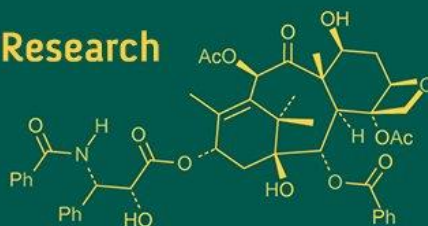


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Effect of garlic oil on serum biochemical parameters and meat characteristics of broilers

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Abstract

This study evaluated the effects of varying levels of garlic oil supplementation on serum biochemical parameters and meat quality characteristics in broiler chickens. A total of 300 one-day-old Vencobb-430Y broiler chicks were randomly divided into five treatment groups (T₁-T₅) with three replicates of twenty birds each. T₁ served as the control (0 mg/kg), while T₂, T₃, T₄, and T₅ received garlic oil at 50, 100, 150, and 200 mg/kg feed, respectively. This study was conducted to evaluate the effect of dietary garlic oil supplementation on meat quality parameters and serum biochemical indices in broiler chickens. Meat quality was assessed through shelf-life indicators including pH, thiobarbituric acid (TBA), and tyrosine values on day 1 and day 3 of storage. Results indicated that pH values showed a slight increase during storage across all treatment groups (T₁-T₅), with no significant differences observed between treatments ($p > 0.05$). TBA values, indicative of lipid oxidation, increased from day 1 to day 3; however, garlic oil-supplemented groups exhibited numerically lower values compared to control, suggesting reduced lipid peroxidation, though differences were statistically non-significant ($p > 0.05$). Similarly, tyrosine values, representing protein degradation, increased during storage, with garlic oil groups showing a trend toward lower values without significant variation ($p > 0.05$).

Serum biochemical parameters, including AST, ALT, triglycerides, and total cholesterol, were evaluated at 21 and 42 days of age. At both time points, no statistically significant differences were observed among treatment groups ($p > 0.05$). However, a consistent numerical reduction in liver enzyme activity and lipid profile parameters was observed in garlic oil-supplemented groups compared to the control group.

In conclusion, dietary supplementation of garlic oil did not significantly affect meat quality or serum biochemical parameters; however, it demonstrated a beneficial trend in reducing lipid oxidation, protein degradation, and serum lipid levels, indicating its potential as a natural feed additive for improving meat shelf life and metabolic health in broilers.

Keywords: Garlic oil, broiler chickens, serum biochemical parameters, meat quality

Introduction

The global poultry industry faces increasing pressure to reduce antibiotic usage while maintaining optimal production efficiency. Antibiotic growth promoters have been widely used in poultry production to enhance growth performance and prevent diseases, but concerns about antimicrobial resistance and consumer demand for antibiotic-free products have necessitated the search for natural alternatives. Phytochemical feed additives, particularly essential oils derived from medicinal plants, have emerged as promising alternatives due to their antimicrobial, antioxidant, and growth-promoting properties. (Abd el Ghany *et al.*, 2024) [2]

Garlic (*Allium sativum*) has been used for centuries in traditional medicine and is recognized for its broad-spectrum antimicrobial, immunomodulatory, and metabolic regulatory effects. The bioactive compounds in garlic, particularly allicin and organosulfur compounds, exhibit potent antibacterial activity against pathogenic microorganisms while promoting beneficial gut microbiota. Garlic essential oil contains dialkyl polysulphides and other sulfur-containing compounds that possess significant antibacterial properties, making it a potential natural growth promoter in poultry nutrition. (Kairalla *et al.*, 2022) [14]

Previous research has demonstrated variable effects of garlic supplementation on broiler performance, with differences attributed to the form of garlic (powder, extract, oil), inclusion

levels, bird genetics, and environmental conditions. While some studies have reported improvements in body weight gain and feed conversion efficiency, others have shown non-significant effects. The bioavailability and stability of garlic oil compared to garlic powder may offer enhanced efficacy, yet systematic dose-response studies evaluating garlic oil supplementation across multiple parameters remain limited. (Abdullahi I. *et al.*, 2025) ^[4]

The objective of this study was to comprehensively evaluate the effects of graded levels of garlic oil supplementation (0, 50, 100, 150, and 200 mg/kg) on serum biochemical profile and meat quality characteristics (pH, TBA, tyrosine values) in commercial broiler production. This research aims to establish the optimal inclusion level of garlic oil for maximizing production efficiency and profitability while ensuring meat quality and bird health.

Materials and Methods

Experimental Design and Birds

The experiment was conducted at the Department of Animal Nutrition, College of Veterinary and Animal Sciences, Parbhani, Maharashtra Animal and Fishery Sciences University, Nagpur, Maharashtra, India. Three hundred day-old Vencobb-430Y broiler chicks were randomly assigned to five treatment groups in a completely randomized design with three replicates of 20 birds each. Treatment T₁ served as the control group (basal diet without garlic oil supplementation), while T₂, T₃, T₄, and T₅ received basal diets supplemented with garlic oil at 50, 100, 150, and 200 mg/kg of feed, respectively. The garlic oil was procured from the local market at Rs. 4000 per kilogram and was thoroughly mixed with the feed during preparation.

Housing and Management

Chicks were housed in well-ventilated pens with adequate floor space, maintaining standard environmental conditions throughout the 42-day experimental period. Temperature was maintained at 32-34 °C during the first week and gradually reduced to 24-26 °C by the third week. Continuous lighting was provided during the first week, followed by 23 hours of light and 1 hour of darkness thereafter. All birds received standard vaccination programs against Newcastle disease, infectious bursal disease, and other endemic diseases as per the recommended schedule.

Vaccination Schedule

The birds were vaccinated against Newcastle disease (Lasota strain) on day 7 and against Infectious Bursal Disease (Georgia strain) on day 14. Booster doses were given on days 21 and 28.

Experimental Diets

Iso-caloric and iso-nitrogenous diets were formulated to meet the nutritional requirements of broiler chickens during three phases: pre-starter (0-7 days), starter (8-21 days), and finisher (22-42 days). The basal diet was formulated using maize, soybean meal, and other conventional ingredients, with lysine and methionine levels balanced across all treatment groups. Garlic oil was incorporated into the respective treatment diets by top-dressing method to ensure uniform distribution. Feed and water were provided ad libitum throughout the experimental period.

Serum Biochemical Parameters

Blood samples were collected from six birds per treatment (two birds per replicate) at 21 and 42 days of age via wing vein puncture using sterile syringes. Serum was separated by centrifugation at 3000 rpm for 5 minutes and stored at -20 °C until analysis. Serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), total cholesterol, and triglycerides were determined using commercial diagnostic kits and an automated biochemistry analyzer.

Biochemical parameters were measured using commercial diagnostic kits and a clinical analyzer:

- **Serum total cholesterol, HDL, LDL:** Cholesterol oxidase-peroxidase method (Allain *et al.*, 1974) ^[17]
- **Serum triglycerides:** Glycerol 3-phosphate oxidase-peroxidase method (Jacobs and Van Denmark, 1960) ^[18]
- **Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST):** UV Kinetic Method per IFCC guidelines

Meat Quality Assessment

Meat samples from breast muscle were collected on day 42 and analyzed for shelf-life parameters on days 1 and 3 of refrigerated storage (4 °C). pH was measured using a digital pH meter. Thiobarbituric acid (TBA) values were determined spectrophotometrically to assess lipid oxidation, with results expressed as mg malondialdehyde/kg of meat. Tyrosine values, indicating protein degradation, were measured using Folin-Ciocalteu reagent and expressed as mg tyrosine/kg of meat.

Statistical Analysis

Data were analyzed using one-way analysis of variance (ANOVA) in a completely randomized design using SPSS software (version 30.0). Treatment means were compared using Duncan's multiple range test at $p < 0.05$ significance level. Results are presented as mean $\pm$ standard error of the mean (SEM).

Results

Meat Quality Parameters

Shelf Life Indicators

On day 1 of storage, pH values were 5.93 ± 0.026 , 5.77 ± 0.032 , 5.98 ± 0.020 , 5.87 ± 0.086 , and 5.86 ± 0.015 for T₁ through T₅, respectively. On day 3, pH values were 6.03 ± 0.011 , 6.01 ± 0.012 , 6.02 ± 0.003 , 6.00 ± 0.006 , and 5.98 ± 0.026 . No significant differences in meat pH were observed on either storage day ($p > 0.05$).

TBA values on day 1 were 0.079 ± 0.002 , 0.078 ± 0.005 , 0.074 ± 0.010 , 0.077 ± 0.011 , and 0.076 ± 0.010 mg MDA/kg for T₁ through T₅. On day 3, TBA values increased to 0.082 ± 0.007 , 0.081 ± 0.011 , 0.077 ± 0.006 , 0.074 ± 0.005 , and 0.073 ± 0.004 mg MDA/kg, respectively. Although garlic oil-supplemented groups showed numerically lower TBA values indicating reduced lipid oxidation, differences were not statistically significant ($p > 0.05$).

Tyrosine values on day 1 were 0.190 ± 0.010 , 0.183 ± 0.009 , 0.176 ± 0.022 , 0.174 ± 0.013 , and 0.170 ± 0.003 mg/kg for T₁ through T₅. On day 3, values increased to 0.597 ± 0.114 , 0.490 ± 0.063 , 0.604 ± 0.136 , 0.404 ± 0.005 , and 0.434 ± 0.011 mg/kg. Despite numerical trends suggesting lower protein degradation in garlic oil groups, differences were not significant ($p > 0.05$).

Table 1: pH, TBA and tyrosine value of different groups supplemented with garlic oil.

Day	1 st Day			3 rd Day		
	pH	TBA (mg MDA/kg)	Tyrosine (mg/kg)	pH	TBA (mg MDA/kg)	Tyrosine (mg/kg)
T ₁	5.93±0.026	0.079±0.002	0.190±0.010	6.03±0.011	0.082±0.007	0.597±0.114
T ₂	5.77±0.032	0.078±0.005	0.183±0.009	6.01±0.012	0.081±0.011	0.490±0.063
T ₃	5.98±0.020	0.074±0.010	0.176±0.022	6.02±0.003	0.077±0.006	0.604±0.136
T ₄	5.87±0.086	0.077±0.011	0.174±0.013	6.00±0.006	0.074±0.005	0.404±0.005
T ₅	5.86±0.015	0.076±0.010	0.170±0.003	5.98±0.026	0.073±0.004	0.434±0.011
P value	0.066	0.991	0.482	0.225	0.411	0.376

TBARS = Thiobarbituric Acid, MDA = Malondialdehyde. TBA (mg MDA/kg), Tyrosine (mg/kg)

Serum Biochemical Parameters

Day 21st Analysis

At 21 days of age, mean AST levels were 220.39±19.30, 211.27±5.82, 202.42±10.04, 209.39±14.61, and 208.18±14.61 U/L for T₁ through T₅. ALT levels were 26.63±2.33, 25.21±2.92, 23.04±3.32, 22.45±1.42, and 21.65±1.40 U/L. Triglyceride concentrations were 50.48±1.44, 48.43±1.61, 47.34±5.13, 45.17±3.74, and 42.10±2.80 mg/dl. Total cholesterol levels were 109.01±2.14, 108.57±14.76, 104.26±4.63, 103.23±3.88, and 102.94±3.36 mg/dl for T₁ through T₅, respectively. Analysis of variance revealed no significant differences among treatment groups for any biochemical parameter at day 21 ($p>0.05$), though garlic oil supplementation resulted in numerical reductions in all measured parameters.

Table 2: Serum biochemical parameters at 21st day of broilers fed different levels of garlic oil in diet.

Groups	AST/SGOT (U/L)	ALT/SGPT (U/L)	Triglycerides (mg/dl)	Total cholesterol (mg/dl)
T ₁	220.39±19.30	26.63±2.33	50.48±1.44	109.01±2.14
T ₂	211.27±5.82	25.21±2.92	48.43±1.61	108.57±14.76
T ₃	202.42±10.04	23.04±3.32	47.34±5.13	104.26±4.63
T ₄	209.39±14.61	22.45±1.42	45.17±3.74	103.23±3.88
T ₅	208.18±14.61	21.65±1.40	42.10±2.80	102.94±3.36
P value	0.914	0.579	0.438	0.956

Day 42nd Analysis

At 42 days, AST levels were 230.02±7.49, 221.51±17.10, 207.65±10.76, 201.53±4.95, and 194.17±24.87 U/L for T₁ through T₅. ALT levels were 27.04±4.92, 26.92±4.15, 25.09±2.84, 24.85±2.24, and 23.81±2.47 U/L. Triglyceride concentrations were 56.97±3.24, 55.14±2.77, 54.43±2.60, 53.67±1.36, and 47.06±1.91 mg/dl. Total cholesterol levels were 112.19±10.38, 111.92±6.94, 110.79±6.02, 109.81±5.69, and 108.35±5.66 mg/dl for T₁ through T₅, respectively. Similar to day 21, no significant differences were observed among treatments ($p>0.05$), with garlic oil groups showing numerical decreases in liver enzymes and lipid parameters compared to control.

Serum biochemical parameters at 42nd day

Groups	AST/SGOT (U/L)	ALT/SGPT (U/L)	Triglycerides (mg/dl)	Total cholesterol (mg/dl)
T ₁	230.02±7.49	27.04±4.92	56.97±3.24	112.19±10.38
T ₂	221.51±17.10	26.92±4.15	55.14±2.77	111.92±6.94
T ₃	207.65±10.76	25.09±2.84	54.43±2.60	110.79±6.02
T ₄	201.53±4.95	24.85±2.24	53.67±1.36	109.81±5.69
T ₅	194.17±24.87	23.81±2.47	47.06±1.91	108.35±5.66
P value	0.283	0.940	0.083	0.982

Discussion

Serum Biochemical Parameters

The non-significant effects of garlic oil supplementation on serum AST, ALT, triglycerides, and total cholesterol at both 21 and 42 days of age indicate that garlic oil does not adversely affect liver function or lipid metabolism in broilers. The numerical reductions observed in liver enzymes and lipid parameters suggest potential hepatoprotective and hypolipidemic effects, though these were not statistically significant at the tested inclusion levels.

In the present study, garlic oil supplementation did not significantly affect AST, ALT, total cholesterol, or triglyceride levels in broilers at 42 days of age. Similar non-significant effects were reported by Elbaz *et al.* (2022) [11] for AST and ALT at 200 mg/kg garlic oil. According to Amiri *et al.* (2024) [7] reported that for non significant effect on serum cholesterol at 75 and 150 mg/kg garlic oil. Adewole *et al.* (2025) [5] found that no significant differences on AST value with garlic extract. Likewise, Iheanacho *et al.* (2024) [17] and Abd AL-Gabar *et al.* (2020) [1] observed no significant changes in cholesterol and triglycerides with garlic powder supplementation, while Abdulkareem *et al.* (2023) [3] reported no significant differences in AST and ALT values among treatments containing garlic powder.

On the contrary, Elbaz *et al.* (2022) [11] reported significant ($p<0.05$) reductions in serum cholesterol and triglycerides in broilers fed garlic oil at 200 mg/kg compared to control group. Similarly, Amiri *et al.* (2024) [7] observed significant ($p<0.05$) decreases in cholesterol and triglycerides at 75 and 150 mg/kg garlic oil. Oluwafemi *et al.* (2021) also found that garlic powder significantly ($p<0.05$) reduced ALT and AST levels. In addition, Darwish *et al.* (2021) [9] also reported that low dietary levels of garlic significantly lowered AST activity compared to the control group.

The maintenance of normal biochemical parameters confirms that garlic oil supplementation does not impose metabolic stress on broilers and is safe for use as a feed additive. The trend toward reduced cholesterol and triglycerides aligns with garlic's documented effects on lipid metabolism through inhibition of hepatic lipogenesis and enhancement of lipid catabolism.

Meat Quality

The non-significant effects on meat pH, TBA values, and tyrosine values indicate that garlic oil supplementation does not compromise meat quality or shelf life. The numerical trends suggesting lower lipid oxidation (TBA) and protein degradation (tyrosine) in garlic oil groups, though not statistically significant, suggest potential antioxidant effects that warrant further investigation with longer storage periods or higher garlic oil concentrations.

Supplementation of garlic oil did not significantly affect meat pH, TBA, or tyrosine values in the present study. Similar findings were reported by Kirpinkar *et al.* (2014)^[16], who observed no significant changes in meat quality with garlic essential oil at 150 mg/kg feed. Ozturk *et al.* (2019)^[20] also reported that graded levels of garlic extract did not significantly influence meat pH. Likewise, Onibi *et al.* (2009)^[19] and other garlic-based essential-oil blend studies reported non-significant effects on meat pH and oxidative indices. Olagoke *et al.* (2020)^[18] further observed that dietary inclusion of 1% garlic powder showed no significant differences in TBA values of frozen broiler meat. These findings support the constant pH and non-significant TBA and tyrosine trends observed in the present investigation. In contrast, according to Karangiya *et al.* (2016)^[15] reported that inclusion 10g/kg of garlic reduced TBA, tyrosine value of fresh and frozen meat. Dhupal *et al.* (2018)^[10] identified that adding of garlic oil at 100 mg/kg & 200 mg/kg significant ($p < 0.05$) differences in TBA value of broiler meat and Tulasi *et al.* (2025)^[21] observed that inclusion of garlic essential oil at 25g/100kg and 50g/100kg revealed that significant ($p < 0.05$) differences in TBA, pH of broiler meat.

Conclusion

This comprehensive study demonstrates that dietary supplementation of garlic oil in broilers did not significantly affect meat quality parameters (pH, TBA, tyrosine) or serum biochemical indices (AST, ALT, triglycerides, cholesterol) at both 21 and 42 days ($p > 0.05$). However, garlic oil-treated groups showed a consistent numerical reduction in lipid oxidation, protein degradation, liver enzymes, and serum lipid levels. Overall, garlic oil may be considered a safe natural feed additive with potential benefits for improving meat shelf life and metabolic health in broilers, although effects were not statistically significant under the present study conditions.

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