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Dietary Effects of Garlic (*Allium sativum*) Powder on Growth Performance of Commercial Broiler

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Abstract

The study was conducted during summer (April-May, 2019) to investigate the growth performance of 120-day-old mixed-sex commercial broiler chicks (Cobb-400) by examining the dietary effects of different levels of garlic (*Allium sativum*) powder supplementation. In a 28-day experiment, four distinct diets (T1, T2, T3, and T4) were utilized, each containing varying amounts of dried garlic powder (0%, 0.5%, 1%, and 2%). The effectiveness of garlic powder on feeding was evaluated by measuring weight gain, feed consumption, feed efficiency, dressing yield, and survivability. The results showed that there were no significant differences in body weight gain among the treatment groups in the first seven days. However, significant differences were observed in broiler diets containing 0.5%, 1%, and 2% garlic powder during the 8-14, 15-21, and 22-28 day periods, with the highest body weight gain observed in birds fed a diet containing 1% garlic powder. Furthermore, significant enhancements ($P<0.05$) in the feed conversion ratio (FCR) were observed by increasing the inclusion of garlic powder compared to the control group during specific age periods (1-7, 15-21, and 22-28 days), with the treatment group fed with 1% garlic powder exhibiting the most favorable FCR at the trial's conclusion. Regarding feed intake and survivability, the study showed no significant differences ($P>0.05$) in broilers with different dietary treatments. The inclusion of garlic powder in broiler feed led to a notable decrease in fat content and an increase in dressing yield, with the highest yield achieved at a 1% supplementation level. Therefore, the study suggests that 1% garlic powder could be a potential feed additive to enhance the overall performance of the broiler.

KEYWORDS
Carcass Characteristics, Dressing yield, FCR, Garlic, Survivability.

INTRODUCTION

The poultry industry in Bangladesh is an important sector that provides cheap animal protein in the form of nutritious eggs and meat to balance the human diet within a short period (Hamid *et al*., 2017; Saleque and Ansarey, 2020). Broiler meat, in particular, is an important source of quality protein, minerals, and vitamins that are superior to other meat sources available for human consumption for its tenderness, palatability, and digestibility (Mir *et al*., 2017). Therefore, the poultry industry in Bangladesh has become a profitable and popular income-generating activity for the people of the country (Rahman *et al*., 2021).

Feed additives, antibiotics, and several chemicals are commonly used in the poultry industry to increase growth rate, improve feed conversion efficiency, increase livability, and reduce mortality in poultry birds. However, the use of antibiotic growth promoters (AGPs) has been widely prevalent in the poultry industry and can result in the development of drug-resistant bacteria, posing a serious threat to human life (Abd El-Hack *et al*., 2022). Thus, in the last few decades, many studies have investigated the use of alternative substances to antibiotic growth promoters (Hameed, 2021; Abd El-Hack *et al*., 2022). In recent years, researchers have focused on herbal and medicinal plants including neem, tulsi, turmeric, ginger, cinnamon, onion, mint, and garlic as natural feed additives to improve gut health and enhance the growth performance of broilers (Dieumou *et al*., 2009; Ziarlarimi *et al*., 2011; Suriya *et al*., 2012; Chitra *et al*., 2020; Akter *et al*., 2021; Hossain *et al*., 2021; Islam *et al*., 2021).

Garlic is a natural, non-toxic, and residue-free plant-based product that has been used for centuries as a flavoring agent, traditional medicine, and functional food to enhance physical and mental health (Oosthuizen *et al*., 2018). Garlic has multifunctional benefits and has been used as an alternative to AGPs in the broiler industry due to its biological activities (Chitra, 2020; Ismail *et al*., 2021). Studies have shown that garlic supplements can improve production performance, carcass quality, feed conversion ratio, and reduce mortality rates in broiler chickens (Elagib *et al*., 2013; Mulugeta *et al*., 2019; Ismail *et al*., 2021; Kairalla *et al*., 2022). Garlic also contains higher concentrations of sulfur compounds than any other Allium species, making it a potential solution to reduce coccidial oocysts without affecting the growth of the broilers. In addition, garlic is also known to have antibacterial, anticancer, antioxidant, immune-modulatory, hepato-protective, and anti-inflammatory properties, which can help to protect broilers against oxidative stress and inflammation (Omar and Al-Wabel, 2010; Sangilimadan *et al*., 2019; Ismail *et al*., 2021). The use of garlic as a feed additive can reduce the cost of feed management in broiler production and provide a healthier and safer alternative

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to AGPs (ELTAZI *et al*., 2014; Karim *et al*., 2017). The Present study was, therefore undertaken to study the dietary effects of garlic powder on feed intake, weight gain, feed conversion ratio (FCR), survivability, and carcass characteristics of commercial broilers.

MATERIALS AND METHODS

From April 24 to May 21, 2019, the experiment was conducted at the poultry farm run by the Department of Dairy and Poultry Science of Hajee Mohammad Danesh Science and Technology University, Dinajpur, to investigate the effect of garlic (*Allium sativum*) powder on broiler production performance. The Ethical Reviewing Board on Institutional Animal Care and Use Committee at the University approved the experimental protocols (Approved code: HSTU/IRT/36303) with corresponding ethical guidelines for this research. To complete the research the following steps were followed:

Experimental birds and layout

A total of 120 day-old broiler chicks (Cobb 500) were purchased from CP Bangladesh Ltd., Ranirbondor, Dinajpur, Bangladesh. The day-old chicks were reared at a brooder house to adjust to the environment for up to 7 days. After 7 days, chicks were randomly allocated to four dietary treatment groups of 30 chicks each; each treatment was composed of three replications with 10 birds. The first group T1 (control) fed only basal diet without any supplements, whereas the group T2, T3, and T4 were fed basal diet plus 0.5%, 1%, and 2% garlic powder/kg diet, respectively.

Experimental house and equipment

The experimental house was properly cleaned and washed with forced water using a hose pipe. After washing with clean water, the rooms were disinfected with quick lime, and the rooms were kept empty for 15 days. At the same time, all feeders, plastic buckets, waterers, and other necessary equipment were also properly cleaned, washed, and disinfected with bleaching powder solution and Timken® solution, subsequently dried, and left empty for two weeks before chicks arrived. The ceiling, walls, and wire mesh were also thoroughly disinfected by spraying with Virocid® (ACI Animal Health) (4 mL/liter of water).

Experimental diet

Ready pelleted feed procured from the local poultry feed market was used throughout the experimental study. The experimental period was divided into two phases (broiler-starter and broiler-finisher). The broiler chicks were fed broiler starter for 0 and 14 days and broiler finisher for 15 to 28 days of age. Dried garlic (*Allium sativum*) was purchased from a local spice market and the samples were further ground into fine powder in a grinding machine. Different levels of garlic powder were then incorporated into the experimental diets manually at appropriate doses with different treatment groups by cross-mixing. The ingredient composition and estimated nutrient content of the diet are shown in Table 1.

Management practices

During the experiment, the litter was covered with clean newspaper for the first 7 days and removed when the newspaper became soiled. After that, the birds are reared on a floor of 3 cm depth of fresh, clean, and dry rice husk. After the first week, the top of the litter with droppings was removed regularly and stirred three times a week until the end of the experiment. Calcium carbonate was spread on the floor before the use of the litter and the litter was disinfected with Virocid® (ACI Animal Health) solution (3mL/liter of water) twice per week. Litter materials, when found damp for any reason, were removed to prevent the accumulation of ammonia and other harmful gases.

Table 1. Chemical composition of the experimental starter and grower diet fed to broilers

Ingredients	Starter (1-14 days)	Finisher (15-28 days)
Maize (kg)	54	58
Rice polish (kg)	12.5	12.5
Soya meal (kg)	18	13
Wheat bran (kg)	8	9
Fish meal (kg)	3	3
Protein concentrate (kg)	1.5	1.5
Di-calcium phosphate (kg)	1	1
Common Salt (kg)	0.5	0.5
Coccidiostat	-	-
Antibiotic	-	-
Vitamin-mineral premix (kg)	0.5	0.5
Garlic (%)	0-2%	0-2%
Total (kg)	100	100
Chemical composition (calculated)		
Metabolizable Energy (kcal/kg)	3135	3195
Crude protein (%)	21.29	20.18
Fat (%)	5.8	6.4
Crude fiber (%)	4.65	4.2
Calcium (%)	0.93	0.87
Nonphytate Phosphorus (%)	0.47	0.45
Arginine (%)	1.37	1.29
Lysine (%)	1.21	1.07
Methionine (%)	0.57	0.51
Total ash (%)	0.93	0.85

Vitamin-mineral premix (Eskavit DB plus® by SK+F Pharmaceutical Ltd.) each kg contains Vitamin A=6.00 MIU; Vitamin D3=2.00 MIU; Vitamin E=0.75 g; Calcium=237.00 g; Phosphorus=54.00 g; Magnesium=5.00 g; Manganese=1.00 g; Zinc=2.00 gm; Iron=2.00 g; Copper=1.00 gm; Cobalt=0.80 g; Iodin=0.18 g; Selenium=1.00 mg; L-Lysine=1.17 g; Methionine=2.25 g.

The experiment was carried out in the summer (April to May/2019), so only additional heat was provided to brood the chicks when it was necessary by placing a 60-watt electric bulb in the center of the pen about 18 inches above the floor. By gradually increasing and decreasing the height of the bulb following the temperature, the temperature was increased and decreased. The brooding temperature was kept at 37°C for the first week and was gradually reduced by 3°C every week until they were adjusted to the normal environmental temperature and the final temperature was 28°C at the end of the experiment.

The area allotted to each pen was 14 square feet for 10 birds; so, the floor space for each bird was maintained at 1.4 square feet. For each pen of 10 birds, a round feeder and round waterer were installed; feed and drinking space was provided as required according to the number of birds in each replicate. The chicks were fed every three hours on clean newspaper for the first three days, which were then replaced by round feeders. Feeders are cleaned once a week and drinkers are washed daily. All birds in different treatment groups received fresh feed and adlibitum water throughout the trial. Birds were vaccinated against New Castle

disease (ND) and Infectious Bursal diseases (IBD) routinely as described earlier by Sangilimadan *et al.* (2019).

Glucose and vitamin C were given to the chicks immediately after unloading from the chick box to reduce stress during transportation. Water-soluble vitamins and normal saline were also provided for the first 3 days of brooding. Moreover, proper hygienic measures and strict sanitation protocols were followed during the experimental period. The service area of the experimental room, outer walls, and feed storage room were kept clean, and disinfectant (Virocid®) was routinely sprayed at the entrance and around the farm.

Processing of broilers

Following the conclusion of the study, one bird of average pen weight was selected randomly from each replicate for slaughter. Feed was withdrawn from pens 24 hours before slain but the water was still available to facilitate proper bleeding. After slaughter, broilers were allowed to bleed for 2 minutes and then scaled in hot water (55-65°C) for about 120 seconds to loosen the feather of the carcasses. After weighing the birds once again, the shank, viscera, abdominal fat, oil gland, kidney, and giblets were separated from the carcasses. After all the offal is removed, the weight is taken again to measure the dressing percentage and internal contents.

Data collection and analysis

The performance of the experimental birds including initial body weight, feed consumption, live weight gain, feed conversion ratio, survivability and dressing yield were recorded weekly from first day of rearing to the last. Data on different variables were subjected to analysis of variance (ANOVA) in a Completely Randomized Design (CRD). The significant differences between the treatment means were calculated from the analysis of variance (ANOVA) table. All analyses were performed by using "IBM SPSS Statistics 20" Program.

RESULTS

This experiment investigated the feed consumption, live weight gain, feed conversion ratio, survival, and dressing yield as indicators of how broiler chickens responded to various dietary levels of the garlic powder shown in Tables 2-3 and figures 1-4.

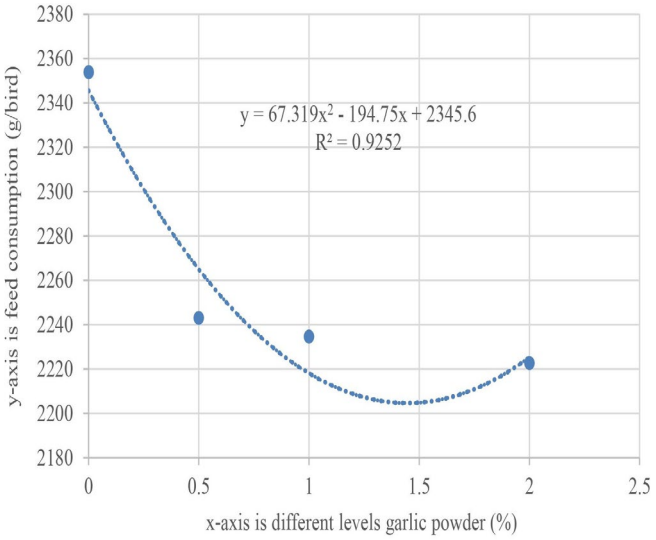

Fig. 1. The polynomial trend line represents the relationship between feed consumption (g/bird) and different levels of dietary garlic powder (%) after 28 days.

Effect on body weight gain

The results showed that there was no significant difference in

Table 2. Effect of garlic powder supplementation on the performance of broiler.

Parameters	T_1	T_2	T_3	T_4	LS
Initial body weight (g/bird)	46.00±0.050	46.00±0.005	46.15±0.050	46.15±0.050	NS
Feed consumption (g/bird)					
1-7 days	27.79±1.76	24.43±1.62	24.31±1.68	23.86±1.62	NS
8-14 days	58.80±2.36	54.92±2.27	54.33±2.29	54.10±2.26	NS
15-21 days	102.57±3.34	98.29±3.31	97.98±3.20	97.48±3.15	NS
22-28 days	147.10±2.60	142.80±2.64	142.61±2.73	142.08±2.66	NS
1-28 days	2353.81±1.28^{b}	2243.07±0.72^{a}	2234.61±0.92^{a}	2222.60±0.94^{a}	*
Weight gain (g/bird)					
1-7 days	92.52±7.02	108.79±8.80	113.63±9.50	108.86±8.89	NS
8-14 days	259.61±15.45^{a}	307.62±17.23^{ab}	326.39±18.36^{b}	308.02±17.47^{ab}	*
15-21 days	600.52±26.69^{a}	676.61±28.38^{ab}	713.39±29.34^{b}	682.56±28.86^{ab}	*
22-28 days	1067.73±33.58^{a}	1172.04±35.39^{b}	1218.63±35.51^{b}	1185.00±35.90^{b}	*
1-28 days	1297.67±0.44^{a}	1415.58±0.36^{b}	1462.58±0.30^{c}	1432.13±0.07^{bc}	*
FCR					
1-7 days	0.92±6.8^{b}	0.68±0.06^{a}	0.64±0.05^{a}	0.66±0.06^{a}	*
8-14 days	1.56±0.016	1.20±0.02	1.29±0.28	1.26±0.02	NS
15-21 days	1.64±0.006^{d}	1.35±0.01^{c}	1.26±0.015^{a}	1.31±0.013^{b}	*
22-28 days	1.76±0.007^{c}	1.52±0.009^{b}	1.45±0.01^{a}	1.47±0.02^{a}	*
1-28 days	1.47±0.00^{b}	1.19±0.003^{a}	1.16±0.06^{a}	1.18±0.008^{a}	*
Survivability (%)					
1-28 days	100±0.000	100±0.000	100±0.000	100±0.000	NS

Where, T1 =0 %; T2 =0.5 %; T3 =1 %; T4 =2 % garlic powder
abcd Means with uncommon in the same row superscripts differ significantly.
* = (P<0.05), NS = (Non-significant), LS = Level of significance.

Table 3. Effect of garlic powder supplementation on the internal organs and dressing yield of broiler at 28 days of age.

Parameters (g)	T_1	T_2	T_3	T_4	LS
Abdominal fat	2.72±0.006[d]	1.72±0.003[c]	1.58±0.003[a]	1.62±0.003[b]	*
Heart	6.46±0.001[a]	7.30±0.01[b]	8.10±0.12[c]	7.50±0.011[b]	*
Liver	38.10±0.06[a]	38.52±0.01[a]	41.21±0.006[d]	39.98±0.006[c]	*
Gizzard	37.47±0.001[a]	37.56±0.01[a]	38.77±0.01[b]	37.80±0.10[a]	*
Dressing yield (%)	57.30±0.06[a]	58.00±0.58[a]	61.24±0.01[c]	59.40±0.06[b]	*

Where, T1 =0 %; T2 =0.5 %; T3 =1 %; T4 =2 % garlic powder
abcd Means with uncommon in the same row superscripts differ significantly.
* = (P<0.05), NS = (Non-significant), LS = Level of significance.

body weight among treatment groups during the first seven days of the experiment. However, broilers fed diets containing 0.5%, 1%, and 2% garlic powder showed a significant increase (P<0.05) in body weight gain at 8-14, 15-21, and 22-28 days of age. The highest body weight gain (1462.58 g) was observed in birds fed a diet containing 1% garlic powder, followed by birds fed diets containing 2% (1432.13 g), 0.5% (1415.58 g), and 0% (1297.67 g) garlic powder during 1 to 28 days of age.

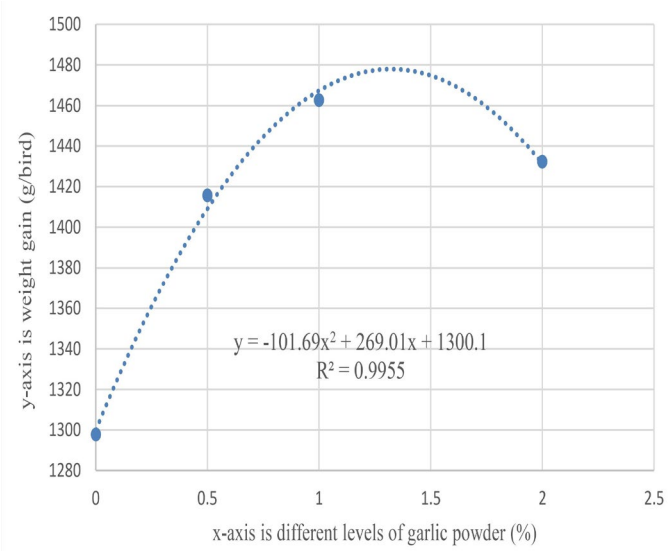

Fig. 2. The polynomial trend line represents the relationship between weight gain (g/bird) and different levels of dietary garlic powder (%) after 28 days.

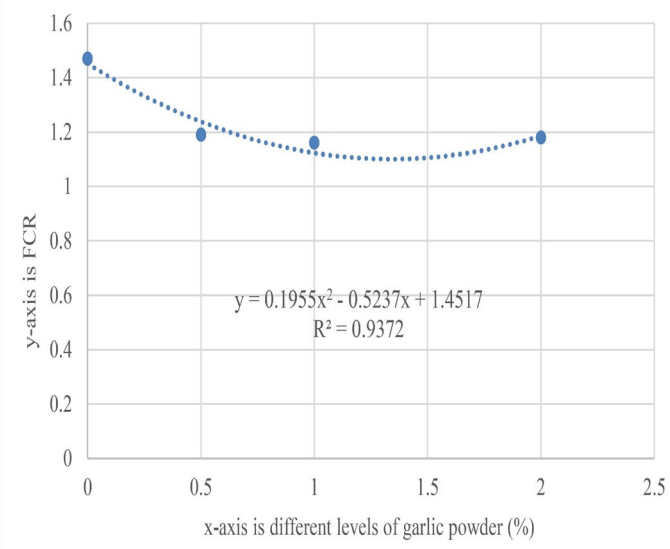

Fig. 3. The polynomial trend line represents the relationship between FCR and different levels of dietary garlic powder (%) after 28 days.

Effect on feed intake

No significant differences (P>0.05) were observed in feed intake at 8-14, 15-21, and 22-28 days of age among treatment groups. However, significant differences (P<0.05) in feed intake were observed during the entire experiment (1-28 days) in broilers fed diets containing 0.5%, 1%, and 2% garlic powder.

Effect on feed conversion ratio

The feed conversion ratio was non-significant (P>0.05) among treatment groups at 8-14 days of age. However, broilers fed diets containing 0.5%, 1%, and 2% garlic powder had a significantly improved feed conversion ratio during 1-7, 15-21, and 22-28 days of age. At the end of the trial (28th days), the best FCR was observed in the group T3 (1.16) followed by T4 (1.18), T2 (1.19), and T1 (1.47), respectively.

Effect on survivability

There were no significant differences (P>0.05) in survivability among broilers fed different dietary treatments throughout the experiment.

Effect on the dressing yield

The present study observed a significant (P<0.05) improvement in dressing yield, with the highest yield found in T3 (61.24%) followed by T4 (59.40%), T2 (58.00%) and the lowest value found in T1 (57.30%).

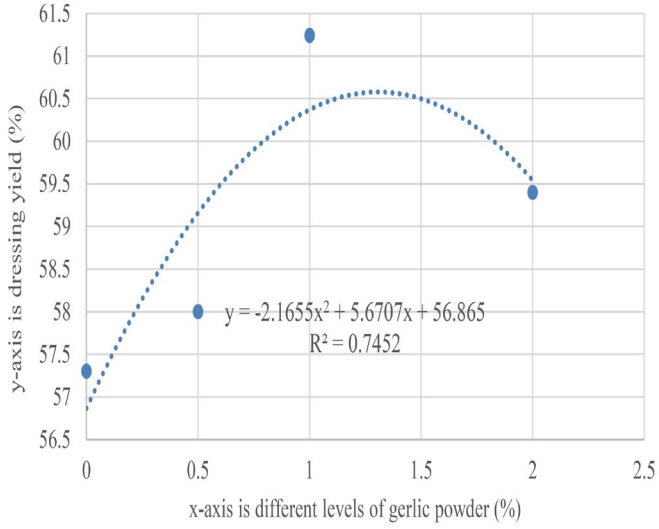

Fig. 4. The polynomial trend line represents the relationship between dressing yield (%) and different levels of dietary garlic powder (%) after 28 days.

Effect on fat content and weight of internal organs

This study showed that fat content of broiler was decreased significantly (P<0.05) by supplementation of garlic powder in

broiler ration. The highest fat content at about 2.72 g was observed in control group (T1) and the lowest about 1.58 g was found at 1% level (T3) of garlic powder. Among different dietary treatments, the internal organs (heart, liver and gizzard) weight were lowest in T2 followed by T1, T4, and T3 respectively.

DISCUSSION

The effect of garlic powder on broiler chick's diet showed that supplementation with 0.5%, 1%, and 2% of garlic powder improved body weight gain and feed conversion ratio, with the highest body weight gain observed in the 1% garlic powder group. These findings are consistent with previous studies (Suriya *et al*., 2012; Elagib *et al*., 2013; Noman *et al*., 2015) that reported similar effects of garlic powder on broiler performance. However, the effect of garlic powder on feed intake was inconsistent across studies, with some reporting significant differences (Karim *et al*., 2017; Mulugeta *et al*., 2019) and others reporting no significant differences (Kairalla *et al*., 2022). Some studies reported improvements in FCR with the inclusion of garlic powder in broiler diets, particularly at levels of 0.5% and above, as seen in Suriya *et al*. (2012); Elagib *et al*. (2013); Mulugeta *et al*. (2019); Kairalla *et al*. (2022). However, the findings of Onibi *et al*. (2009) and Issa and Omar, (2012) contradict the present study, possibly due to variations in the source and quality of garlic, dosage, duration of treatment, and environmental conditions. Survivability was not affected by garlic powder supplementation in this study, consistent with previous studies (Patel *et al*., 2017; Sangilimadan *et al*., 2019).

The significant (P>0.05) effect of garlic powder on broilers rations was in close agreement with the observation of ELTAZI *et al*. (2014); Karim *et al*. (2017) and Sangilimadan *et al*. (2019), who reported that feeding of garlic powder lowers the abdominal fat content and reduce the weight of internal organs (liver, heart, and gizzard). Dieumou *et al*. (2009) reported a significant increase in dressing percentage when using a garlic powder diet with 1% inclusion. On the other hand, Elagib *et al*. (2013) and ELTAZI *et al*. (2014) found that supplementation of garlic at a level of 3% in the basal diet significantly enhanced dressing yield compared to the lower level of garlic powder in the basal diet.

Thus, garlic powder could be a potential feed additive for improving the production and carcass characteristics of broilers. The beneficial effects of garlic powder on broiler growth performance are attributed to its bioactive compounds, such as allicin and alliin, which exhibit antibacterial, antifungal, and immuno-modulatory properties, leading to improved gut health, nutrient absorption, and growth performance (Ziarlarimi *et al*., 2011; Chitra, 2020; Ismail *et al*., 2021).

CONCLUSION

The inclusion of garlic powder in broiler diets has a positive impact on body weight gain, feed conservation ratio, reduction of abdominal fat content, and dressing percentage. The 1% level of garlic powder is the most effective in improving these performance parameters. However, it had no significant effect on feed intake and survivability. Overall, the findings of the present study and previous research suggest that the inclusion of garlic powder in broiler feed at appropriate levels may have beneficial effects on body weight gain. However, further studies are needed to investigate the optimal levels of garlic powder supplementation and its potential effects on other aspects of broiler health and productivity.

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CONFLICT OF INTEREST

The authors declared that there are no conflicts of interest.

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