diet on mortality rate (MR) was highly significant ($P<0.0001$). The group fed on diet containing 200 g garlic powder/tonne was significantly decreased MR to become 7% compared with the other groups received 0, 100 and 150 g garlic powder/tone which showed MR ranging from 10 to 20 %. Birds fed on diets supplemented with garlic powder had lowest MR comparable to the control group. This result means that garlic powder had a higher effect on immune response of birds. It must have decreased infection of diseases that reflect on livability and performance of birds generally which received 200 g garlic powder/tonne. These results are agreement with Gbenga *et al.* (2009), they reported that garlic supplementation raw garlic was decreased the percent of mortality by 1.67 to 3.33%. This might due to the effectiveness of herbal extracts plant supplementation was relatively low, but high digestibility of nutrients and reduction of *E. coli* and *Clostridium* sp. in intestinal content were stated. Jamroz *et al.* (2003) explained that the 80% concentration for garlic had inhibition effects on the *E. coli*, *Salmonella* and *Staphylococcus*. This tended to decrease mortality rate because it was cleaned biological surface for all birds and decreased microbial count in intestine. Shams *et al.* (2003) reported that the 10% concentration of aqueous extracts of garlic and onion had antifungal activity. Results in Table 2 show that sex effect was not significant on mortality rate.

Table 2: Effect of Garlic levels in diet and sex on cumulative feed intake (CFI), feed conversation (FCR) and mortality ratio (MR) during the experimental period (7 weeks) in Hubbard chickens.

Effect	CFI(g)	FCR	MR
Diet^{++}			
GP0	3958±4.37 a	1.79± 0.01 a	20.4± 0.08 a
GP100	3903±4.14 b	1.71± 0.01 b	15.0± 0.08 b
GP150	3827±4.03 c	1.66± 0.01 c	10.0± 0.07 c
GP200	3767±3.95 d	1.58± 0.01 d	7.0± 0.07 d
Prob.<	0.0001	0.0001	0.0001
Sex			
Male	3871±2.99 a	1.68± 0.04 b	13.2±0.05
Female	3858±2.83 b	1.70± 0.04 a	13.2± 0.05
Prob.<	0.0020	0.0013	0.3375

Means with the same letters within each effect and within column are non- significantly difference ($p<0.05$).
$^{++}$GP0, GP100, GP150 and GP200 = diets contains 0, 100, 150 and 200 g garlic powder/tonne, respectively.

Immune response

Titer antibodies for Newcastle virus diseases

Effect of diets supplemented with garlic powder was highly significant ($p<0.0001$) on titer of antibodies for Newcastle virus diseases (NVD**)** at different periods of 7, 14 and 21 days post vaccination (Table 3). The groups fed on diet containing 200 and 100 g garlic powder per tonne had significantly higher antibodies titer against NVD than the two other birds' group fed on diet containing 0 and 150 g garlic powder/tonne at different periods post vaccination. Thus, one could suggest that humoral immune response to NVD was elicited after vaccination. This result agrees with Haq *et al.* (1999) who showed that garlic supplementation increase level antibodies against NVD. For sex effect, there was no significant effect of sex on antibodies titer against Newcastle virus disease at different periods of 7, 14 and 21 days post vaccination (Table 3). These results are similar to those reported by Rahimi *et al.* (2011).

Titer antibodies for avian influenza virus diseases (AIV)

Results in Table 3 show a trend similar to the effect of garlic powder on antibody titer against NVD. It shows that highly significant ($p<0.0001$) effect of garlic on titer of antibodies for Avian Influenza virus diseases (AIV**)** at different periods of 15, 22 and 29 days post vaccination. The group fed diet containing 200 g garlic per tonne had the highest antibodies titer for AIV compared to the other three groups fed on 0, 100 and 150 g garlic powder/tonne at different periods post vaccination. The means of antibodies titer for AIV were 6.34, 5.51, 4.87 and 4.62 for groups fed on diet containing 200, 150, 100

and 0 g garlic powder per tonne, respectively at 29 day post vaccination. These are the same results shown by Jafari *et al.* (2009), who found that antibody levels were considerably higher in the vaccinated chicks than in those of the non-vaccinated control throughout the experimental period ($p<0.05$), but not affected by the treatment. In addition, the removal of garlic from diet had no significant effect on serum titer. They suggested that diet supplemented with garlic powder cannot stimulate the humoral response of chickens against AIV vaccine.

No significant effect of sex was observed in the present study on titer of antibodies for AIV disease at 15, 22 and 29 days post vaccination (Table 3). This result is the same shown by Jafari *et al.* (2009), who found that removal of garlic from diet had no significant effect on serum titer of (AIV).

Table 3. Effect of Garlic levels and sex on antibodies titer (Ab) against Newcastle and avian influenza virus diseases at different periods post vaccination in Hubbard chickens.

Effect	Newcastle disease			Avian Influenza disease		
	Ab at 7d	Ab at 14d	Ab at 21d	Ab at 15d	Ab at 22d	Ab at 29d
Diet^{++}						
GP0	6.55±0.01 c	5.58±0.10 c	5.02±0.07 c	5.59±0.09 c	5.50±0.09 c	4.62±0.09 c
GP100	7.59±0.01 a	6.59±0.10 a	5.62±0.07 a	5.78±0.09 c	5.49±0.09 c	4.87±0.09 c
GP150	7.15±0.09 b	6.20±0.10 b	5.88±0.06 b	6.45±0.08 b	6.08±0.09 b	5.51±0.08 b
GP200	7.59±0.09 a	6.57±0.10 a	6.05±0.06 a	7.54±0.08 a	6.81±0.09 a	6.34±0.08 a
Prob.<	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Sex						
Male	7.15±0.07	6.21±0.07	5.61±0.05	6.34±0.06	5.97±0.06	5.29±0.06
Female	7.28±0.07	6.27±0.07	5.67±0.05	6.36±0.06	5.96±0.06	5.38±0.05
Prob.<	0.2728	0.5508	0.3920	0.7839	0.9547	0.3312

Means with the same letters within each effect and within column are not- significantly difference ($p<0.05$).
$^{++}$GP0, GP100, GP150 and GP200 = diets contains 0, 100, 150 and 200 g garlic powder/tonne, respectively.

Blood profile

Results in Table 4 show that the differences between diet effect were highly significant ($p<0.0001$) on count of white blood cells (WBC). The group fed on diet of GP200 had the highest ($P<0.05$) count of WBC (28.5×10^3), followed by group fed on GP150 (28.0×10^3). The same trend was observed for means of count for red blood cells (RBC). Means count of RBC were highest in the group fed on GP200 diet (2.85×10^6) and the lowest (2.73×10^6) was for group fed on GP0 diet. In this concern, Jamroz *et al.* (2003) explained that the 80% concentration of garlic had inhibition effects on the *E.coli*, *Salmonella* and *Staphylococcus*, thus white blood cells count are increased. An opposite results was reported by Ologhobo *et al.* (2008) and Onyimonyi *et al.* (2012) who found that dried garlic incorporation into the ration of broilers did not affect the normal hematological integrity of the birds. They concluded that garlic decreased tissue lipid content first and subsequently affected WBC and lymphocyte concentration.

The sex effect was significant ($p<0.001$ or $p<0.01$, respectively) on count of WBC and RBC (Table 4). The mean of WBC was higher in females (27.1×10^3) than in males (26.5×10^3), but the reverse trend was shown for RBC trait. Eid (2010) found that count of WBC was higher in males than females.

Hematological parameters

Highly significant effect ($p<0.0001$) was observed between diets for count of heterophyles (H), lymphocytes (L) and percentage of H/L as presented in Table 4. Means of H (6.94×10^3), L (18.27×10^3) and H/L (37.90) were the highest ($p<0.05$) for group fed on diet of GP200, followed by GP150. But the lowest counts were shown by the group which received 0 and 100g garlic powder/tonne. This indicates that garlic administration induced positive effect on animals at early stages of their development. Tatara *et al.* (2005) reported that the immune system of finishing pigs was well developed thus making it unresponsive to such an antimicrobial agent. The slight rise in lymphocyte and heterophyle counts observed in garlic supplemented groups may be due to immunostimulatory effect of garlic. These results disagree with findings of Ologhobo *et al.* (2008) and Onyimonyi *et al.* (2012). They showed that dried garlic incorporation into the ration of broilers did not affect the normal hematological integrity of the birds.

On other hand, sex effect was significant ($p<0.01$) on count of H, but not for L and H/L ratio (Table 4). Count of heterophyles and lymphocytes were higher in males than females. The same result was observed for L and H/L traits by Eid (2010).

Hemoglobin (HP)

Results in Table 4 show that higher significant ($p<0.0001$) effect of diet on hemoglobin (HP). The group fed on GP200 diet has higher hemoglobin (HP) (15.0 g/dL) compared to the rest. However, the lowest HP mean was (12.4 g/dI) in the group fed on GP0 diet. These effects may be due to the presence

of some hemolytic bioactive constituents and/or their metabolites in garlic. The same results are obtained by Rahimi *et al.* (2011). They showed that adding garlic in feed of broilers improved hemoglobin concentration. Conversely, Ademola (2004) showed a slight decrease in hemoglobin concentration when fed birds on garlic powder. On the other hand, sex had no significant effect on hemoglobin (Table 4). This result agrees with Rahimi *et al.* (2011).

Table 4. Effect of Garlic levels and sex on hematology traits in Hubbard chickens.

Parameter[+]	Diet[++]					Sex		
	GP0	GP100	GP150	GP200	Prob.<	Male	Female	Prob.<
WBC x 10^3/ µL	24.5±0.1d	26.1±0.1c	28.0±0.09b	28.5±0.09a	0.0001	26.5±0.07b	27.1±0.07a	0.0001
RBC x10^6 /µL	2.73±0.01d	2.7±0.08c	2.80±0.01b	2.85±0.01a	0.0001	2.73±0.01b	2.75±0.01a	0.0021
HX10^3/µL	4.5±0.12d	5.2±0.11c	6.1±0.11b	6.9±0.11a	0.0001	5.6±0.08b	5.8±0.08a	0.0029
L X10^3/µL	14.6±0.12d	16.4±0.12c	17.4±0.11b	18.3±0.11a	0.0001	16.6±0.08	16.7±0.08	0.4227
H/L	30.9±0.76c	32.2±0.73c	35.3±0.7b	37.9±0.68a	0.0001	33.3±0.52	34.8±0.49	0.0461
HPg/ dI	12.4±0.11d	13.5±0.11c	14.4±0.1b	15.0±0.10a	0.0001	13.8±0.07	13.9±0.07	0.0911

Means with the same letters within each effect and within column are non- significantly difference ($p<0.05$)

[+]WBC= Wight blood cell, RBC= red blood cell, H= heterophyles, L= lymphocytes and H/L= ratio of heterophyles to lymphocytes.

[++]GP0, GP100, GP150 and GP200 = diets contains 0, 100, 150 and 200 g garlic powder/tonne, respectively.

Conclusion

In conclusion, garlic had a highly significant effect on growth performance in broilers. It significantly increased live body weight and feed conversation rate, but decreased cumulative feed intake and mortality rate. In addition, it had a highly significant effect on antibodies titer against diseases like Newcastle and avian influenza viruses, as well as blood hematology. Therefore, garlic may be an alternative for antibiotic of growth promoters in feeding animals. Therefor, it is recommended that the garlic powder could be a good probiotic offers to improve meat production in broilers.

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