

Effect of Periodically Use of Garlic (*Allium sativum*) Powder on Performance and Carcass Characteristics in Broiler Chickens

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Abstract—A feeding trial was conducted to investigate the effect of periodically use of garlic on performance and carcass characteristics in broiler chickens. 240 1-day-old Ross broiler chicks randomly allocated into the 10 dietary treatments (A, B, C, D, E, F, G, H, I and J) for 6 wk. Treatment A or control group, received basal diet (based on standards of Ross management guidelines) without supplementation of garlic powder while B, C and D dietary treatments were basal diet supplemented with 0.5, 1 and 3% garlic powder, respectively for the whole time of experiment (6 weeks). Birds in group E, F and G were fed control diet supplemented with 0.5, 1 and 3% garlic powder, respectively just in their starter diet (0-21d). Birds in three other treatments (H, I and J) received control diet for the first 21 days and 0.5, 1 and 3% of garlic powder was added to their finisher diets, respectively. 1 and 3% supplemented groups in finisher period had better performance as compared with other groups. Since present study conducted in optimum and antiseptic conditions, it seems that better or more responses could be expected in performance if the raising conditions would not be healthy.

Keywords—Garlic powder, periodically use, broiler chickens, carcass characteristics

I. INTRODUCTION

REACHING to the highest body weight or maximum egg production in return for each unit of feed intake is the aim of raising commercial poultries these days. Anyhow, there is negative correlation between productive traits and immune responses and also resistance against diseases [11]. For example, negative correlation between production and immunity in high performance strains, results in poor performance and immune responses [11]. Antimicrobial compounds produced by microorganisms have been used in animal rations as growth promoters for many years ([10], [6]). Antibiotics affect birds' gut microflora [7] and they have been used widely to prevent infections and poultry diseases for the

improvement of meat and egg production. However, use of antibiotics is restricted due to drug resistance in bacteria, drug residue in carcass and also alteration of natural gut microflora (CAFA, 1997). Thus, use of antibiotics growth promoters is restricted in many countries around the world [27]. Removing these kinds of growth promoters from broilers' diet result in low growth performance, and also less resistance against diseases. Therefore, using other alternatives is being concerned. Several compounds like, enzymes, organic acids, probiotics, prebiotics and phytochemicals are used to improve the performance [23]. Recently, aromatic plants, and their associated essential oils or extracts are being concerned as potentially growth promoters. Garlic (*Allium sativum*) has been used as a spice and a native medicine since long ago [25]. Bioactive components of garlic like sulfur containing compounds (Alliin, Diallylsulfides and Allicin) may be responsible for some specific characteristics of this plant [1]. It has been indicated that these compounds have antibacterial, antifungal, anti parasite, antiviral, antioxidant, antithrombotic, ant cancerous and vasodilator characteristics. Garlic bulbs yield approximately 760 g/kg cloves, and 240 g/kg outer and inner husks [24]. Garlic powder as a natural growth promoter can be a potential alternative for common artificial growth promoters like antibiotics and in this respect, it can improve performance and carcass characteristics in broiler chickens ([11], [20]). Konjufca et al. [18] reported that although performance was not affected when broiler diets were supplemented with 1.5, 3 and 4.5% garlic powder, their serum and liver cholesterol decreased significantly. Yalcin et al. [28] showed that egg production, egg weight, egg mass, feed intake, weight gain and feed efficiency were not affected when they use garlic in diets of laying hens. Chowdhury et al. [9] reported that when levels of garlic increased, egg yolk and serum cholesterol decreased linearly. Horton et al. [14] concluded that triglyceride was not affected by garlic in broiler chickens. Lewis et al. [20] showed that addition of plant extracts to broilers' diet has some effects on performance and microbial activity of intestinal tract but, none of them were significant. Using thyme and garlic powder in broilers' diet had no significant effect on performance but it influenced meat quality and carcass yield positively [11]. Freitas et al. [13] and Kim et al. [16] also used garlic as a growth promoter and also to assay its antimicrobial effects in broilers and pigs.

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In spite of many researches which were conducted in this field, effect of periodically use of garlic (*Allium sativum*) powder on growth and carcass yield in broilers, has not been studied yet. Thus, the aim of this experiment is to study the effect of periodically use of garlic on performance and carcass characteristics in broiler chickens.

II. MATERIAL AND METHODS

A. Birds, Diets and Treatments

Two hundred forty 1-d-old Ross × Ross broiler chicks were obtained from a commercial hatchery on day of hatch. Chicks were randomly allocated into the 10 dietary treatments (A, B, C, D, E, F, G, H, I and J) with 3 replicates of 8 birds per replicate pen (80 × 100 cm) for each treatment. The experimental arrangement consisted of a 3 × 4 factorial design (3 period of consumption and 4 levels of garlic). Treatment A or control group, received basal diet (based on standards of Ross management guidelines) without supplementation of garlic powder while B, C and D dietary treatments were basal diet supplemented with 0.5, 1 and 3% garlic powder, respectively for the whole time of raising (6 weeks). To determine the impact of periodically use of garlic powder, birds in group E, F and G were fed control diet supplemented with 0.5, 1 and 3% garlic powder, respectively just in their starter diet (0-21d). After day 21, they received control diet (without garlic) until the end of the experiment. Birds in three other treatments (H, I and J) received control diet for the first 21 days of the experiment and 0.5, 1 and 3% of garlic powder was added to their finisher diets, respectively. Experimental treatments in this study were 10, instead of 12, because the factor of using period has no effect in control group (with 0% garlic powder). Two removed treatment were counted as superstition treatments and data of group A were used during statistical analysis instead of these two treatments. Diets were fed from 1 to 42 d including starter (1 to 21 d) and finisher (21 to 42 d) phases. The composition and nutrient levels of basal diets are shown in table 1. All chicks were given ad libitum access to feed and water. All birds were weighed individually after their arrival from the hatchery to the experimental farm (initial weight). Weekly weight gain for each dietary treatment was calculated. Feed intake was recorded in the course of the whole experiment for each treatment, weekly and the feed conversion rates were calculated subsequently.

B. Carcass Characteristics

At the end of the experiment, one bird with BW close to the mean was selected from each pen. Feed was withdrawn 12 h before slaughter. Birds were defeathered and eviscerated after slaughtered by bleeding the left jugular vein. The gizzard, heart, liver, pancreas, spleen, bursa of Fabricius and abdominal fat were excised and weighed and their relative weights to live BW were calculated. Then, after removal of head, shanks and offal, ready to cook carcass was obtained. The ready to cook carcass weight was then determined, and the carcass yield percentage was calculated by dividing the

ready to cook weight by the live BW of birds multiplied by 100.

TABLE I
COMPOSITION OF THE BASAL EXPERIMENTAL DIET

Item	Starter	Finisher
Ingredients (%)		
Corn	56.85	61.9
Soybean meal	37.85	32.8
Soy oil	4	1.4
Monocalcium phosphate	1.025	1.05
Limestone	1.825	1.7
NaCl	0.3	0.3
DL-Methionine	0.2	0.2
L-Lysine	0.1	0.1
Vitamin-mineral premix ^a	5	5
Salinomycin	0.05	0.05
Nutrition composition		
ME (kcal/kg)	2845	2954
Cp (%)	21.2	19
Methionine (%)	0.55	0.52
Lysine (%)	1.33	1.1
Available P (%)	0.45	0.43

^aEach kilogram contains calcium, 196 g; phosphorous, 64 g; sodium, 30 mg; manganese, 1,200 mg; cobalt, 20 mg; iodine, 40 mg; selenium, 8 mg; vitamin A, 200,000 IU; vitamin D3, 80,000 IU; vitamin E, 1,600 mg; vitamin K3, 34 mg; vitamin C, 1,300 mg; vitamin B1, 35 mg; vitamin B2, 135 mg; vitamin B6, 100 mg; vitamin B12, 670 µg; nicotinic acid, 1,340 mg; calcium pantothenic acid, 235 mg; choline chloride, 8,400 mg; folic acid, 34 mg; biotin, 3,350 µg; and methionine, 30 g.

C. Chemical Analysis

Garlic powder which was used in this experiment was provided from a commercial brand with the purity of 100% and had medicinal and culinary usage. Garlic powder was analyzed for moisture and ash according to the methods of the Association of Official Analytical Chemists International (AOAC, 1990). Nutritional information of this product is available in table 2.

TABLE II
COMPOSITION OF GARLIC POWDER

Nutrition composition (Average in 100 gr)	
Energy (cal)	332
Protein (%)	16.8
Moisture (%)	5.61
Fat (%)	0.76
Total ash (%)	3.18
Acid insoluble ash (%)	0.21

D. Statistical Analysis

Statistical analyses were conducted using the SPSS for Windows statistical package program, (version 18) to determine if variables differed between groups. Significant effects were further explored using Duncan's multiple range tests to ascertain differences among treatment means. A significance level of $P < 0.05$ was used.

III. RESULTS AND DISCUSSION

A. Growth performance

The effect of garlic supplementation in different levels and periods, on BW gain, feed intake and FCR are shown in table 3.

Although birds which received 1 and 3% garlic powder had greater weight gain than those who were fed 0.5% garlic powder or control group, the weight gain did not show significant differences between treatments from 0 to 21d.

From day 22-42, treatments which received 1% garlic powder, had greater body weight gain than others. These differences were not significant except between these treatments and those which got 0.5% garlic powder ($p>0.05$). Although birds who received garlic in their finisher diet only, had greater body weight gain than others, period of feeding garlic (starter, finisher or the whole of the experiment) had no significant effect on body weight gain.

In whole of the experiment (0-42 d), addition of 1 and 3% garlic to basal diets, significantly increased body weight gain as compared with 0.5% garlic supplemented groups ($p>0.05$) but it was not significant in comparison with control group. Groups which were fed garlic in the finisher diet, had greater body weight gain but, generally period of using garlic did not affect body weight gain significantly.

Mohan et al, [21] studied the effect of thyme and cinnamon extracts on broilers performance. They reported that thyme extract decreased body weight gain as compared with control group while cinnamon did not affect weight gain. Sarica et al, [26] found no significant effects of garlic and thyme powder on performance, when they added them to broilers diet which is in agreement with current study. Lee et al., [19] reported that cinamaldehyde can improve performance in broilers. They suggested that it might be due to its role in improvement of lipid digestion. Amooz mehre et al., [2] reported that garlic extract did not influence broilers performance. Botsoglou et al. [7] indicated that dietary oregano oil exerted no growth promoting effect on broilers when administered at 50 or 100 mg/kg of feed. Freitas et al. [13] did not observe significant differences in the performance of 24-day-old broilers fed garlic or antibiotics, and attributed these results to the low health challenge to which birds were exposed. Studies on broilers, suggest that body weight will be higher in garlic supplemented groups than control group. Furthermore, garlic powder can facilitate activity of enzymes which are involved in the conversion of cholesterol to bilious acids and subsequently, there will be less cholesterol in the carcass[5].

B. Feed Intake

Feed intake was significantly higher in control group ($p>0.01$). Birds received garlic for the whole of the experiment, had higher feed intake but generally, period of feeding garlic did not affect feed intake significantly. Chowdhury et al, [9] added different levels of garlic to layers diet. They reported no significant effects of this supplementation on growth, feed intake and feed efficiency.

C. Feed Conversion Rate

Supplementation of 1% garlic powder, decreased feed conversion rate (FCR) compared with 0.5% supplemented and control group, significantly ($p>0.05$). Birds received 3% garlic powder in their diets had better FCR than control group. Control groups significantly consumed more feed than the others, except those which were supplemented with 0.5% garlic powder ($p>0.05$). There were no significant differences between control and 0.5% supplemented group, although the latter had lower FCR. Groups which were supplemented with garlic powder in just the finisher diet had better FCR than those which were supplemented for the whole of the experiment. Control groups consumed more feed than the others ($p>0.05$) but they had no significant difference with those which supplemented with garlic in starter diet. Jamroz et al. [15] reported that capsaicin, cinamaldehyde and carvacrol decreased FCR significantly in broiler chickens. However they did not affect body weight gain at all. Demir et al. [11] added thyme and garlic powder to broilers diet. They concluded that this supplementation did not affect growth, feed intake and feed conversion rate in whole of the experiment. Konjufca et al. [18] reported that although performance was not affected when broiler diets were supplemented with 1.5, 3 and 4.5% garlic in powder form, their serum and liver cholesterol decreased significantly. They also indicated that this supplementation did not influence feed conversion rate. Lewis et al., [20] reported that garlic extract increased body weight gain and also improved feed conversion rate in broilers between 7-27d. Alcicek et al., [3] indicated that broilers which received blend of essential oils, had higher weight and feed intake and also lower feed conversion rate than control group.

D. Carcass Characteristics

The effect of garlic supplementation in different levels and periods, on carcass characteristics and organ weights are reported in table 4 and 5.

Carcass yield was higher in groups supplemented with garlic than control groups ($p<0.001$). Diets supplemented with 1% garlic powder had higher carcass yield than those which received 0.5 and 3% ($p<0.001$). Supplementation of garlic powder in finisher diet, resulted in higher carcass yield ($p<0.001$) than those which received garlic in starter diet or for whole of the experiment. Results showed that level and period of feeding garlic had mutual effect ($p<0.001$). Feeding garlic for whole of the experiment resulted in higher thigh yield ($p<0.001$). Thigh yield was also higher in groups received garlic in their starter diet than finisher diet ($p<0.001$). Supplementation of 1% garlic powder caused higher thigh yield ($p<0.001$) while the poorest thigh yield belonged to 3% supplemented group. Groups received 1% garlic powder significantly had higher breast yield than others ($p<0.001$). Breast yield was also higher in groups received garlic in their finisher diet than others ($p<0.001$). Results showed that level

TABLE III
EFFECT OF GARLIC SUPPLEMENTATION IN DIFFERENT LEVELS AND PERIODS, ON BW GAIN, FEED INTAKE AND FCR (MEAN±STANDARD ERROR)
^{a,b} Within the same column, means with different superscripts are significantly different (p<0.05).

BW Gain				Feed Intake				FCR					
0-21				22-42		0-42		0-21		22-42		0-42	
Level of garlic powder													
control	626.33±10.97	1662.66±17.78 ^{ab}	2289±26.83 ^{ab}	1022.66±7.65 ^b	3379±41.02 ^a	4401.66±46.84 ^b	1.65±0.01	2.00±0.02 ^a	1.91±0.015 ^a				
	618.66±10.82	1602.33±29.94 ^b	2221±30.61 ^b	1063.11±27.58 ^{ab}	3095.55±12.94 ^b	4158.66±38.93 ^b	1.72±0.04	1.94±0.03 ^{ab}	1.86±0.019 ^{ab}				
	643.22±7.99	1714.11±25.28 ^a	2368.2±29.35 ^a	1092.33±7.05 ^a	3155±14.11 ^b	4247.33±15.51 ^b	1.67±0.02	1.84±0.02 ^c	1.79±0.019 ^c				
3% garlic	645.77±10.21	1674.55±35.23 ^{ab}	2320.3±29.12 ^a	1082.88±15.87 ^a	3131.22±17.26 ^b	4214.11±30.01 ^a	1.68±0.03	1.87±0.03 ^{bc}	1.82±0.019 ^{bc}				
P	NS	*	*	*	***	***	NS	**	***				

Period of feeding

The whole of experiment	644.00±8.52	1655.66±22.67	2299.6±25.37	1090.83±15.96 ^a	3212.41±35.24	4303.25±28.24	1.69±0.02	1.934±0.02	1.86±0.019 ^a
	636.75±9.86	1636.33±22.85	2281.2±29.90	1057.50±17.18 ^{ab}	3166.50±42.26	4224±44.90	1.64±0.03	1.932±0.02	1.85±0.019 ^{ab}
Starter	636.75±9.86	1636.33±22.85	2281.2±29.90	1057.50±17.18 ^{ab}	3166.50±42.26	4224±44.90	1.64±0.03	1.932±0.02	1.85±0.019 ^{ab}
Finisher	619.75±7.64	1698.25±30.11	2318±31.87	1047.41±12.76 ^b	3191.66±38.97	4239.08±41.57	1.69±0.02	1.88±0.03	1.82±0.019 ^b
P	NS	NS	NS	*	NS	NS	NS	NS	*

* (p<0.05), ** (p<0.01), *** (p<0.001) NS: Non Significant

TABLE IV
EFFECT OF GARLIC SUPPLEMENTATION IN DIFFERENT LEVELS AND PERIODS, ON CARCASS CHARACTERISTICS (%) (MAEN±STANDARD ERROR)

	Carcass yield	Breast yield	Thigh yield	Back yield	Wing yield	Neck yield
Level of garlic powder						
control	70.53±0.06 ^c	35.16±0.04 ^d	28.32±0.02 ^b	19.72±0.042 ^c	10.96±0.01 ^a	5.81±0.01 ^b
0/5% garlic	72.01±0.24 ^b	35.43±0.53 ^c	28.29±0.09 ^b	20.13±0.36 ^b	10.21±0.19 ^c	5.92±0.15 ^a
1% garlic	73.04±0.45 ^a	37.62±0.62 ^a	28.88±0.78 ^a	18.64±0.29 ^d	9.21±0.08 ^d	5.62±0.14 ^c
3% garlic	71.86±0.15 ^b	36.35±0.17 ^b	26.89±0.21 ^c	20.95±0.18 ^a	10.33±0.39 ^b	5.47±0.11 ^d
P	***	***	***	***	***	***
Period of feeding						
The whole of experiment	71.70±0.28 ^b	35.69±0.37 ^c	28.81±0.42 ^a	19.79±0.41 ^b	9.88±0.29 ^b	5.81±0.05 ^a
Starter	71.48±0.23 ^b	36.12±0.25 ^b	28.25±0.27 ^b	19.70±0.36 ^b	10.34±0.16 ^a	5.58±0.12 ^b
Finisher	72.40±0.45 ^a	36.62±0.62 ^a	27.23±0.37 ^c	20.09±0.13 ^a	10.31±0.29 ^a	5.72±0.13 ^c
P	***	***	***	***	***	***

^{a,b}Within the same column, means with different superscripts are significantly different (p<0.05).
* (p<0.05), ** (p<0.01), *** (p<0.001) NS: Non Significant

TABLE V
EFFECT OF GARLIC SUPPLEMENTATION IN DIFFERENT LEVELS AND PERIODS, ON ORGAN WEIGHTS RELATIVE TO BW OF BROILER CHICKENS (%) (MAEN±STANDARD ERROR)

	Abdominal fat	Heart	Pancreas	Liver	Gizzard	Bursa	Spleen
Level of garlic powder							
control	3.169±0.018 ^a	0.427±0.002 ^a	0.281±0.0009 ^a	2.250±0.001 ^a	1.499±0.001 ^a	0.0873±0.0001 ^b	0.173±0.0009 ^a
0/5% garlic	2.690±0.089 ^b	0.436±0.008 ^a	0.264±0.0069 ^b	2.099±0.052 ^b	1.350±0.043 ^c	0.0642±0.0020 ^d	0.087±0.0064 ^d
1% garlic	2.514±0.091 ^c	0.408±0.022 ^b	0.222±0.0084 ^d	2.0016±0.086 ^c	1.454±0.045 ^b	0.0659±0.0084 ^c	0.133±0.0052 ^b
3% garlic	2.406±0.062 ^d	0.397±0.007 ^c	0.243±0.0122 ^c	2.235±0.068 ^a	1.356±0.034 ^c	0.0951±0.0135 ^a	0.120±0.0140 ^c
P	***	***	***	***	***	***	***
Period of feeding							
The whole of experiment	2.516±0.126 ^c	0.445±0.008 ^a	0.260±0.008 ^a	2.155±0.049 ^b	1.494±0.017 ^a	0.0764±0.0048 ^b	0.126±0.010 ^b
Starter	2.950±0.053 ^a	0.414±0.003 ^b	0.257±0.009 ^a	2.202±0.078 ^a	1.393±0.039 ^b	0.0886±0.0108 ^a	0.139±0.013 ^a
Finisher	2.619±0.098 ^b	0.392±0.014 ^c	0.240±0.009 ^b	2.08±0.041 ^c	1.359±0.033 ^c	0.0694±0.0055 ^c	0.119±0.010 ^c
P	***	***	***	***	***	***	***

^{a,b}Within the same column, means with different superscripts are significantly different (p<0.05).
* (p<0.05), ** (p<0.01), *** (p<0.001) NS: Non Significant

and period of feeding garlic had mutual effect ($p < 0.001$). Relative weight of bursa was significantly higher in 3% supplemented groups ($p < 0.001$). Birds which received garlic in their starter diets had higher relative bursa weight than those which were fed garlic for the whole of the experiment or just in finisher diet ($p < 0.001$). Relative weight of liver was significantly higher in control and 3% supplemented groups ($p < 0.001$). When birds fed garlic in their starter diets, they showed higher relative liver weight ($p < 0.001$). Relative weight of gizzard was significantly higher in control groups ($p < 0.001$). When supplementation took place whole of the experiment, birds showed higher relative gizzard weight ($p < 0.001$). 0.5% supplemented group had the greatest relative heart weight compared with 1 and 3% supplemented groups ($p < 0.001$). Relative weight of abdominal fat was higher in 3% supplemented groups than 1%, 0.5% and control groups ($p < 0.001$). Relative abdominal fat weight also was higher when garlic was fed in starter and finisher diets than the whole of the experiment ($p < 0.001$). Relative weight of spleen and pancreas were higher in control groups ($p < 0.001$). Relative weight of spleen also was higher, when starter diet was supplemented with garlic, while relative pancreas weight was higher when birds received garlic in starter and also for the whole of the experiment.

Dieumou et al. [12] who, studied the effects of ginger and garlic essential oils on growth performance reported that all organ weights and carcass characteristics were not affected by the treatments, except for a decrease ($P < 0.05$) in relative liver weight of birds on garlic oil treatment compared with those given ginger oil and control. These results contradict with the results of the present study which might be due to lower stock density, optimum and antiseptic conditions of raising in current study. In agreement with this experiment, dosages effects showed a decrease in relative weight of organs only for gizzard ($P < 0.05$) compared to the control.

IV. CONCLUSION

In conclusion, 1 and 3% supplemented groups in finisher period had better performance as compared with other groups. Since present study conducted in optimum and antiseptic conditions, it seems that better or more responses could be expected in performance if the raising conditions would not be healthy. The authors suggest it needs more studies to conduct in more periods to achieve more accurate results.

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