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Effects of Garlic Powder on Productive Performance and Immune Response of Broiler Chickens Challenged with Newcastle Disease Virus

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Abstract: A study was designed to investigate the effects of different levels of garlic powder on productive performance and immune response of broiler chickens from 0-42 days of age. 240 day-old male Ross 308 broiler chickens were randomly allocated to 6 treatments consisting of 4 replications with 10 chicks each. The groups were assigned to receive the treatment diets as follows: no added garlic powder (control group) and control diet supplemented with 0.2, 0.4, 0.6, 0.8 and 1.0% garlic powder. Average daily feed intake (ADFI), body weight gain (BWG), feed conversion ratio (FCR), performance index (PI), survivability and production number (PN) were determined during the whole experimental period. The serum antibody level against Newcastle Disease Virus (NDV) was measured by hem agglutination-inhibition test (HI) in 3 periods after vaccination during days 8 and 22 and carcass trait of broilers were evaluated at the end of the experiment. Garlic supplementation, significantly ($P< 0.05$) influenced production performance of broilers at 0-14, 14-28 and 28-42 days of age and the whole experimental period. The best ADFI, BWG, FCR and PI in overall period obtained from chickens received 0.2% garlic powder and the worst obtained from chickens received maximum level of garlic (1.0%). Carcass traits of broilers were numerically affected by high levels of dietary garlic supplementation. Serum antibody titer level against NDV in all ages were not significantly affected ($P< 0.05$) by dietary garlic supplementation.

Key words: Garlic Powder · Productive Performance · Immune response · Broiler Chickens

INTRODUCTION

One of the most active research areas in recent years has focused on finding new feed additives that stimulating immune reactions and improving performance of animal [1-3]. The positive effects of herbal supplements on broiler performance, carcass quality and quality traits of meat have been demonstrated by Schleicher *et al.* [4] and Onibi [5]. A variety of herbal supplements including garlic (*A. sativum)* have been widely used to maintain and improve health of humans [6]. It has long been considered that garlic has several beneficial effects for human and animals, exhibiting antimicrobial, antioxidant properties [7], antiviral [8] and antifungal and antiparasitic [9]. Tolba and Hassan [10] found that garlic improve broiler growth, feed conversion ratio and decreased mortality rate.

It was reported that dietary immunomodulators or vaccines that enhance humoral immunity and minimize immunological stress will affect growth performance most positively [11].

Garlic supplement in broiler chickens has been recognized for its strong stimulating effect on the immune system in addition to its positive effect on digestion in birds due to the very rich aromatic oils content of garlic [12]. Previous researches suggested that those functions are mainly attributed to the bioactive components of garlic, including sulphur containing compounds, such as allin, diallylsulphides and allicin [13]. Many beneficial health properties of garlic are attributed to organosulphur compounds, particularly to thiosulfinates [14]. Allicin (diallythiosulfinate) is the most abundant compound representing about 70% of all thiosulfinates present, or formed in crushed garlic [3,15], S-allyl cysteine, present in the crushed garlic, was found to inhibit tumor metabolism and enhance the immune response [16]. The allium species show immune enhancing activities that include promotion of lymphocyte synthesis, cytokine release, phagocytosis and natural killer cell activity [17]. A higher antibody titer to Newcastle Disease Virus (NDV) as well as a sustained antibody level to Infectious

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Bursal Disease Virus (IBDV) in chickens when added mannan to killed vaccines was reported by Chinnah *et al.* [18]. As well, A positive effect of oil extracted propolis on humoral immunity of broilers to ND, IBD and AI viruses was also observed by Taheri *et al.* [19]. However. It has been showed that mice injected with garlic extracts had no antibody response, to sheep Red Blood Cell (RBC) [20]. Researches about the effects of garlic powder on immune response in broilers chicken are insufficient with quite dicrepancy. Therefore, the objective of this study was to evaluate the effect of garlic powder on performance and immune response of broiler chickens.

MATERIALS AND METHODS

A total of 240 commercial male broilers (Ross 308) were used in a completely randomized design with 6 treatments and 4 replicate with 10 chicks each (1.8m^2 floor space in each pen). Day-old broilers (average initial body weight of 45 g) were allocated to dietary treatments. The groups were assigned to receive the treatment diets as follows: A balanced mash corn soybean meal based diet was used as control group (T1), control diet supplemented with 0.2, 0.4 0.6, 0.8 and 1% garlic powder (T2-T6). The birds were exposed to a continuous lighting of 24 hours of photoperiod. Initial room temperature was 32°C and was then gradually decreased according to usual practices. The relative humidity was recorded using dry and wet bulb hygrometer. Fresh and dried rice husk was used as litter at a depth of about 5 cm. Feed and water were given *ad libitum* and were supplied to the experimental birds daily once in the morning and again in the afternoon. The composition of experimental diets is presented in Table 1. During the experimental period, performance criteria such as feed consumption, body weight gain and survivability, were recorded weekly and data on performance index (PI) and production number (PN) were calculated from the below mentioned formulae:

Performance Index (PI) = Live weight (g) / Feed intake (g) × 100

Production Number (PN) = Average live weight (g) × % survivability/days× FCR ÷ 10

All birds were vaccinated with 1 mg L^{-1} eye drop NDV vaccines (b1 strain) during days 8 and 22 days of age and then four blood samples were taken via wing vein from each group on days 14, 28 and 42 after vaccination and blood serum stored in -20°C . The serum antibody level against NDV was measured by hem agglutination-inhibition test (HI) according to method of Thayer and Beard [21]. The data were analyzed by ANOVA procedure and differences among treatments means were compared by Duncan's multiple range test.

Table1: Composition (%) of experimental diets from 0-42 days of age

Ingredients	0-14days	15-28days	29-42days
Corn grain	51.64	56.61	60.37
Soybean meal	37.74	32.3	27.81
Wheat grain	5	5	5
Soybean oil	1.40	2.03	2.84
Dical. Phosphate	1.56	1.47	1.39
Oyster shells	1.17	1.13	1.08
DL-Methionine	0.3	0.29	0.27
L-lysine	0.13	0.13	0.3
Common salt	0.26	0.24	0.14
Coccidiostate	0.1	0.1	0.1
Sodium bicarbonate	0.1	0.1	0.1
Vit+Min premix[1]	0.6	0.6	0.6
Calculated nutrient content			
ME, Kcal /kg	2.850	2.950	3.050
CP %	22.0	20.0	18.5
Ca %	0.90	0.85	0.80
Av. P%	0.45	0.42	0.40
Na%	0.16	0.15	0.15
Lys%	1.35	1.20	1.16
Met + Cys%	0.97	0.87	0.85

[1] Different levels of garlic powder added to balanced basal diet(all diets aren't shown here, only basal diet is shown) Supplied per kilogram of feed: 7,500 IU of vitamin A, 2,000 IU of vitamin D3, 30 mg of vitamin E (all-*rac*- á-tocopheryl acetate), 15 µg of vitamin B12, 2 mg of vitamin B6, 5 mg of vitamin K, 5 mg of vitamin B2, 1 mg of vitamin B1, 40 mg nicotinic acid, 160 µg of biotin, 12 mg of calcium pantothenate, 1 mg of folic acid, 20 mg of Fe (ferrous sulfate), 71 mg of Mn (manganese oxide), 100 µg of Se (sodium selenite), 37 mg of Zn (zinc oxide), 6 mg of Cu (copper sulfate), 1.14 mg of I (potassium iodide), 400 µg of Co (cobalt sulfate) and 4 mg of butylated hydroxytoluene

RESULTS AND DISCUSSION

The effect of the experimental treatments on the performance parameters are presented in Tables 2 and 3. Dietry garlic supplementation had significant ($P< 0.05$) effect on production performance of chickens during 0-14, 14-28 and 28-42 days of age and total period. These results are in agreement with those of Kumar *et al.* [22] and Javandel *et al.* [23] who observed positive effect of garlic on broiler performance. Similarly, Lewis *et al.* [24] and Demir *et al.* [25] reported an improvement in BWG and FCR in broiler chickens fed low concentrations of commercial garlic products. In contrast with these results,

Table 2: Effect of dietary garlic powder on production performance of chickens from 0-42 days of age[1]

	Starter (0-14 d)			Grower (14-28 d)			Finisher (28-42)		
Garlic (%)	ADFI (g/b/d)	BWG(g/b/d)	FCR(g:g)	ADFI (g/b/d)	BWG(g/b/d)	FCR(g:g)	ADFI (g/b/d)	BWG(g/b/d)	FCR(g:g)
Control	25.7^{ab}	18.1^{b}	1.42^{a}	83.2	44.9^{bc}	1.86^{a}	119.5^{a}	47.7^{b}	2.50^{a}
0.2	25.5^{ab}	19.2^{a}	1.27^{b}	85.7	50.9^{a}	1.62^{c}	121.4^{a}	55.7^{a}	2.18^{b}
0.4	26.5^{a}	19.3^{a}	1.37^{a}	86.0	49.4^{a}	1.72^{b}	119.6^{a}	52.9	2.26^{b}
0.6	24.8^{bc}	17.3^{b}	1.43^{a}	83.4	46.1^{bc}	1.81^{ab}	113.2^{b}	46.0^{b}	2.47^{a}
0.8	24.8^{bc}	17.6^{b}	1.40^{a}	82.3	44.2^{c}	1.86^{a}	112.0^{b}	44.1^{b}	2.55^{a}
1	24.3^{c}	17.5^{b}	1.38^{a}	83.7	43.8^{c}	1.91^{a}	113.0^{b}	43.7^{b}	2.58^{a}
±SEM	0.120	0.091	0.073	0.538	0.113	0.095	1.398	1.034	0.101
P value	0.006	0.018	0.007	0.280	0.007	0.006	0.016	0.007	0.006

[1]240 chicks (6 treatments with 10 bird per each pen) with initial BW of 45.5 g.

[2]ADFI=Average Daily Feed Intake, BWG=Body Weight Gain, FCR=Feed Conversion Ratio

[a,b] Values in the same row and variable with no common superscript differ significantly (P < 0.05).

Table 3: Effect of dietary garlic powder on production performance of chickens from 0-42 days of age[1]

Garlic (%)	FI (g)	BWG (g)	FCR(g:g)	Performance index (%)	Survivability (%)	Production number
Control	3197.5^{a}	1545.1^{c}	2.07^{a}	49.75^{d}	94.99^{ab}	175.97^{b}
0.2	3243.7^{a}	1790.2^{a}	1.81^{c}	56.57^{a}	93.33^{ab}	221.32^{a}
0.4	3193.7^{a}	1676.0^{b}	1.90^{b}	53.98^{b}	86.18^{b}	184.04^{b}
0.6	3100.0^{b}	1532..0^{c}	2.02^{a}	50.64^{c}	89.99^{ab}	164.44^{cd}
0.8	3068.5^{b}	1482.5^{c}	2.07^{a}	50.30^{c}	89.76^{ab}	156.69^{d}
1	3094.7^{b}	1472.2^{c}	2.10^{a}	50.43^{c}	92.61^{ab}	156.97^{d}
±SEM	5.821	4.143	0.111	0.712	0.946	1.565
P value	0.004	0.006	0.006	0.002	0.104	0.006

[1]240 chicks (6 treatments with 10 bird per each pen) with initial BW of 45.5 g.

[a,b] Values in the same row and variable with no common superscript differ significantly (P < 0.05).

[3]FI=Feed Intake, BWG=Body Weight Gain, FCR=Feed Conversion Ratio

Horton *et al.* [26] and Onibi *et al.* [5] reported that supplementation of garlic powder had no significant effect on weight gain and feed conversion ratio in the whole experimental period. As shown in Table 2, ADFI, BWG and FCR were affected by dietary garlic powder level. Fed diets containing 0.6 % and higher garlic powder had lower ADFI, BWG at 0-14, 14-28 and 28-42 days of age. Also, Horton *et al.* [26] indicated that garlic increase average daily weight gain (P< 0.05) during first 21 days of age. However, Javandel *et al.* [27] reported no significant difference for daily weight gain of broiler at 1-21 days of age. The diet containing the highest level of garlic powder (1%) had the worst BWG and FCR when compared to other groups in the whole experimental period (P< 0.05). Javandel *et al.* [27] showed that diet with 2% garlic meal supplement had higher FCR in comparison to birds fed diets containing 0.125, 0.50 or 1.0% garlic meal. The relative growth promoting effect of garlic powder was investigated earlier by Demir *et al.* [25] and Lewis *et al.* [23] who reported BWG was improved in broiler fed low concentration of garlic. As well as, lewis *et al.* [23] mentioned that garlic contains allicin, which promotes the performance of the intestinal flora, thereby improving digestion and enhancing the utilization of energy, leading to improved growth. These results are in agreement with the results of this study. However, the repulsive odor and the taste of diets with the level of garlic powder more than 0.6% probably decreases ADFI and consequently BWG in comparison to diets containing lower levels of garlic (control, 0.2 and 0.4%). At the end of the experiment, the best FCR and PI, PN obtained from chicks received diet containing 0.2% of garlic powder. Inconsistency among the results in different studies might be due to different usage of garlic powder, source of garlic, preparation processes of garlic and diets, management and environmental conditions.

The effect of garlic supplementation on carcass traits of chicken is given in Table 4. Carcass traits of broilers were not significantly affected by dietary garlic supplementation. However, abdominal fat was numerically

Table 4: Effect of garlic supplementation on carcass traits of chicken in 42 day

Garlic (%)	Carcass yield[1] %	Breast[2]	Thigh[2]	Pancreas[2]	Abdominal fat[1]
Control	66.3	33.9	37.1	0.26	1.90
0.2	67.5	32.9	36.9	0.29	1.86
0.4	67.8	33.1	36.6	0.29	1.89
0.6	68.1	34.3	38.2	0.30	2.01
0.8	67.7	33.4	37.1	0.27	1.81
1.0	67.1	34.1	38.5	0.31	1.84
±SEM	1.444	1.243	1.536	0.113	0.207

[a,b] Values in each row with no common superscript differ significantly (P< 0.05).

[1] as a percent of live weight;

[2] as a percent of carcass weight

Table 5: Effects of garlic on blood serum hemagglutination-inhibition (HI) titer ($\log_2$) in chicks vaccinated against ND virus

Garlic (%)	day 14	day 28	day 42
0.0	4.00	4.66	5.89
0.2	4.33	4.90	5.30
0.4	4.00	5.00	6.09
0.6	4.50	4.55	5.33
0.8	4.66	4.33	6.16
1.0	4.89	5.00	6.02
±SEM	0.117	0.093	0.172

[a,b] Values in the same row and variable with no common superscript differ significantly (P< 0. 05).

lower when higher levels of garlic were used. These results are in agreement with those of Javandel *et al.* [27] who showed no significant difference in carcass traits among birds fed garlic powder in the range of 0-2%.

The effect of garlic supplementation on Newcastle Antibody Titer (NDHI) of broilers is presented in Table 5. Garlic powder statistically had no effect on treatments. No consistent effect was derived from supplementation of garlic on Newcastle Antibody titer at days 28 and 42 of age, but when compared to day 14 of age, it tended to increase in all levels except level of 0.4 percent. Serum antibody titer at 14 day for levels 0, 0.2, 0.6, 0.8 and 1 percent are numerically 4, 4.33, 4.50, 4.66 and 4.89, respectively that increase sustainly. These results are in agreement with many studies. In recent works, Jafari *et al.* [28, 29] who showed that inclusion of garlic powder to the diet of broilers had no beneficial effect on humoral immune response. As well as, Ghazanfari *et al.* [20] evaluated the effect of injection fresh and commercial table extract on mice, but couldn't find any significant antibody response to seep red blood cell. However, there are some data in contrast to our results. Haq *et al.* [30] showed higher garlic supplement increase level titer Anti-NDV, as well, Gabor *et al.* [31] made a significant rise in serological response of broilers when using garlic extract in a concentration of 1 mg L^{-1} in drinking water for 17-20 days.

This discrepancy likely related to type of garlic, preparation, process, dose and short-term period feeding garlic that are different in various investigations. The differences in the herbs were expected. Gorinstein *et al.* [32] showed that the contents of bioactive compounds in the herbs are influenced by geographical region, weather and storage conditions and their degree of ripeness. The other possible reason for these discrepancies are maternal antibody titer that could disturb titer antibody level in broilers. Besides, bird strain, dosage and quality of vaccines and method measurement antibody titer should not be ignored

In conclusion, results of the present study showed that supplementation of diet with 0.2%garlic powder , improve performance criteria such as performance index and production number of chicks in the whole experimental period. Garlic powder supplement in broiler chickens in levels mention in this research likely can not effectively enhance the serological response of broilers to NDV vaccine. Although, an overall judgment about immunomodulatory properties of garlic needs more studies with purified active components like allicin and also an evaluation of humoral and cell-mediated defense mechanisms as well as, certain cells of the immune system (lymphocytes, mast cells and basophils) and focusing on health gut of bird.

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