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# EFFECTS OF DIETARY SUPPLEMENTATION OF GARLIC (*ALLIUM SATIVUM L.*) ON PRODUCTION AND HAEMATOLOGICAL PARAMETERS AND SERUM CHOLESTEROL LEVEL IN THE BROILERS

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**Abstract**

*A study was executed to evaluate the influence of supplementation of garlic powder (GP) on production and hematological parameters and serum cholesterol level in the broilers. In total, 240, day old (Ross 308) broiler chicks were purchased and placed in a completely randomized design to one of five treatment groups with each containing 48 broilers. The treatment groups were replicated thrice with each replicate containing 16 broilers. The experimental rations were formulated by supplementing GP at different concentrations of 1.5, 3.0, 4.5 and 6g per kg to the basal diet. The results revealed significantly higher feed intake and body weight gain and improved feed conversion ratio in the broilers fed either 4.5 or 6g of garlic powder supplemented diets. Regarding hematological analysis, the broilers fed GP supplemented diets (6g) has resulted in significantly increased packed cell volume, improved hemoglobin percentage, higher red and white blood cell, platelet and lymphocyte counts, enhanced mean corpuscular hemoglobin concentration, whereas reduced monocytes and mean corpuscular volume. Serum cholesterol level was reduced significantly in the broilers fed GP supplemented diets compared to control. In short, dietary garlic powder supplementation has resulted in better production performance, higher dressing percentage, improved hematological profile and reduced serum cholesterol level in the broilers.*

**Keywords:** *Garlic powder, Production performance, Dressing percentage, Broilers*

## INTRODUCTION

Poultry industry in Pakistan is growing at a rapid pace from the past few years and emerged as an important sub-segment of livestock sector with an annual turnover of about 750 billion rupees (1). This sector is playing an important role in Pakistan economy by contributing about 1.3% in national Gross Domestic Product (GDP) and providing employment to 1.5 million people (2). Despite better production performance, poultry industry is unable to meet the per capita consumption of the country. There are various factors that affects the poultry production in Pakistan including lack of proper biosecurity, low quality feed with higher mycotoxin levels, poor feed efficiency, power shortage, price fluctuation and health problems (3). Health problems, among these, are of significant importance as disease outbreaks cause significant losses to the industry in terms of production and cost. Various strategies are, therefore, used in order to control the occurrence of these outbreaks in broilers including vaccine and preliminary use of antibiotics (4).

Antibiotics are supplemented as growth promoter in the diet in order to improve feed efficiency and increase the production potential of broilers (5). However, the use of antibiotics for sub-therapeutic purposes is discouraged round the globe due to development of an increased anti-microbial resistance both in humans and animals. Various other substances are, therefore, to replace these antibiotic growth promoters in order to maintain the production performance of broilers. These include probiotics, prebiotics, acidifiers, enzymes and herbal products. Herbal products, among these, are extensively used as growth promoting agents in broiler diets due to their exceptional economic and health benefits. These include lower production cost, minimum health hazards and reduced risk of toxicity (6). These products exert beneficial effects on feed intake (FI), digestive tract secretions and immunity of the broilers (7).

The efficacy of various herbal products, however, varies depending on the concentration of active ingredients and its interaction with feed components. Herbal plants that are used as growth promoters in broiler diets include thyme, garlic, superliv, oregano and quiponin (8). Garlic, among these, is used most commonly as growth promoter in broiler diets. Garlic, scientifically termed as *Allium Sativum*, is an annual herb that is endemic in central Asia. However, due to its exceptional medicinal properties, it is cultivated in almost all continents of the world. The vegetable ranks second in terms of production in the world and is used as spice and flavoring in various types of dishes (9). China is the largest cultivator with an annual production of about 78% of the total garlic produced round the globe.

About 100 varieties of garlic are now being discovered in the world which are morphologically different from each other in terms of number of clove bulbs and size, shape and color of cloves (10). The amount of various nutrients including water, carbohydrates, sulphur, fiber and protein present in the garlic are 65, 28, 4, 1.5 and 2%, respectively. In addition, garlic contain significant concentrations of sweet oils of aromatic nature which improve nutrients digestion and exert positive effects on respiratory system after inhalation through air sacs and lungs of the birds (11). Furthermore, selenium, vitamin C and B6 and organosulfur compounds are present in significant concentrations in the garlic. These organosulfur compounds are responsible for typical aroma and unique medicinal properties of the garlic (12).

Various organosulfur compounds including diallyl sulfides, allicin and alliin are present in the garlic. Allicin, among these, is beneficial in cardiovascular disorders due to its ability to reduce the serum cholesterol, triglycerides and low density lipoprotein levels. This compound reduces the serum cholesterol and triglycerides level by lowering the activities of various lipogenic enzymes including glucose 6 phosphate dehydrogenase, fatty acid synthetase and glutaryl CoA reductase (13). Besides cardiovascular disorders, garlic is beneficial in diabetic, atherosclerotic and hypertensive conditions (14).

In the broilers, garlic improve the feed efficiency by decreasing the intestinal pathogenic microbes population, enhancing the absorption capacity of small intestine and limiting the nutrients loss, ultimately leading to better production performance of broilers. Furthermore, this herbal product improves the intestinal which in turn is responsible for an increased deposition of proteins in the body tissues of the birds (15). There is, however, a lack of uniformity among the results of various studies regarding the influence of supplementation of garlic on different performance parameters broilers. For instance, Fadlalla et al. (16), on one hand, documented significant positive effects by supplementing garlic in broilers diet, whereas Doley et al. (17) found no significant effects of garlic supplementation on production performance of broilers.

A study was executed, therefore, to investigate the influence of various levels of garlic powder (GP) supplementation on production and hematological parameters and serum cholesterol level in the broilers.

# MATERIALS AND METHODS

## EXPERIMENTAL DESIGN

Two hundred and forty, straight run, day old (Ross 308) broiler chicks were procured from a local hatchery, brought to experimental station and weighed initially. After weighing, the broilers were placed into one of five treatment groups with each containing 48 birds on random basis. The treatment groups were replicated thrice of 16 broilers each. Experimental layout was presented in Table 3.1. Corn soy based ration was used as basal diet to which GP was supplemented at various concentrations. Test diets were prepared by supplementing GP at inclusion levels of 1.5, 3, 4.5 and 6g per kg of the ration. All the experimental diets

formulated were isonitrogenous and isocaloric and were in accordance with the strain recommendations. The broilers of all treatment groups were provided with ad libitum supply of feed and water throughout the entire experimental period. The experiment was lasted for 42 days.

## PREPARATION OF GARLIC POWDER

Garlic powder was prepared by initially purchasing fresh garlic from local market and then drying it in oven. The dried garlic was grounded afterwards by using hammer mill.

## FEED INTAKE AND FEED CONVERSION RATIO

Feed intake was determined on weekly basis at d7, 14, 21, 35 and 42 of age by subtracting the amount of feed offered from leftover.

FI = Feed offered - Feed refusal

For determination of feed conversion ratio (FCR), FI was divided by body weight gain.

FCR = FI/BWG

## HEAMATOLOGICAL PARAMETERS

At d 42 of the experiment, 5 birds were selected from each replicate group on random basis, slaughtered and blood sample (5ml) was taken directly from heart. These samples were poured immediately into EDTA coated tubes and transported to laboratory. In the laboratory, these samples were analyzed by using automated analyzer for determination of packed cell volume, red and white blood cell count, hemoglobin concentration and differential white cell count which include monocytes, lymphocytes and basophils.

## SERUM CHOLESTEROL LEVEL

For serum cholesterol determination, five birds were selected, at the end of the experimental period, from each replicate group, slaughtered and blood sample (3ml) was taken from jugular vein by using syringe. After collection, these samples were placed in centrifuge tubes that are not coated by anticoagulant. On arriving in laboratory, these tubes were placed in centrifuge machine for 10 minutes for serum separation. The serum cholesterol level was determined, thereafter, by using specific kit.

## DATA ANALYSIS

Data were analyzed with the help of ANOVA by using SAS software version 9.1.

# RESULTS

## FEED INTAKE

Table I represents the influence of supplementation of various concentrations of GP on FI of the broiler chickens. Higher ($P < 0.05$) FI was observed in the group E offered feed supplemented with GP @ 6.0g/kg followed by group D. Feed intake, however, was significantly lower in group A, without supplementation of garlic powder. The results revealed that the groups A, B and C showed no significant differences ($P > 0.05$) with each other in respect of feed intake.

**Table I.** Effects of dietary supplementation of garlic powder on feed intake of broilers

| Group | Treatment | Feed intake (g) / bird | Mean ± SD |
|---|---|---|---|
| A | *B (Basal diet) | 3693 | 3693.66±26.83[b] |
| B | 1.5 g/kg GP | 3660 | 3660.66±25.54[b] |
| C | 3.0 g/kg GP | 3684 | 3684.33±27.97[b] |
| D | 4.5 g/kg GP | 4070 | 4070.66±26.57[a] |
| E | 6.0 g/kg GP | 4105 | 4105.00±30.04[a] |

Different alphabets (a, b) on mean represent significant differences. Value of each treatment group is the mean of 6 replicates.
GP = Garlic powder

## BODY WEIGHT GAIN

The influence of supplementation of various levels of GP on BWG of the broilers was presented in Table II. The results indicated significantly higher body weight in the group E offered feed supplemented

with GP @ 6.0g/kg followed by group D. The BWG, however, was lowered ($P < 0.05$) in group A which was kept as control group. The data further revealed that the groups A, B and C showed a no significant differences with each other in respect of body weight.

**Table II.** Effects of dietary supplementation of garlic powder on body weight gain of broilers

| Group | Treatment | Body weight (g/bird) | Mean ± SD |
|---|---|---|---|
| A | B (Basal diet) | 1823 | 1823.66±27.61[b] |
| B | 1.5 g/kg GP[2] | 1882 | 1882.00±21.65[b] |
| C | 3.0 g/kg GP | 1919 | 1919.33±24.82[b] |
| D | 4.5 g/kg GP | 2136 | 2136.33±21.00[a] |
| E | 6.0 g/kg GP | 2227 | 2227.66±28.58[a] |

Different alphabets (a, b) on mean represent significant differences. Value of each treatment group is the mean of 6 replicates.
GP = Garlic powder

## FEED CONVERSION RATIO

Data regarding the influence of supplementation of various levels of GP on FCR of broiler chickens were presented in Table III. Feed conversion ratio was improved ($P < 0.05$) in the group E broiler chickens offered feed supplemented with GP @ 6.0g/kg followed by group D. Significantly poor FCR, however, was recorded in group A which was kept as control group. The results showed no significant differences regarding FCR among the broilers included in groups A, B and C.

**Table III.** Effects of dietary supplementation of garlic powder on feed conversion ratio of broilers

| Group | Treatment | Feed conversion ratio | Mean ± SD |
|---|---|---|---|
| A | *B (Basal diet) | 2.02 | 2.02±0.40[a] |
| B | 1.5 g/kg GP | 1.96 | 1.96±0.01[a] |
| C | 3.0 g/kg GP | 1.92 | 1.92±0.03[a] |
| D | 4.5 g/kg GP | 1.89 | 1.89±0.00[b] |
| E | 6.0 g/kg GP | 1.87 | 1.87±0.01[b] |

Different alphabets (a, b) on mean represent significant differences. Value of each treatment group is the mean of 6 replicates.
GP = Garlic powder

## HEAMATIOLOGICAL PARAMETERS

Results regarding the blood parameters of the broilers fed various levels of GP supplemented diets were presented in Table IV. Red and white blood cells and platelets count, PCV, Hb level, erythrocyte sedimentation rate (ESR), lymphocytes and mean corpuscular hemoglobin concentration (MCHC) were significantly increased, whereas monocytes count and mean corpuscular volume (MCV) were decreased ($P < 0.05$) in the broilers of group E offered feed supplemented with GP @ 6.0g/kg followed by group D. Haematological values, however, were reduced significantly in group A broilers which were kept as control. The data further revealed that the groups A, B and C showed no ($P>0.05$) differences with each other regarding haematological parameters in the broilers.

**Table IV.** Effects of dietary supplementation of garlic powder on hematological parameters of broilers

| Parameters | Treatment | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| Hb (g/dl) | 9.70 ± 0.40[b] | 10.20 ± 0.25[b] | 10.70 ± 0.20[b] | 11.30 ± 0.34[a] | 11.90 ± 0.30[a] |
| PCV (%) | 38.20 ± 0.73[b] | 39.50 ± 0.40[b] | 40.30 ± 0.25[b] | 42.00 ± 0.79[a] | 44.20 ± 0.66[a] |
| RBC ($10^6$/µl) | 2.40 ± 0.02[b] | 2.49 ± 0.03[b] | 2.52 ± 0.03[b] | 2.60 ± 0.03[a] | 2.64 ± 0.02[a] |
| WBC ($10^3$/µl) | 79.65 ± 1.43[b] | 80.65 ± 1.15[b] | 83.23 ± 1.30[b] | 82.86 ± 1.24[a] | 85.54 ± 1.25[a] |
| Lymphocytes ($10^6$/µl) | 66.17 ± 1.31[b] | 70.43 ± 1.55[b] | 71.22 ± 1.19[b] | 72.23 ± 1.42[a] | 73.78 ± 1.01[a] |
| Monocytes ($10^6$/µl) | 4.45 ± 0.15[b] | 4.21 ± 0.14[b] | 3.91 ± 0.16[b] | 3.72 ± 0.28[a] | 3.11 ± 0.09[a] |
| Platelets ($10^6$/µl) | 32.96 ± 0.92[b] | 34.44 ± 0.52[b] | 35.75 ±0.58[b] | 37.29 ± 0.70[a] | 39.32 ± 0.60[a] |
| MCV (FL) | 121.4 ± 1.75[b] | 120.5 ±1.78[b] | 115.6 ±1.63[b] | 110.1 ±1.80[a] | 105.3 ±1.40[a] |
| MCH (pg) | 24.39 ± 1.38[b] | 23.35 ± 1.16[b] | 22.32 ± 1.09[b] | 20.00 ± 1.48[a] | 19.18 ± 1.21[a] |
| MCHC (g/dl) | 20.65 ± 1.36[b] | 22.03 ± 1.11[b] | 25.76 ± 1.30[b] | 29.22 ± 1.38[a] | 31.22 ± 1.12[a] |
| ESR (mm) | 2.60 ± 0.06[b] | 2.72 ± 0.02[b] | 2.96 ± 0.04[b] | 3.20 ± 0.04[a] | 3.85 ± 0.03[a] |

Different alphabets (a, b) on means represent significant differences. Value of each treatment group is the mean of 6 replicates.
Hb = Hemoglobin, PCV = Packed cell volume, RBC = Red blood cell, WBC = White blood cell, MCV = Mean corpuscular volume, MCH = Mean corpuscular hemoglobin, MCHC = Mean corpuscular hemoglobin concentration, ESR = Erythrocyte sedimentation rate.
T1 = Control, T2 = Garlic powder 0.06%, T3 = Garlic powder 0.12%, T4 = Garlic powder 0.24%, T5 = Garlic powder 0.48%.

## SERUM CHOLESTEROL LEVEL

Data regarding the influence of dietary supplementation of GP on serum cholesterol level of broilers were presented in Table V. Serum cholesterol level was significantly higher in group E offered feed supplemented with GP @ 6.0g/kg followed by group D and significantly lower cholesterol level was recorded in group A which was kept as control group. The data further revealed that the groups A, B and C showed a no significant differences with each other in respect of cholesterol level.

**Table V.** Effects of dietary supplementation of garlic powder on serum cholesterol level of broilers

| Group | Treatment | Cholesterol level | Mean ± SD |
|---|---|---|---|
| A | *B (Basal diet) | 165.0 (g/dl) | 165.00 ± 2.64[b] |
| B | 1.5 g/kg GP | 152.0 (g/dl) | 152.00 ± 2.00[b] |
| C | 3.0 g/kg GP | 136.0 (g/dl) | 136.00 ± 2.51[b] |
| D | 4.5 g/kg GP | 131.0 (g/dl) | 131.00 ± 2.52[a] |
| E | 6.0 g/kg GP | 127.0 (g/dl) | 127.00 ± 2.64[a] |

Different alphabets (a, b) on mean represent significant differences. Value of each treatment group is the mean of 6 replicates. GP = Garlic powder.

# DISCUSSION

The current findings regarding FI (feed intake) are in agreement with those reported by (18). These authors also observed significantly higher FI in the broilers fed garlic extracts supplemented diets. Similarly, Borgohain et al. (19) found an increased ($P < 0.05$) FI with the supplementation of GP (garlic powder) in the diet of broilers. The higher FI observed in our study and previous research may be associated with an increased activity of intestinal microbiota, stimulated by the allicin, an organosulfur compound found in garlic. This improved activity in the gut promotes the digestion of nutrients, ultimately leading to higher FI in the broilers (20). However, it is worth noting that Khaidem et al. (21) observed non-significant effects of dietary supplementation of GP on FI and feed efficiency in broilers. This discrepancy might be attributed to variations in experimental conditions, dosage, and source of garlic used in the diets.

The present findings regarding BWG (body weight gain) are in accordance with expectations (22, 23). These authors also found significantly higher BWG in the broilers fed a garlic powder supplemented diet. The higher BWG may possibly be due to the presence of various organosulfur and anti-bacterial compounds, including allicin and dialkyl polysulphides in garlic. These compounds inhibit the growth of pathogenic gut microbes and fungi and stimulate the activity of beneficial intestinal microflora, which in turn, improves the utilization of nutrients and ultimately body weight of broilers (6).

The present findings regarding FCR (feed conversion ratio) were in accordance with previous studies in broilers (18, 24, 25). These authors observed significantly improved FCR with the dietary supplementation of GP in broilers. Similarly, Oleforuh-Okoleh et al. (26) found an improved FCR in broilers fed a GP supplemented diet. The major factor associated with the improvement of FCR by dietary supplementation of garlic is its antimicrobial properties, which enhance the absorption of nutrients from the gut. This increased absorption, in turn, has resulted in better FCR in the broilers (27). These results are consistent with those reported by Mohamed et al. (28), who observed significantly improved FCR with the supplementation of GP in the diet of broilers.

The present findings regarding hematological parameters were in line with those reported by Khaidem et al. (21), who observed significantly increased RBC (red blood cell) and white blood cell (WBC) count with the supplementation of 0.75% GP in the diet of broilers. However, in contrast to the current study, these authors did not find any significant effects on Hb (hemoglobin) concentration, PCV (packed cell volume), lymphocyte, and monocyte counts in the broilers. Ari et al. (29) documented significantly higher PCV and Hb concentration in broilers fed GP supplemented diet. These results are consistent with those documented by Ismail et al. (30), who observed significantly higher RBC, WBC, and lymphocyte counts, and increased Hb concentration with the supplementation of GP in the diet of broilers. However, these later authors found no significant effects of dietary supplementation of GP on PCV and WBC count in the broilers. The variations in hematological parameters observed in different studies might be attributed to differences in garlic dosage, supplementation duration, and the overall health status of the birds.

The present findings regarding serum cholesterol level were in accordance with previous studies in broilers (31, 32). These authors found significantly reduced serum cholesterol levels with the supplementation of GP in the diet of broilers. Bamidele and Adejumo (33) similarly reported lowered serum cholesterol levels in broilers fed a GP supplemented diet. The reduced serum cholesterol levels may possibly be due to the fact that garlic stimulates the excretion of bile acids. The inclusion of 0.3% garlic powder in the diet resulted in enhanced broiler performance (34). Moreover, this supplementation was associated with elevated monocyte and lymphocyte levels, as well as increased HDL and decreased LDL levels, indicating improved health status in the birds. Therefore, it can be inferred that the addition of 0.3% garlic powder as a growth promoter not only improves growth performance but also contributes to cost reduction in production by enhancing bird health (34).

Furthermore, garlic exerts inhibitory effects on hepatic cholestrogenic and lipogenic enzymes, such as glutarayl CoA reductase, fatty acid synthetase, and glucose 6 phosphate dehydrogenase, resulting in reduced levels of serum cholesterol in broilers (13).

# CONCLUSION

In conclusion, our findings support previous research indicating the beneficial effects of dietary supplementation of GP in broilers. The supplementation of GP improved feed intake, body weight gain, and feed conversion ratio, which are key performance indicators in broiler production. Additionally, GP supplementation influenced hematological parameters and serum cholesterol levels, potentially contributing to the overall health and well-being of broilers. However, further research is needed to optimize the dosage, duration, and specific mechanisms by which garlic and its bioactive compounds exert their effects on broiler performance and physiological parameters.

By expanding our knowledge on the effects of GP supplementation, we can develop more effective feeding strategies and maximize broiler production efficiency while promoting animal health.

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