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## Influence of dietary garlic powder on growth efficiency, cut-up yields, and meat quality attributes in broilers

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### Abstract

This study evaluated the effects of dietary garlic (*Allium sativum* L.) powder supplementation on weekly growth performance, feed conversion efficiency, carcass traits, proximate chemical composition, and sensory attributes of broiler chickens over a 42-day rearing period. Day-old commercial broiler chicks were randomly allocated into five dietary treatments (T0, T1, T2, T3, and T4) in a Completely Randomized Design, receiving graded levels of garlic powder alongside an unsupplemented control (T0). During the starter phase (weeks 1-3), no significant differences ( $p > 0.05$ ) were observed among groups. However, during the finisher phase (weeks 4-6), treatment T3 achieved significantly higher ( $p < 0.01$ ) weekly body weight gains (621.15, 674.95, and 665.15 g) and superior feed conversion ratios (1.31, 1.59, and 1.62) alongside reduced feed intake compared to the control (T0). Carcass cut-up yields (breast, thigh, drumstick, wing, back, neck) and edible giblet percentages (liver, gizzard, heart) exhibited no significant differences ( $p > 0.05$ ), confirming proportionate allometric growth. Similarly, proximate meat composition (moisture, dry matter, crude protein, crude fat, and total ash) remained stable across all treatments ( $p > 0.05$ ). Sensory evaluation using a 9-point Hedonic scale revealed significant improvements ( $p < 0.05$ ) in texture, juiciness, and overall consumer acceptability in supplemented groups, with T4 and T2 recording the highest scores without affecting natural meat colour or flavour. In conclusion, dietary garlic powder supplementation, optimally at T3 for growth efficiency and T4 for sensory appeal, serves as an effective, non-residual phytogetic feed additive in broiler production.

**Keywords:** Broiler, Garlic powder, Growth performance, Feed conversion ratio, Carcass traits, Meat quality, Phytogetic feed additive

### 1. Introduction

Poultry production is one of the fastest-growing sectors of animal agriculture and plays an important role in meeting the increasing demand for affordable, high-quality animal protein. The expansion of poultry production has been driven by population growth, urbanization, increasing purchasing power and changing dietary preferences (Mottet and Tempio, 2017; FAO, 2025) [13, 17]. Broiler chickens are particularly important because of their rapid growth rate, short production cycle and efficient utilization of dietary nutrients. However, intensive broiler production and genetic selection for rapid growth can increase the susceptibility of birds to metabolic, environmental and oxidative stresses, which may adversely affect intestinal health, nutrient utilization, growth performance and meat quality (Sugiharto, 2016; El-Saadony *et al.*, 2024) [12, 27].

Historically, antibiotic growth promoters (AGPs) were widely incorporated into poultry diets to improve growth performance and feed efficiency. Their beneficial effects were primarily associated with suppression of undesirable intestinal microorganisms and improvement of the overall gastrointestinal environment (Castanon, 2007) [8]. However, prolonged and extensive use of antibiotics in animal production has raised serious concerns regarding antimicrobial resistance, alteration of intestinal microbial populations and potential risks to food safety and public health (Abd El-Hack *et al.*, 2025) [3]. These concerns have stimulated increasing research interest in natural and sustainable alternatives to antibiotic growth promoters. Among the available alternatives, phytogetic feed additives have attracted considerable attention because

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of their diverse biological activities and potential to support animal health and productivity (Puvača *et al.*, 2013; Valenzuela-Grijalva *et al.*, 2017) <sup>[23, 28]</sup>.

Phytogenic feed additives comprise plant-derived materials such as herbs, spices, essential oils and plant extracts containing a wide variety of biologically active secondary metabolites. Their potential beneficial effects in poultry include antimicrobial, antioxidant, digestive-stimulatory, immunomodulatory and metabolic activities. The use of such natural feed additives has therefore gained importance in modern poultry nutrition, particularly in the context of reducing reliance on conventional antibiotic growth promoters. Among the different phytogenic materials evaluated in poultry diets, garlic (*Allium sativum* L.) has received considerable scientific attention because of its rich phytochemical composition and multiple biological properties (Shang *et al.*, 2019) <sup>[26]</sup>.

Garlic (*Allium sativum* L.) is an important culinary and medicinal plant belonging to the family Amaryllidaceae. The bulb contains several biologically active organosulfur compounds, including alliin, allicin, ajoene, diallyl disulfide, diallyl trisulfide and S-allylcysteine, along with phenolic compounds and flavonoids (Amagase, 2006; Shang *et al.*, 2019) <sup>[4, 26]</sup>. The characteristic biological activity of garlic is largely associated with its organosulfur compounds. When garlic tissue is mechanically disrupted, the enzyme alliinase converts alliin into allicin, a highly reactive sulfur-containing compound that contributes substantially to the antimicrobial and biological activity of garlic (Borlinghaus *et al.*, 2014) <sup>[7]</sup>.

The biological properties of garlic provide several possible mechanisms through which it may influence poultry performance. Garlic-derived compounds have demonstrated antimicrobial activity against a range of microorganisms and may help regulate the gastrointestinal microbial environment (Ankri and Mirelman, 1999) <sup>[5]</sup>. Garlic and its bioactive constituents may also stimulate digestive processes and influence the activity of digestive enzymes, potentially contributing to improved nutrient digestion and utilization (Platel and Srinivasan, 2004) <sup>[21]</sup>. In addition, the antioxidant properties of garlic may contribute to protection against oxidative stress by influencing endogenous antioxidant defence mechanisms such as superoxide dismutase, catalase and glutathione peroxidase (El-Saadony, 2024) <sup>[12]</sup>. These combined properties make garlic a promising phytogenic feed additive for improving the productive efficiency and physiological status of broiler chickens.

Growth performance and feed efficiency are among the most important indicators used to assess the nutritional and economic value of a feed additive in broiler production. Dietary garlic supplementation has been investigated for its potential effects on body weight gain, feed intake and feed conversion efficiency. Previous studies have reported improvements in broiler performance following garlic supplementation, although the magnitude of response has varied according to inclusion level, duration of feeding, basal diet and experimental conditions (Puvača *et al.*, 2013) <sup>[23]</sup>. Garlic supplementation may improve feed utilization through a combination of antimicrobial, digestive-stimulatory and antioxidant effects, thereby supporting efficient nutrient utilization and tissue growth.

The effect of garlic supplementation may also extend beyond growth performance to carcass characteristics and meat quality. Carcass yield and the distribution of commercially important cuts are economically important traits in broiler production. Dietary phytogenic additives have been reported to influence

carcass characteristics and meat quality through their effects on nutrient metabolism, antioxidant status and nutrient partitioning (Demir *et al.*, 2003; Lewis *et al.*, 2003; Orłowski *et al.*, 2018) <sup>[11, 16, 20]</sup>. Garlic supplementation has therefore been investigated as a potential nutritional strategy for improving carcass yield and maintaining desirable meat-quality characteristics.

The proximate composition of broiler meat is another important consideration when evaluating dietary interventions. Moisture, dry matter, crude protein, crude fat and ash determine the nutritional composition and overall quality of poultry meat. Dietary supplementation with phytogenic additives may influence nutrient deposition and lipid metabolism, potentially affecting the chemical composition of muscle tissue (Orłowski *et al.*, 2018) <sup>[20]</sup>. Garlic, in particular, has been associated with alterations in lipid metabolism, including effects on cholesterol and fatty acid biosynthesis (Qureshi *et al.*, 1983; Chowdhury *et al.*, 2002) <sup>[10, 24]</sup>. Consequently, determination of the proximate composition of meat provides useful information regarding whether dietary garlic supplementation influences the nutritional characteristics of the final poultry product.

Meat quality is not determined solely by chemical composition and carcass yield; sensory characteristics are also important for consumer acceptance. Attributes such as colour, flavour, tenderness, texture, juiciness and overall acceptability determine the eating quality of poultry meat. The antioxidant properties of garlic may help protect meat against oxidative deterioration, while its phytochemical constituents may influence certain organoleptic characteristics (Onibi *et al.*, 2009) <sup>[19]</sup>. Previous investigations have reported that dietary garlic supplementation can influence meat quality and sensory characteristics, although responses may depend on the level and duration of supplementation (Onibi *et al.*, 2009; Orłowski *et al.*, 2018; Puvača *et al.*, 2013) <sup>[19, 20, 23]</sup>.

Despite the considerable research conducted on garlic as a phytogenic feed additive, the reported effects on broiler performance and meat quality are not completely consistent. Differences in garlic variety, processing method, dietary inclusion level, basal diet, broiler strain, environmental conditions and experimental duration may contribute to variation among studies. Furthermore, many studies have focused on individual response variables, whereas simultaneous assessment of growth performance, feed conversion efficiency, proximate meat composition, carcass characteristics and sensory quality provides a more comprehensive evaluation of the practical usefulness of garlic powder in broiler nutrition.

Therefore, further controlled studies are warranted to evaluate the effects of dietary garlic powder supplementation across different aspects of broiler production and product quality. The present study was undertaken to investigate the effect of supplementation of garlic (*Allium sativum*) powder on growth performance and carcass quality of broilers, with particular emphasis on weekly growth performance, feed conversion efficiency, proximate chemical composition of meat, carcass and commercial cut-up characteristics, edible organ yields and sensory attributes.

## 2. Materials and Methods

### 2.1 Experimental Design, Birds, and Diets

A 42-day feeding trial was conducted using day-old commercial broiler chicks (*Gallus domesticus*) randomly allocated to five dietary treatment groups ( $T_0$ ,  $T_1$ ,  $T_2$ ,  $T_3$ , and  $T_4$ ) under a Completely Randomized Design (CRD) with uniform

brooding, deep-litter housing, and standard vaccination management.

Clean, shade- and oven-dried (50°C) garlic (*Allium sativum* L.) bulbs were ground (1.0 mm sieve) and incorporated into standard isocaloric and isonitrogenous starter (0-3 weeks) and finisher (4-6 weeks) basal mash diets:

- $T_0$  (Control): Basal diet without garlic powder.
- $T_1$  to  $T_4$ : Basal diet supplemented with graded levels of garlic powder.

Feed and potable water were provided *ad libitum* throughout the 6-week experimental period.

## 2.2 Growth Performance and Feed Efficiency

Individual live body weight and pen feed intake were recorded weekly (weeks 1 to 6) in the morning before feeding. Body weight gain (BWG), feed intake (FI), and Feed Conversion Ratio (FCR) were calculated weekly as:

$$\text{BWG (g)} = \text{Final Weight} - \text{Initial Weight}$$

$$\text{FCR} = \frac{\text{Feed Intake (g)}}{\text{Body Weight Gain (g)}}$$

## 2.3 Carcass Traits and Commercial Cut-Up Yields

At 42 days of age, representative birds per treatment were fasted for 12 hours (with free water access), weighed to record pre-slaughter live weight, and humanely sacrificed via standard halal/kosher exsanguination. Following scalding (58°C for 90 s), defeathering, and evisceration, carcasses were portioned into commercial cuts (breast, thigh, drumstick, wing, back, neck) and edible giblets (liver, heart, cleaned gizzard). All yields were recorded on a precision balance and expressed as a percentage of pre-slaughter live weight:

$$\text{Yield (\%)} = \left( \frac{\text{Weight of Cut or Organ (g)}}{\text{Pre-slaughter Live Body Weight (g)}} \right) \times 100$$

## 2.4 Proximate Chemical Composition of Meat

Homogenized, skinless breast and thigh muscle samples were analyzed in triplicate following standard AOAC (2016) procedures:

- Moisture & Dry Matter (DM): Gravimetrically by oven-drying at 105°C to constant weight (AOAC 930.15);  $\text{DM (\%)} = 100 - \text{Moisture (\%)}$ .
- Crude Protein (CP): Micro-Kjeldahl method ( $\text{N} \times 6.25$ ) (AOAC 984.13).
- Crude Fat (Ether Extract): Soxhlet extraction using petroleum ether (AOAC 920.39).
- Total Ash: Muffle furnace incineration at 550°C for 4-6 h (AOAC 942.05).

## 2.5 Sensory and Organoleptic Evaluation

Cooked, unseasoned breast meat samples ( $2 \times 2 \times 2$  cm, steam-cooked to an internal core temperature of 75°C with 1.5% NaCl) were evaluated by a semi-trained panel. Coded samples were served warm under uniform testing conditions. Attributes including Colour, Flavour, Texture, Juiciness, and Overall Acceptability were scored using a standard 9-point Hedonic Scale (1 = Dislike extremely, 9 = Like extremely).

## 2.6 Statistical Analysis

All data were subjected to One-way Analysis of Variance (ANOVA) for a Completely Randomized Design (CRD). Significant differences between treatment means were separated using the Critical Difference (CD) / Least Significant Difference (LSD) test at  $p < 0.01$  and  $p < 0.05$ . Results are presented as Treatment Means, Standard Error of the Mean [SE(m)  $\pm$ ], and CD values.

## 3. Results and discussion

### 3.1 Growth Performance and Feed Conversion Efficiency

The average weekly body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR) of commercial broilers under different dietary treatments over the 6-week experimental period are presented in Table 1.

**Table 1:** Growth performance and feed efficiency of broilers (Weeks 1 to 6)

| Parameter                   | T0                   | T1                   | T2                   | T3                   | T4                   | SE(m) $\pm$ | CD ( $P < 0.01$ ) |
|-----------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-------------|-------------------|
| Body Weight Gain (g)        |                      |                      |                      |                      |                      |             |                   |
| 1st Week                    | 128.57               | 129.94               | 131.15               | 130.82               | 127.30               | 1.34        | NS                |
| 2nd Week                    | 315.10               | 289.68               | 307.48               | 292.34               | 292.45               | 7.26        | NS                |
| 3rd Week                    | 478.35               | 493.47               | 479.20               | 487.83               | 497.88               | 7.97        | NS                |
| 4th Week                    | 547.91 <sup>a</sup>  | 550.21 <sup>a</sup>  | 558.26 <sup>a</sup>  | 621.15 <sup>b</sup>  | 607.51 <sup>a</sup>  | 21.42       | 60.14             |
| 5th Week                    | 569.15 <sup>a</sup>  | 572.20 <sup>a</sup>  | 567.95 <sup>a</sup>  | 674.95 <sup>b</sup>  | 627.65 <sup>a</sup>  | 27.81       | 78.08             |
| 6th Week                    | 544.20 <sup>a</sup>  | 561.05 <sup>a</sup>  | 551.35 <sup>a</sup>  | 665.15 <sup>b</sup>  | 602.65 <sup>a</sup>  | 31.37       | 88.08             |
| Feed Intake (g)             |                      |                      |                      |                      |                      |             |                   |
| 1st Week                    | 122.27               | 121.06               | 121.97               | 120.90               | 121.00               | 2.53        | NS                |
| 2nd Week                    | 300.58               | 298.71               | 298.35               | 286.10               | 291.63               | 4.45        | NS                |
| 3rd Week                    | 543.61               | 539.98               | 534.14               | 515.55               | 531.76               | 12.92       | NS                |
| 4th Week                    | 825.65 <sup>c</sup>  | 802.95 <sup>b</sup>  | 796.93 <sup>a</sup>  | 792.84 <sup>a</sup>  | 796.18 <sup>a</sup>  | 3.55        | 9.96              |
| 5th Week                    | 1030.00 <sup>b</sup> | 1018.75 <sup>b</sup> | 1007.00 <sup>a</sup> | 996.80 <sup>a</sup>  | 1000.10 <sup>a</sup> | 6.66        | 18.69             |
| 6th Week                    | 1042.45 <sup>b</sup> | 1037.55 <sup>b</sup> | 1016.70 <sup>a</sup> | 1003.60 <sup>a</sup> | 1014.20 <sup>a</sup> | 8.11        | 22.76             |
| Feed Conversion Ratio (FCR) |                      |                      |                      |                      |                      |             |                   |
| 1st Week                    | 0.92                 | 0.92                 | 0.89                 | 0.91                 | 0.91                 | 0.01        | NS                |
| 2nd Week                    | 1.03                 | 1.04                 | 1.01                 | 1.01                 | 1.02                 | 0.02        | NS                |
| 3rd Week                    | 1.15                 | 1.15                 | 1.12                 | 1.06                 | 1.11                 | 0.03        | NS                |
| 4th Week                    | 1.57 <sup>c</sup>    | 1.52 <sup>b</sup>    | 1.52 <sup>b</sup>    | 1.31 <sup>a</sup>    | 1.34 <sup>ab</sup>   | 0.07        | 0.18              |
| 5th Week                    | 1.97 <sup>c</sup>    | 1.91 <sup>b</sup>    | 1.86 <sup>b</sup>    | 1.59 <sup>a</sup>    | 1.68 <sup>a</sup>    | 0.09        | 0.25              |
| 6th Week                    | 2.02 <sup>b</sup>    | 2.01 <sup>b</sup>    | 1.90 <sup>a</sup>    | 1.62 <sup>a</sup>    | 1.80 <sup>a</sup>    | 0.10        | 0.29              |

- NS: Non-Significant ( $p > 0.05$ )

- Means bearing different superscripts (a, b, c) within the same row differ significantly ( $p < 0.01$ )

During the starter phase (Weeks 1 to 3), dietary supplementation of garlic powder exerted no statistically significant effect ( $p > 0.05$ ) on weekly body weight gain, feed intake, or feed conversion ratio among the experimental groups. This initial lack of differentiation is consistent with findings reported by Sugiharto (2016) [27] and Windisch *et al.* (2008) [29], who noted that the immature gastrointestinal tract of young chicks relies primarily on highly digestible nutrients in basal prestarter/starter rations, rendering phytobiotic stimulation less pronounced during early brooding.

In contrast, a highly significant treatment effect ( $p < 0.01$ ) emerged during the finisher phase (Weeks 4 to 6). Treatment group  $T_3$  consistently recorded the highest weekly body weight gain during the 4th (621.15 g), 5th (674.95 g), and 6th (665.15 g) weeks, differing significantly from the control group  $T_0$  (547.91 g, 569.15 g, and 544.20 g) and all other treatments. Concurrently, feed intake during weeks 5 and 6 was significantly lower ( $p < 0.01$ ) in garlic-supplemented groups ( $T_2, T_3$ , and  $T_4$ ) compared to the unsupplemented control ( $T_0$ ), with  $T_3$  exhibiting the lowest intake (996.80 g and 1003.60 g). Consequently,  $T_3$  achieved the most efficient (lowest) FCR across weeks 4 (1.31), 5 (1.59), and 6 (1.62), whereas  $T_0$  exhibited the poorest conversion efficiency (1.57, 1.97, and 2.02).

The substantial improvement in growth performance and feed efficiency observed in group  $T_3$  can be attributed to the multifunctional properties of garlic's bioactive organosulfur constituents, principally allicin (Borlinghaus *et al.*, 2014) [7]. Allicin enhances the secretion of endogenous digestive

enzymes including pancreatic amylase, lipase, trypsin, and intestinal disaccharidases thereby improving the hydrolysis and absorption of dietary nutrients (Platel & Srinivasan, 2004) [21]. Furthermore, garlic exhibits potent broad-spectrum antibacterial activity against enteric pathogens (such as *Escherichia coli* and *Clostridium perfringens*) while preserving beneficial *Lactobacillus* populations, thereby promoting greater villus height, improved mucosal architecture, and enhanced intestinal absorptive surface area (Ankri & Mirelman, 1999; Abd El-Ghany *et al.*, 2024; Yitbarek *et al.*, 2015) [2, 5, 30]. Similar improvements in finisher body weight gain and feed conversion efficiency resulting from dietary garlic powder have been documented by Issa & Abo Omar (2012), Puvāča *et al.* (2013), and Abd El-Ghany *et al.* (2024) [2, 15, 23].

Khiredkar *et al.* (2026) [23] reported that dietary garlic powder supplementation improved growth performance and feed efficiency in broiler chickens. Supplementation with 1.5% garlic powder resulted in the highest final body weight, greater body weight gain, lower feed intake, and improved feed conversion ratio. The authors suggested that these beneficial effects may be associated with improved nutrient utilization, gut health, and metabolic efficiency. The study concluded that garlic powder at 1.5% could serve as a promising natural phyto-genic feed additive for improving broiler productivity.

### 3.2 Carcass Traits, Cut-Up Yields, and Edible Organs

The relative yields of commercial cut-up parts and edible giblets, expressed as a percentage of pre-slaughter live body weight, are summarized in Table 2.

**Table 2:** Carcass traits, cut-up yields, and edible organ weights (% of live weight)

| Parameter (% of Live Wt.) | T0    | T1    | T2    | T3    | T4    | SE(m) ± | CD (P > 0.05) |
|---------------------------|-------|-------|-------|-------|-------|---------|---------------|
| Commercial Cut Yields     |       |       |       |       |       |         |               |
| Breast                    | 20.61 | 20.55 | 20.84 | 21.18 | 21.20 | 0.25    | NS            |
| Thigh                     | 18.80 | 19.00 | 19.11 | 19.04 | 19.08 | 0.25    | NS            |
| Back                      | 15.92 | 15.86 | 15.84 | 16.02 | 15.88 | 0.41    | NS            |
| Drumstick                 | 10.13 | 10.19 | 10.27 | 10.11 | 10.07 | 0.07    | NS            |
| Wing                      | 8.78  | 8.93  | 9.00  | 9.24  | 9.07  | 0.40    | NS            |
| Neck                      | 3.77  | 3.71  | 3.79  | 3.75  | 3.84  | 0.06    | NS            |
| Giblet Yields             |       |       |       |       |       |         |               |
| Liver                     | 3.52  | 3.54  | 3.62  | 3.61  | 3.60  | 0.09    | NS            |
| Gizzard                   | 1.77  | 1.76  | 1.76  | 1.69  | 1.73  | 0.05    | NS            |
| Heart                     | 0.54  | 0.44  | 0.54  | 0.58  | 0.48  | 0.06    | NS            |

NS: Non-Significant ( $p > 0.05$ )

Statistical analysis revealed no significant differences ( $p > 0.05$ ) among dietary treatments for any commercial cut proportions or edible offal yields. Breast yield ranged between 20.55% ( $T_1$ ) and 21.20% ( $T_4$ ), thigh yield between 18.80% ( $T_0$ ) and 19.11% ( $T_2$ ), and drumstick yield between 10.07% ( $T_4$ ) and 10.27% ( $T_2$ ). Proportions of back (15.84% to 16.02%), wings (8.78% to 9.24%), and neck (3.71% to 3.84%) also remained uniform across groups. Similarly, giblet yields comprising liver (3.52% to 3.62%), gizzard (1.69% to 1.77%), and heart (0.44% to 0.58%) showed no statistical variation ( $p > 0.05$ ).

The lack of significant variation in relative cut percentages indicates that dietary garlic powder stimulated proportionate allometric body growth. Because birds in the supplemented groups (specifically  $T_3$ ) achieved higher absolute live body

weights, the absolute yield (g) of prime commercial cuts scaled up proportionally without inducing anatomical imbalances (Demir *et al.*, 2003; Lewis *et al.*, 2003) [11, 16]. Furthermore, the stable liver and heart percentages confirm that garlic supplementation at the tested dosages did not cause visceral hypertrophy, hepatic lipid overload, or physiological toxicity (Saghi *et al.*, 2022; Puvāča *et al.*, 2023) [22, 25]. These observations agree with Onibi *et al.* (2009) [19] and Orlowski *et al.* (2018) [20], who demonstrated that phyto-genic feed additives support overall carcass development while maintaining consistent cut-up yields.

### 3.3 Proximate Chemical Composition of Meat

The proximate chemical composition of broiler meat under different dietary treatments is presented in Table 3.

**Table 3:** Proximate chemical composition (%) of broiler meat

| Parameter (%) | T0    | T1    | T2    | T3    | T4    | SE(m) ± | CD (P > 0.05) |
|---------------|-------|-------|-------|-------|-------|---------|---------------|
| Moisture      | 71.65 | 70.50 | 71.75 | 69.50 | 72.50 | 0.94    | NS            |
| Dry Matter    | 26.85 | 26.00 | 26.25 | 27.38 | 27.25 | 0.80    | NS            |
| Crude Protein | 18.00 | 18.89 | 17.90 | 17.50 | 17.00 | 0.64    | NS            |
| Crude Fat     | 3.08  | 3.13  | 3.03  | 3.05  | 3.00  | 0.15    | NS            |
| Ash           | 0.98  | 1.02  | 1.05  | 1.05  | 1.03  | 0.03    | NS            |

NS: Non-Significant ( $p > 0.05$ ).

No statistically significant variations ( $p > 0.05$ ) were observed across dietary treatments for moisture (69.50% to 72.50%), dry matter (26.00% to 27.38%), crude protein (17.00% to 18.89%), crude fat (3.00% to 3.13%), or total ash (0.98% to 1.05%). All proximate values remained within normal physiological ranges for commercial broiler meat.

These findings indicate that dietary garlic powder supplementation did not alter the fundamental nutritional composition of the meat. The stability in crude protein and lipid concentrations indicates that the superior live weight gain achieved in group  $T_3$  represented true skeletal muscle protein accretion rather than excessive fluid retention or intramuscular adipose deposition (Orlowski *et al.*, 2018) [20]. Garlic's

organosulfur compounds are known to inhibit key hepatic lipogenic enzymes, such as 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase, acetyl-CoA carboxylase, and fatty acid synthase, which suppresses excessive visceral lipid accumulation while maintaining normal cellular lipid architecture (Qureshi *et al.*, 1983; Chowdhury *et al.*, 2002) [10, 24]. These results are in accordance with the findings of Choi *et al.* (2010) and Valenzuela-Grijalva *et al.* (2017) [28], who reported that dietary phytochemicals do not adversely modify the proximate chemical composition of broiler muscle.

### 3.4 Sensory and Organoleptic Characteristics

The sensory evaluation scores of cooked broiler meat evaluated on a standard 9-point Hedonic scale are presented in Table 4.

**Table 4:** Sensory evaluation and organoleptic profile of broiler meat

| Parameter             | T0                | T1                | T2                | T3                | T4                | Mean | CD ( $p < 0.05$ ) |
|-----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|-------------------|
| Colour                | 7.50              | 7.38              | 7.37              | 7.45              | 7.67              | 7.48 | NS                |
| Flavour               | 7.39              | 7.33              | 7.28              | 7.26              | 7.30              | 7.31 | NS                |
| Texture               | 7.39 <sup>a</sup> | 7.70 <sup>b</sup> | 8.01 <sup>c</sup> | 7.48 <sup>a</sup> | 7.97 <sup>c</sup> | 7.71 | 0.12              |
| Juiciness             | 7.14 <sup>a</sup> | 7.57 <sup>c</sup> | 7.76 <sup>c</sup> | 7.43 <sup>b</sup> | 8.25 <sup>d</sup> | 7.63 | 0.12              |
| Overall Acceptability | 7.39 <sup>a</sup> | 7.78 <sup>b</sup> | 8.14 <sup>c</sup> | 7.68 <sup>b</sup> | 8.24 <sup>c</sup> | 7.85 | 0.23              |

NS: Non-Significant ( $p > 0.05$ ). Means bearing different superscripts (a, b, c, d) within the same row differ significantly ( $P < 0.05$ )

Sensory analysis revealed no significant differences ( $p > 0.05$ ) among treatments for colour (scores ranging from 7.37 to 7.67) and flavour (scores ranging from 7.26 to 7.39). This indicates that dietary garlic powder did not impart an undesirable odor, pungent aftertaste, or visual discoloration to the cooked meat product, preserving standard consumer appeal.

However, dietary supplementation had a significant positive effect ( $p < 0.05$ ) on texture, juiciness, and overall acceptability. Meat from groups  $T_2$  (8.01) and  $T_4$  (7.97) exhibited significantly superior texture (tenderness) scores compared to the control group  $T_0$  (7.39) and  $T_3$  (7.48). Meat from group  $T_4$  recorded the highest juiciness score (8.25), differing significantly ( $p < 0.05$ ) from all other treatments. Consequently, overall acceptability was significantly higher in  $T_4$  (8.24) and  $T_2$  (8.14) relative to  $T_0$  (7.39), with all garlic-supplemented groups ( $T_1$ - $T_4$ ) receiving superior scores over the

control.

The improvements in meat tenderness, juiciness, and consumer acceptability can be linked to the antioxidant protection provided by the phenolic compounds and organosulfur molecules in garlic (El-Saadony, 2024; Shang *et al.*, 2019) [12, 26]. During post-mortem storage and thermal preparation, free-radical-mediated lipid oxidation compromises cell membrane integrity, leading to drip loss, moisture release, and myofibrillar toughening (El-Saadony *et al.*, 2024) [12]. Garlic's antioxidant properties help mitigate post-mortem lipid peroxidation, improving water-holding capacity (WHC) and retaining bound intracellular moisture, which enhances meat tenderness and juiciness (Onibi *et al.*, 2009; Orlowski *et al.*, 2018) [19, 20]. These findings are consistent with Puvāča *et al.* (2023) [22], who reported elevated sensory acceptance and improved eating quality in meat from broilers fed phytochemical supplements.

**Table 1:** Growth performance and feed efficiency of broilers (Finisher Phase & Overall)

| Parameter            | T0                  | T1                  | T2                  | T3                  | T4                  | SE(m) ± | CD ( $p < 0.01$ ) |
|----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------|-------------------|
| Body Weight Gain (g) |                     |                     |                     |                     |                     |         |                   |
| 1st Week             | 128.57              | 129.94              | 131.15              | 130.82              | 127.30              | 1.34    | NS                |
| 2nd Week             | 315.10              | 289.68              | 307.48              | 292.34              | 292.45              | 7.26    | NS                |
| 3rd Week             | 478.35              | 493.47              | 479.20              | 487.83              | 497.88              | 7.97    | NS                |
| 4th Week             | 547.91 <sup>a</sup> | 550.21 <sup>a</sup> | 558.26 <sup>a</sup> | 621.15 <sup>b</sup> | 607.51 <sup>a</sup> | 21.42   | 60.14             |
| 5th Week             | 569.15 <sup>a</sup> | 572.20 <sup>a</sup> | 567.95 <sup>a</sup> | 674.95 <sup>b</sup> | 627.65 <sup>a</sup> | 27.81   | 78.08             |
| 6th Week             | 544.20 <sup>a</sup> | 561.05 <sup>a</sup> | 551.35 <sup>a</sup> | 665.15 <sup>b</sup> | 602.65 <sup>a</sup> | 31.37   | 88.08             |
| Feed Intake (g)      |                     |                     |                     |                     |                     |         |                   |
| 1st Week             | 122.27              | 121.06              | 121.97              | 120.90              | 121.00              | 2.53    | NS                |
| 2nd Week             | 300.58              | 298.71              | 298.35              | 286.10              | 291.63              | 4.45    | NS                |
| 3rd Week             | 543.61              | 539.98              | 534.14              | 515.55              | 531.76              | 12.92   | NS                |
| 4th Week             | 825.65 <sup>c</sup> | 802.95 <sup>b</sup> | 796.93 <sup>a</sup> | 792.84 <sup>a</sup> | 796.18 <sup>a</sup> | 3.55    | 9.96              |

|                             |                      |                      |                      |                      |                      |      |       |
|-----------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|------|-------|
| 5th Week                    | 1030.00 <sup>b</sup> | 1018.75 <sup>b</sup> | 1007.00 <sup>a</sup> | 996.80 <sup>a</sup>  | 1000.10 <sup>a</sup> | 6.66 | 18.69 |
| 6th Week                    | 1042.45 <sup>b</sup> | 1037.55 <sup>b</sup> | 1016.70 <sup>a</sup> | 1003.60 <sup>a</sup> | 1014.20 <sup>a</sup> | 8.11 | 22.76 |
| Feed Conversion Ratio (FCR) |                      |                      |                      |                      |                      |      |       |
| 1st Week                    | 0.92                 | 0.92                 | 0.89                 | 0.91                 | 0.91                 | 0.01 | NS    |
| 2nd Week                    | 1.03                 | 1.04                 | 1.01                 | 1.01                 | 1.02                 | 0.02 | NS    |
| 3rd Week                    | 1.15                 | 1.15                 | 1.12                 | 1.06                 | 1.11                 | 0.03 | NS    |
| 4th Week                    | 1.57 <sup>c</sup>    | 1.52 <sup>b</sup>    | 1.52 <sup>b</sup>    | 1.31 <sup>a</sup>    | 1.34 <sup>ab</sup>   | 0.07 | 0.18  |
| 5th Week                    | 1.97 <sup>c</sup>    | 1.91 <sup>b</sup>    | 1.86 <sup>b</sup>    | 1.59 <sup>a</sup>    | 1.68 <sup>a</sup>    | 0.09 | 0.25  |
| 6th Week                    | 2.02 <sup>b</sup>    | 2.01 <sup>b</sup>    | 1.90 <sup>a</sup>    | 1.62 <sup>a</sup>    | 1.80 <sup>a</sup>    | 0.10 | 0.29  |

**Table 2:** Carcass traits, cut-up yields, and edible organ weights (% of live weight)

| Parameter (% of Live Wt.) | T0    | T1    | T2    | T3    | T4    | SE(m) ± | CD (p > 0.05) |
|---------------------------|-------|-------|-------|-------|-------|---------|---------------|
| Commercial Cut Yields     |       |       |       |       |       |         |               |
| Breast                    | 20.61 | 20.55 | 20.84 | 21.18 | 21.20 | 0.25    | NS            |
| Thigh                     | 18.80 | 19.00 | 19.11 | 19.04 | 19.08 | 0.25    | NS            |
| Back                      | 15.92 | 15.86 | 15.84 | 16.02 | 15.88 | 0.41    | NS            |
| Drumstick                 | 10.13 | 10.19 | 10.27 | 10.11 | 10.07 | 0.07    | NS            |
| Wing                      | 8.78  | 8.93  | 9.00  | 9.24  | 9.07  | 0.40    | NS            |
| Neck                      | 3.77  | 3.71  | 3.79  | 3.75  | 3.84  | 0.06    | NS            |
| Giblet Yields             |       |       |       |       |       |         |               |
| Liver                     | 3.52  | 3.54  | 3.62  | 3.61  | 3.60  | 0.09    | NS            |
| Gizzard                   | 1.77  | 1.76  | 1.76  | 1.69  | 1.73  | 0.05    | NS            |
| Heart                     | 0.54  | 0.44  | 0.54  | 0.58  | 0.48  | 0.06    | NS            |

NS: Non-Significant ( $P > 0.05$ )**Table 3:** Proximate chemical composition (%) of broiler meat

| Parameter (%) | T0    | T1    | T2    | T3    | T4    | SE(m) ± | CD (p > 0.05) |
|---------------|-------|-------|-------|-------|-------|---------|---------------|
| Moisture      | 71.65 | 70.50 | 71.75 | 69.50 | 72.50 | 0.94    | NS            |
| Dry Matter    | 26.85 | 26.00 | 26.25 | 27.38 | 27.25 | 0.80    | NS            |
| Crude Protein | 18.00 | 18.89 | 17.90 | 17.50 | 17.00 | 0.64    | NS            |
| Crude Fat     | 3.08  | 3.13  | 3.03  | 3.05  | 3.00  | 0.15    | NS            |
| Ash           | 0.98  | 1.02  | 1.05  | 1.05  | 1.03  | 0.03    | NS            |

NS: Non-Significant ( $P > 0.05$ ).**Table 4:** Sensory evaluation and organoleptic profile of broiler meat

| Parameter             | T0                | T1                | T2                | T3                | T4                | Mean | CD (p < 0.05) |
|-----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|---------------|
| Colour                | 7.50              | 7.38              | 7.37              | 7.45              | 7.67              | 7.48 | NS            |
| Flavour               | 7.39              | 7.33              | 7.28              | 7.26              | 7.30              | 7.31 | NS            |
| Texture               | 7.39 <sup>a</sup> | 7.70 <sup>b</sup> | 8.01 <sup>c</sup> | 7.48 <sup>a</sup> | 7.97 <sup>c</sup> | 7.71 | 0.12          |
| Juiciness             | 7.14 <sup>a</sup> | 7.57 <sup>c</sup> | 7.76 <sup>c</sup> | 7.43 <sup>b</sup> | 8.25 <sup>d</sup> | 7.63 | 0.12          |
| Overall Acceptability | 7.39 <sup>a</sup> | 7.78 <sup>b</sup> | 8.14 <sup>c</sup> | 7.68 <sup>b</sup> | 8.24 <sup>c</sup> | 7.85 | 0.23          |

Means bearing different superscripts (a, b, c, d) within the same row differ significantly ( $p < 0.05$ )

#### 4. Conclusion

Based on the findings of the present investigation, dietary supplementation with garlic (*Allium sativum* L.) powder serves as an effective, natural, non-residual phytogenic feed additive in commercial broiler production. Supplementation exerted a highly significant positive effect on growth performance and feed efficiency during the finisher phase (weeks 4 to 6), with treatment group  $T_3$  consistently achieving the highest weekly body weight gain, lower feed intake, and superior feed conversion ratio (FCR). Carcass evaluation demonstrated that dietary garlic powder supported balanced, allometric growth, maintaining uniform relative proportions across all commercial cut-up parts (breast, thigh, drumstick, wing, back, neck) and edible giblets (liver, gizzard, heart) without inducing physiological or visceral abnormalities. Furthermore, the proximate chemical composition of broiler meat including moisture, dry matter, crude protein, crude fat, and total ash remained stable across all groups, confirming that the accelerated growth represented genuine lean muscle accretion rather than excessive lipid deposition. In addition, garlic supplementation significantly enhanced cooked meat sensory attributes, with groups  $T_4$  and  $T_2$  scoring highest for tenderness (texture), juiciness, and overall consumer acceptability without

altering natural meat colour or flavour. In conclusion, dietary garlic powder supplementation particularly at the level evaluated in  $T_3$  for maximum growth efficiency and  $T_4$  for optimal organoleptic appeal can be safely recommended as a sustainable nutritional strategy to optimize broiler performance and meat eating quality.

#### Conflict of Interest

The authors declare that there are no known conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

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