# Evaluation of the effect of Garlic Powder and Thyme leaves on Productive Performance, Blood parameters, and Antioxidant Status in Japanese Quails

## تقييم تأثير مسحوق الثوم وأوراق الزعتر على الأداء الإنتاجي وخصائص الدم والحالة المضادة للأكسدة في طائر السمان الياباني

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## Abstract:

This investigation sought to assess the impact of incorporating garlic powder and thyme leaves on the growth performance, carcass attributes, specific hematological parameters, and antioxidant capacity in Japanese quails throughout the growth phase (7–42 days). A total of 225 seven-day-old Japanese quail chicks were allocated into three distinct dietary treatments (75 birds/treatment) with three replicates for each treatment (25 birds/replicate). The chicks were systematically assigned to the following treatments: T1: Administered a basal diet devoid of any additives (control). T2: Administered a basal diet augmented with 10 g of garlic powder per kg of feed. T3: Administered a basal diet augmented with 10 g of thyme leaves per kg of feed. The findings from the statistical analysis revealed that body weight, weight gain, and feed conversion efficiency exhibited significant enhancement ($P \leq 0.05$) commencing at 21 days of age and persisted until 42 days of age (the conclusion of the experiment). Nevertheless, no significant discrepancies were observed among treatments regarding feed intake. The findings further indicated that levels of total protein, albumin, globulin, and glucose experienced significant elevation in diets supplemented with garlic powder and thyme leaves. Conversely, the inclusion of these additives significantly ($P \leq 0.05$) diminished cholesterol levels in the blood of quails within the experimental groups in comparison to the control group. Additionally, a marked reduction in total lipid levels was noted in the additive groups relative to the control group. The study also demonstrated a notable decrease in




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malondialdehyde (MDA) concentration alongside a significant increase in glutathione (GSH) levels within the additive groups. In summary, the incorporation of garlic powder and thyme leaves into the diet positively influenced growth performance, select blood parameters, and the antioxidant status of Japanese quails.

**Keywords:** Garlic powder, Thyme leaves, Quail, Growth performance, Blood parameters, Antioxidants.

**المستخلص:**

استهدفت الدراسة تقييم تأثير إضافة مسحوق الثوم واوراق الزعتر على أداء النمو، وخصائص الذبيحة، وبعض صفات الدم وحالة مضادات الأكسدة لطائر السمان الياباني خلال فترة النمو (٧-٤٢) يوماً، تم توزيع (٢٢٥) فرخ طائر السمان الياباني بعمر ٧ أيام على ٣ معاملات غذائية (٧٥/طائر/معاملة)، ٣ مكررات (٢٥/طائر/مكرر)، تم تقسيم الكتاكيت إلى ثلاثة معاملات على النحو التالي:T1 : تمت تغذيته على علف أساسي بدون أي إضافات (السيطرة)، T2 تم تغذيته على علف أساسي مكمل ب ١٠جم من مسحوق الثوم/ كجم من العليقة، T3 تم تغذيته على ١٠جم من أوراق الزعتر /كجم من العليقة. اشارت نتائج التحليل الإحصائي إلى أن وزن الجسم والزيادة الوزنية ومعدل التحويل الغذائي قد تحسنت معنوياً ($P\geq0.05$) بداية من عمر ٢١ يوم واستمرت حتى عمر ٤٢ يوماً (نهاية التجربة)، في حين لم يكن هناك فروقات معنوية بين المعاملات في معدل استهلاك العلف، وأظهرت النتائج كذلك أن مستوى البروتين الكلي والألبومين والجلوبيولين والجلوكوز زاد معنويا في العلائق المحتوية على مسحوق الثوم واوراق الزعتر، بينما كان تأثير الإضافة على مستوى الكوليسترول بشكل معنوي($P\geq0.05$) في دم طائر السمان حيث انخفض في معاملتي الإضافة، كذلك نلاحظ انخفاض معنوي في مستوى اللبيبدات الكلية لمجموعة الإضافة مقارنة مع مجموعة السيطرة، وحيث أظهرت النتائج أيضا أن هناك انخفاض معنوي في تركيز MDA ، وزيادة معنوية في( GSH). وخلصت هذه الدراسة إلى أن إضافة مسحوق الثوم واوراق الزعتر أدت لتحسين معدل الأداء وبعض صفات الدم ومضادات الأكسدة لطائر السمان الياباني.

**الكلمات المفتاحية**: مسحوق الثوم، أوراق الزعتر، السمان، أداء النمو، صفات الدم، مضادات الأكسدة.

## Introduction

The transformation of lifestyle patterns in numerous nations, propelled by escalating living standards and economic advancement, has resulted in a progressively heightened daily requirement for protein-dense foods that are crucial for development, such as poultry and eggs. These food items are characterized by their elevated levels of unsaturated fatty acids **(Adeola *et al.*, 2006),** which are indispensable for human health and development. Among the various poultry species, the Japanese quail is notable for its high production of table eggs and meat while maintaining a relatively low economic burden. The cholesterol concentration in quail meat is quantified at 14.22 mg/kg **(Aloui *et al.*, 2013)**. Consequently, considerable scholarly focus has been directed towards identifying factors that mitigate cholesterol levels in meat and eggs, as well as enhancing the quality of fatty acids in these products through the application of antioxidant agents. These antioxidants are derived from a multitude of plant sources and serve a critical function in the prevention of diseases in humans, animals, and avians owing to their bioactive properties **(Chowdhury *et al.*, 2002)**. Poultry meat is characterized by substantial concentrations of unsaturated fatty acids, rendering it susceptible to biochemical alterations, predominantly oxidation **(Mortran *et al.*, 1987).** Oxidative processes culminate in rancidity, as well as the generation of undesirable odors, flavors, and tastes, which consequently diminish the quality of the meat **(Olorunsanya *et al.*, 2009).** This advancement has also introduced obstacles, including the emergence of poultry diseases attributable to accelerated growth rates and diminished immunity resulting from the excessive application of synthetic antibiotics **(Grashorn *et al.*, 2010).** In response to the widespread incidence of diseases in poultry, researchers have investigated natural


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alternatives to chemical additives aimed at bolstering immunity by stimulating the immune system and integrating these agents into poultry feed **(Alagawany *et al.*, 2020).**

Currently, a primary focus within the domain of poultry agriculture and the production of white meat is the exploration of novel alternatives to feed additives that enhance animal well-being and augment both quantitative and qualitative production metrics **(Gerzilov *et al.*, 2015).** Numerous medicinal flora exhibit a variety of biological properties attributable to the rich presence of active compounds that bolster animal growth and immunity **(Morsy *et al.*, 2018).** The utilization of medicinal herbs or their extracts represents one of the most expedient and effective methodologies for the incorporation of natural antioxidants into the physiology of animals **(Soltan *et al.*, 2018)**. Moreover, antioxidants are instrumental in preserving animal health, fortifying the immune system, and optimizing production efficiency **(Qi *et al.*, 1998).**

Among the botanicals recognized for their medicinal attributes are garlic (Allium sativum) and thyme (Thymus vulgaris). Garlic is characterized by the presence of allicin, a compound that exhibits antibiotic-like effects. It acts to inhibit the proliferation of pathogenic bacteria and fungi responsible for the production of aflatoxins **(Meraj *et al.*, 1998).** Investigators **Samanta and Dey (1991)** reported that the incorporation of garlic powder into quail diets was associated with an increase in live body weight. In a similar vein, **Aporn *et al.* (2008)** discovered that the inclusion of 0.7–1.3% garlic in dietary formulations markedly enhanced weight gain and feed conversion ratio, without adversely impacting abdominal fat deposition or the cholesterol content of the meat. Additional research has indicated that the supplementation of garlic in broiler diets has been shown to stimulate immune responses,


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diminish glutathione peroxidase activity in hepatic tissue, and reduce oxidative stress markers in the bloodstream **(Zsolt *et al.*, 2009).**Thyme, an essential aromatic herb, derives its efficacy from the presence of thymol and carvacrol. **Dorman *et al.* (2000)** and **Giannenas *et al.* (2013)** elucidated the antibacterial, antiparasitic, and antifungal characteristics of thyme extracts. **Williams *et al.* (2001)** noted that thyme exerted a beneficial effect on the digestive system and enhanced production efficiency in poultry. Various investigations have demonstrated that the addition of thyme to broiler diets at varying ages and proportions significantly augmented live body weight, weight gain, and feed conversion efficiency **(Jamil, 2008).** Furthermore, thyme has been shown to exert a favorable influence on certain carcass characteristics and hematological parameters in broilers **(Al-Qubaisi and Jamil, 2009; Saleh *et al*., 2014).**

The significance of this study resides in the examination of the impact of garlic and thyme supplementation on productive performance, blood parameters, antioxidant status, and Japanese quails.

## Materials and Methods

This study was conducted in a private poultry house on a farm in Surman City from February 8, 2024, to March 14, 2024, over five weeks. The aim was to evaluate the effect of adding garlic powder and thyme powder to the diet on productive performance, carcass characteristics, and blood biochemical parameters in Japanese quails.

225 unsexed Japanese quails (white, gray, and black plumage) aged one week were randomly divided into three experimental groups, each with three replicates of 25 birds per replicate. The birds were reared in cages inside a closed hall equipped with the necessary environmental conditions for quail farming. Electric heaters were used to maintain appropriate



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warmth, and the lighting system provided 24 hours of light daily. Feed and water were offered ad libitum throughout the trial. The thyme and garlic powders were procured from local markets. The experiment included three dietary treatments as follows:

**Control group:** No additives.

**Treatment 2:** Diet supplemented with 1% thyme powder.

**Treatment 3:** Diet supplemented with 1% garlic powder.

The birds were fed a diet formulated according to **NRC (1944**) recommendations.

**Measured Traits**

**Live Body Weight:** Birds were weighed at the end of each week, from the start of the experiment until the fifth week, using a precision scale.

**Weight Gain:** Weight gain was calculated as follows: **Weight gain (g) =** Final body weight − Initial body weight.

**Total Feed Intake:** Total feed intake was determined using the formula:

**Total feed intake =** Feed offered at the beginning of the week − Feed leftover at the end of the week.

**Feed Conversion Ratio (FCR):** FCR was calculated, as the amount of feed (g) required achieving 1 g of weight gain.

**Blood Biochemical Parameters**

At the end of the experiment, four birds from each replicate were slaughtered, and blood samples were collected. The serum was separated and used to measure total protein, albumin, globulin, fibrinogen, glucose, cholesterol, HDL, LDL, and triglycerides. These parameters were determined using ready-to-use test kits supplied by **Biolabo, France**, following the manufacturer's instructions. Measurements were conducted with a spectrophotometer, and concentrations were calculated based on the equations provided by the manufacturer.



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**Antioxidant Status**

**Glutathione (GSH):** GSH levels in red blood cells were measured as an indicator of antioxidant status, using the modified method of **Burtis and Ashwood (1999**).

**Malondialdehyde (MDA): Beuge and Aust (1978**) assessed MDA levels in serum, as an indicator of lipid peroxidation, using the modified Thiobarbituric Acid Reaction Substance (TBARS) method.

**2.4 Statistical Analysis**

Data were analyzed using SPSS software version 25. Analysis of variance (ANOVA) was employed to evaluate the data and mean differences among treatments were compared using Duncan, 1955 test.

The statistical model used was:

**Yi = M + Ti + Eijk**

Where: **Yi** = Response variable, **M** = Overall mean, **Ti** = Effect of treatment, **Eijk** = Experimental error.

**Results and Discussion**

**Productive Performance**

**1. Body Weight and Weight Gain:** The results presented in Table (1) show the effect of adding garlic powder and thyme leaves on the live body weight of Japanese quails during the experiment. Statistical analysis revealed no significant differences in initial body weight among the experimental groups. Similarly, no significant differences were observed in body weight at 14 and 21 days of age. However, starting from 21 days of age, significant differences in body weight were observed between the supplementation treatments (T2 and T3) and the control group (T1). The average body weights at 21 days were 86.14 g (T1), 89.55 g (T2), and 90.53 g (T3). Although the differences between T2 and T3 were numerical, and not statistical, both treatments significantly outperformed the control


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group (P ≤ 0.05) in live body weight at 28, 35, and 42 days of age. The final body weights at 42 days were 195.22 g (T1), 188.17 g (T2), and 201.35 g (T3). **Dorman and Deans (2000)** who reported similar findings, where thyme supplementation led to significant increases in broiler body weight due to the presence of active biological compounds such as thymol and carvacrol, which act as digestive stimulants. These results are consistent with previous studies by **Khalaji (2011)**, which demonstrated significant improvements (P ≤ 0.05) in live body weight when thyme powder was added to poultry diets. Conversely, this study's results contradict those of **Sadeghi et al. (2012)**, who reported no significant effect of thyme powder supplementation (5 g/L in drinking water) on live body weight. Likewise, **Narimani et al. (2003)**, concluded that adding 200–300 mg/kg of carvacrol (a thyme essential oil) to broiler diets improved weight gain and overall performance. Similarly, **Toghyani et al. (2010)** found that thyme powder at 5 g/kg increased daily weight gain and live body weight.

The observed improvements in productive traits are likely due to the antioxidant properties of garlic and thyme. These plants contain compounds with antibacterial and antibiotic-like properties that combat harmful gut bacteria, enhancing the efficiency of nutrient utilization (**Kabouche et al., 2005**). Additionally, thyme contains menthol, which acts as an aromatic agent, purifying the digestive system, reducing harmful microbes, and increasing pancreatic secretions. These effects enhance digestion and absorption, ultimately improving growth performance (**Kabouche et al., 2005; Lin et al., 2006**). Garlic's effects on weight gain may stem from its ability to enhance feed flavor and stimulate appetite. This could also be attributed to the allicin compound, which reduces cortisol (stress hormone) levels, as **Kothari et al. (2019)** suggested. Furthermore, the


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results align with findings from **Cross et al. (2007)**, who demonstrated thyme oil and flower supplements' positive effects on growth and feed conversion. Thyme's essential oils balance gut microbiota and stimulate digestive enzyme secretion, enhancing nutrient absorption (**Singh et al., 2019**). , garlic and thyme enhance growth by improving digestive enzyme activity, nutrient absorption, and feed conversion efficiency, resulting in better immunity and higher body weight.

**Table (1): Effect of Adding Garlic Powder and Thyme Leaves on Live Body Weight of Japanese Quails**

| **Experimental Treatments** | **Live body weight (g)** | | | **P.Value** |
|---|---|---|---|---|
| | T1 (Control) | T2 (Garlic) | T3 (Thyme) | |
| Initial Weight (7 days) | 25.12 ± 0.11 (a) | 26.34 ± 0.16 (a) | 26.68 ± 0.17 (a) | 0.084 |
| Weight at 14 days | 55.22 ± 1.20 (a) | 56.87 ± 1.34 (a) | 57.43 ± 1.38 (a) | 0.070 |
| Weight at 21 days | 86.14 ± 1.70 (b) | 89.55 ± 1.60 (a) | 90.53 ± 1.78 (a) | 0.034 |
| Weight at 28 days | 123.55 ± 2.21 (b) | 129.48 ± 2.16 (b) | 132.45 ± 2.11 (a) | 0.019 |
| Weight at 35 days | 160.17 ± 2.12 (c) | 168.22 ± 2.37 (b) | 175.17 ± 2.50 (a) | 0.0001 |
| Final Weight at 42 days | 198.17 ± 2.42 (c) | 205.22 ± 2.16 (b) | 211.35 ± 2.61 (a) | 0.0001 |

(Means followed different letters in the same row indicate significant differences differences $P \leq 0.05$).

The results presented in Table (2) show the effect of adding garlic powder and thyme leaves on the weight gain of quail. The results indicated no significant differences between the supplementation treatments and the control group at 7 days and 14 days. However, statistical analysis revealed significant differences ($P \leq 0.05$) between the supplementation treatments (T3, T2) and the control group (T1) starting from the third week of the experiment, with weight gains of 41.92, 39.93, and 37.41


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g, respectively. There were no significant differences between the supplementation treatments. In the fourth week, significant differences were ($P \leq 0.05$) observed in the T3 supplementation group compared to the T2 supplementation group and compared to the control group. Statistical analysis showed no significant differences between the supplementation treatments and the control group in the fifth week of the experiment. The total weight gain of the quail significantly improved in the ($P \leq 0.05$) supplementations treatments (T3, T2) compared to the control group (T1), with total gains of 163.05, 168.88, and 174.67 g, respectively. The results of this study are consistent with the findings of **Singh (2019),** as well as the addition of garlic powder (1%, 1.5%) in line with the results of **Singh et al. (2019).** The interpretation of these results is attributed to the effect of garlic essential oil as a natural growth promoter. This effect may also be due to the fermentation of inulin in the colon by beneficial bacteria, which is associated with enhancing the digestive system and immune function. Additionally, garlic has been shown to increase the absorption of calcium and magnesium. Allicin, a compound in garlic, inhibits the growth of intestinal bacteria such as *Staphylococcus aureus* and *Escherichia coli* and prevents fungal aflatoxins, thereby improving feed consumption, feed conversion efficiency, and body weight gain.

**Singh et al. (2019)** found that garlic significantly enhances the number of villous and crypt cells in the duodenum and jejunum of birds. These intestinal morphological changes improve nutrient absorption. Furthermore, allicin's ability to suppress the growth of intestinal bacteria (*Staphylococcus aureus* and *Escherichia coli*) and prevent aflatoxin production in fungi leads to better nutrient absorption in the intestines. This, in


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turn, improves feed conversion, increases glycogen levels in the liver and muscles, and enhances metabolism.

**Table (2): Effect of Adding Garlic Powder and Thyme Leaves on Weight Gain of Japanese Quails**

| Experimental Treatments | Weight gain (g) | | | P.Value |
|---|---|---|---|---|
| | T1 (Control) | T2 (Garlic) | T3 (Thyme) | |
| 7–14 days | 30.1 ± 0.16 (a) | 30.53 ± 0.22 (a) | 30.75 ± 0.42 (a) | 0.097 |
| 14–21 days | 30.92 ± 0.17 (a) | 32.68 ± 0.21 (a) | 33.1 ± 0.23 (a) | 0.073 |
| 21–28 days | 37.41 ± 0.30 (b) | 39.93 ± 0.67 (a) | 41.92 ± 0.42 (a) | 0.0001 |
| 28–35 days | 36.62 ± 0.34 (c) | 38.74 ± 0.56 (b) | 42.72 ± 0.65 (a) | 0.0001 |
| 35–42 days | 38.00 ± 0.15 (b) | 37.00 ± 0.12 (a) | 36.18 ± 0.18 (a) | 0.021 |
| Total Weight Gain (7–42 days) | 173.05±2.11 (c) | 178.88 ± 2.51 (b) | 184.67 ± 2.16 (a) | 0.0001 |

(Means followed different letters in the same row indicate significant differences differences P≤0.05).

2. Feed Consumption and Feed Conversion Efficiency:

The results presented in Table (3) illustrate the impact of adding garlic powder and thyme leaves on feed consumption rates. The data show significant differences in total feed consumption between the supplementation treatments and the control group. By the end of the experiment, the total feed consumption rates for the experimental groups were reported as follows: **[values from the table should be included here for precision]**.

The total feed consumption rates at the end of the experiment were recorded as **537.30 g, 536.64 g, and 573.74 g** for the control group, garlic powder group, and thyme leaves group, respectively. These findings align with those of the study (62), which reported no significant differences in feed consumption rates between laying hens fed a diet supplemented with thyme leaves powder (at 0.5% and 1%) and those fed a control diet.

However, these results differ from those of **Al-Naeef et al. (2010)**, who observed a significant reduction in feed


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consumption among laying hens in treatments supplemented with crushed thyme leaves compared to the control. Similarly, **Kazim et al. (2009)** reported a significant increase in feed consumption when crushed thyme leaves were added to the diet, favoring thyme-supplemented treatments compared to the additive-free control diet.

**Table (3): Effect of Adding Garlic Powder and Thyme Leaves on Feed Intake of Japanese Quails (g/bird/week)**

| Experimental Treatments | Feed intake (g) | | | P.Value |
|---|---|---|---|---|
| | T1 (Control) | T2 (Garlic) | T3 (Thyme) | |
| 7–14 days | 84.70 ± 1.25 (a) | 83.92 ± 1.31 (a) | 84.13 ± 1.21 (a) | 0.087 |
| 14–21 days | 94.42 ± 1.45 (a) | 94.22 ± 0.67 (a) | 95.11 ± 1.23 (a) | 0.067 |
| 21–28 days | 104.11 ± 1.70 (a) | 105.16 ± 1.37 (a) | 106.12 ± 1.85 (a) | 0.076 |
| 28–35 days | 117.22 ± 1.82 (a) | 116.12 ± 1.35 (a) | 117.22 ± 1.42 (a) | 0.098 |
| 35–42 days | 136.35 ± 1.62 (a) | 137.22 ± 1.52 (a) | 135.16 ± 1.63 (a) | 0.064 |
| Total Feed Intake (7–42 days) | 537.30 ± 2.16 (a) | 536.64 ± 2.41 (a) | 537.74 ± 2.16 (a) | 0.098 |

(Means followed different letters in the same row indicate significant differences differences $P \leq 0.05$).

Table (4) illustrates the impact of adding garlic powder and thyme leaves on Japanese quail's feed conversion efficiency (FCE). A significant improvement ($P \geq 0.05$) in FCE was observed with adding garlic powder and thyme leaves. For the first week, the FCE values were **2.73, 2.74, and 2.81 g** for the control group, T2 (garlic powder), and T3 (thyme leaves), respectively, with no significant differences between the supplementation treatments.Additionally, the total feed conversion efficiency (g/1 g weight gain) improved significantly ($P \geq 0.05$) across all experimental periods, with final FCE values of **2.91, 3.00, and 3.10 g** for the control group, T2, and T3,


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respectively. These results are consistent with the findings of **Kazim (2009**) and **Al-Naeef (2010),** who reported significant improvements in FCE when thyme leaf powder was added to the diet.

**Table (4): Effect of Adding Garlic Powder and Thyme Leaves on Feed Conversion Ratio (FCR) of Japanese Quails (g feed/g weight gain)**

| Experimental Treatments | Feed conversion ratio (FCR) | | | P.Value |
|---|---|---|---|---|
| | T1 (Control) | T2 (Garlic) | T3 (Thyme) | |
| 7–14 days | 2.81 ± 0.12 (a) | 2.74 ± 0.16 (b) | 2.73 ± 0.16 (b) | 0.035 |
| 14–21 days | 3.06 ± 0.35 (a) | 2.88 ± 0.28 (b) | 2.87 ± 0.17 (b) | 0.024 |
| 21–28 days | 2.78 ± 0.42 (a) | 2.63 ± 0.11 (b) | 2.53 ± 0.18 (c) | 0.038 |
| 28–35 days | 3.20 ± 0.51 (a) | 2.99 ± 0.16 (b) | 2.74 ± 0.12 (c) | 0.021 |
| 35–42 days | 3.58 ± 0.11 (b) | 3.70 ± 0.12 (a) | 3.73 ± 0.21 (a) | 0.021 |
| Total FCR (7–42 days) | 3.10 ± 0.21 (a) | 3.00 ± 0.11 (b) | 2.91 ± 0.14 (c) | 0.033 |

(Means followed different letters in the same row indicate significant differences differences P≤0.05).

However, these findings contrast with the study by Zweil et al. (2006), which found no significant differences in FCE between quail fed a diet with thyme powder (1–2 g/kg feed) and those fed a control diet.

The observed improvement in FCE reflects the weight gain stability achieved alongside a consistent feed consumption rate. This improvement may be attributed to thyme's inhibitory effect on Gram-positive and Gram-negative bacteria in the bird's digestive tract due to its active compounds, such as thymol and carvacrol. These compounds disrupt bacterial cell membranes, leading to bacterial death, as reported by **Al-Jugifi (2015),** and **Isa (2013).**

Moreover, thyme contains key digestive enzymes, such as lipase, amylase, and protease, which enhance the breakdown and absorption of fats, carbohydrates, and proteins. This enzymatic


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activity, as noted by Al-Hadeethy et al. (2006), further enhances the nutritional benefits of the feed, increasing its utilization and contributing to better overall health and vitality of the birds.

The findings of this study align with the results of **Bollinger et al. (1998**), who reported that Vitamin E improves feed conversion efficiency due to its antioxidant properties and its role in enhancing fat metabolism in the body.

**2. Blood Measurements:**

The results presented in Table (5) show the effect of adding garlic powder and thyme leaves on some biochemical blood indices in Japanese quail. The findings indicated a significant increase in total protein, albumin, and globulin levels ($P \geq 0.05$) in diets containing garlic powder and thyme leaves compared to the control group. This can be attributed to garlic's ability to improve digestion in birds (**Gardzielewska et al., 2003**), contributing to an increase in nutrients, including protein bound to glutathione in the liver, and subsequently enhancing protein released into the blood (**Wang et al., 1997**). Additionally, an increase in Y-globulin protein levels was observed in the blood (**Ali, 2001)**.

**Table (5): Effect of Adding Garlic Powder and Thyme Leaves on Blood Biochemical Parameters of Japanese Quails**

| Blood Parameters | T1 (Control) | T2 (Garlic) | T3 (Thyme) | P.Value |
|---|---|---|---|---|
| Total Protein (g/dl) | 4.29 ± 0.2 (b) | 4.66 ± 0.3 (a) | 4.64 ± 0.2 (a) | 0.034 |
| Albumin (g/dl) | 1.44 ± 0.06 (b) | 1.51 ± 0.05 (a) | 1.66 ± 0.06 (a) | 0.025 |
| Globulin (g/dl) | 2.85 ± 0.05 (b) | 2.97 ± 0.03 (a) | 3.10 ± 0.03 (a) | 0.031 |
| Cholesterol (mg/dl) | 222 ± 6.8 (a) | 182 ± 5.7 (b) | 185 ± 6.3 (b) | 0.025 |
| Glucose (mg/dl) | 217 ± 5.32 (b) | 250 ± 6.12 (a) | 242 ± 4.41 (a) | 0.045 |
| Triglycerides (mg/dl) | 150 ± 6.21 (a) | 84.86 ± 2.32 (b) | 97.47 ± 4.35 (b) | 0.023 |
| *HDL | 140 ± 6.52 (b) | 183.29 ± 4.12 (a) | 172.22 ± 6.19 (a) | 0.001 |
| **LDL | 35.46 ± 3.11 (a) | 24.27 ± 3.32 (b) | 26.06 ± 3.17 (b) | 0.001 |

(Means followed different letters in the same row indicate significant differences differences $P \leq 0.05$).



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***HDL** high-density lipoprotein.

****LDL** Low-density lipoprotein.

The results also showed a reduction in blood cholesterol levels in the supplementation groups compared to the control. This aligns with the findings of **Nasir et al. (2005)**, who reported a decrease in total cholesterol in the serum of laying hens fed a diet containing 1.5% thyme leaves. Similarly, **Aporn et al. (2008)** observed a cholesterol reduction when garlic was added to broiler diets at 0.7–1.3%.

Furthermore, blood glucose levels increased significantly in the garlic and thyme groups compared to the control group. This agrees with **Meraj et al. (1998**), who suggested that the increase in protein bound to glutathione contributes to the elevated levels of various nutrients, including glucose. These findings are consistent with previous research (**Amad et al., 2011)**, which highlighted the effectiveness of certain medicinal and aromatic plants in reducing blood cholesterol due to their active essential oils (**Lee, 2009**).

The reduction in blood cholesterol levels in the supplementation groups can be attributed to carvacrol and thymol in herbs like garlic and thyme (**Zargari, 2001**). These compounds affect cholesterol and triglycerides by reducing harmful LDL cholesterol levels **(Zargari, 2001**). Additionally, garlic components can inhibit cholesterol synthesis in the liver by suppressing HMG-CoA reductase, a rate-determining enzyme in cholesterol biosynthesis (**Chen et al., 2002**).

Table (5) also indicates that thyme leaves may help prevent an increase in blood triglycerides without affecting cholesterol metabolism (**Lee et al., 2009**). Garlic powder preparation reduces the oxidation of lipoproteins both in vitro and in in vivo **(Kourounakis and Rekka, 1991**).


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The noticeable increase in HDL is a critical indicator of anti-hypercholesterolemic activity. High HDL levels have been associated with a reduced risk of cardiovascular diseases (CVD) (Yousef, 2004). This implies that HDL may play a protective role by reversing cholesterol transport, inhibiting LDL oxidation, and preventing atherosclerosis caused by oxidized LDL.

**3. Antioxidants**:

The results in Table (6) demonstrate the effect of garlic powder and thyme leaves supplementation on malondialdehyde (MDA) and glutathione (GSH) levels in Japanese quail blood serum. The study found that adding garlic powder and thyme leaves significantly increased ($P \geq 0.05$) glutathione levels while reducing malondialdehyde levels compared to the control group. This indicates enhanced antioxidant capacity in quail, which aligns with findings by **AL- Hameed et al. (2021),** confirming garlic powder's ability to reduce malondialdehyde levels and lipid peroxidation in blood serum.

Similarly, the results agree with **Abo Ghanima et al. (2023)** and **Zweil et al. (2016)**, who reported that feeding Japanese quail varying levels of garlic powder reduced malondialdehyde levels and increased glutathione levels. This highlights garlic powder's potent antioxidant activity.

This is consistent with **Shaaboun (2011**), who observed improved antioxidant status in broiler hens given an aqueous extract of thyme leaves (5–10%) in drinking water. It also agrees with **Al-Qattan et al. (2006**), who found that administering thyme capsules (1000 mg/kg body weight) to local male rabbits significantly increased glutathione levels and reduced malondialdehyde levels in liver tissue compared to the control.

The improvement in antioxidant status is attributed to compounds like carvacrol and thymol in thyme, which enhance the activity of antioxidant systems by increasing the



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effectiveness of enzymes responsible for lipid peroxidation regulation (**Hashemipour et al., 2013**).

**Table (6): Effect of Adding Garlic Powder and Thyme Leaves on Antioxidant Status in Blood Serum**

| Parameter | T1 (Control) | T2 (Garlic) | T3 (Thyme) | P.Value |
|---|---|---|---|---|
| MDA (nmol/L) | 24.34 ± 0.45a | 22.54 ± 0.25b | 20.14 ± 0.15c | 0.0001 |
| GSH (µmol/L) | 10.34 ± 0.32c | 11.12 ± 0.15b | 14.14 ± 0.21a | 0.0001 |

(Means followed different letters in the same row indicate significant differences differences P≤0.05).

**Conclusion:**

This study concludes that incorporating 1% garlic powder and 1% thyme leaves into the diet enhances the production performance of Japanese quail by improving digestion and metabolism. The antimicrobial properties of these supplements contribute to better health outcomes, including improved biochemical blood components and enhanced antioxidant status. These findings support the use of garlic powder and thyme leaves as a safer, more economical alternative to antibiotics, addressing concerns over the potential adverse effects of synthetic additives in poultry diets.


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