JWPR
Journal of World's Poultry Research
2025, Scienceline Publication
J. World Poult. Res. 15(2): 184-193, 2025
Research Paper
DOI: https://dx.doi.org/10.36380/jwpr.2025.19
PII: S2322455X2500019-15
ISSN: 2322-455X

Effects of Supplementation of Oregano Essential Oil on the Growth Efficiency and Blood Biochemical Parameters of Broiler Chickens

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Received: March 19, 2025, Revised: April 21, 2025, Accepted: May 24, 2025, Published: June 25, 2025

ABSTRACT

Oregano essential oil (OEO) has emerged as a safe, effective, and bioactive additive, increasingly incorporated into feed formulations to enhance the growth performance and overall well-being of broiler chickens. This experiment aimed to investigate the consequences of the dietary supplementation of OEO regarding the growth efficiency, carcass characteristics, and blood biochemical profiles of broiler chickens. The 35-day feeding trial involved 200 unsexed Hubbard Classic broiler chickens with an average initial body weight of 42.79 g. The broiler chicks were randomly assigned to four experimental groups, each comprising five replicates of ten birds. The treatment groups were fed basal diets supplemented with 300 mg/kg (OEO_{-1}), 400 mg/kg (OEO_{-2}), and 500 mg/kg (OEO_{-3}) of OEO, while the untreated group (OEO_{-0}) was fed a basal diet without any additives. Weekly assessments of growth performance metrics were conducted for 5 weeks, and blood parameters were examined once on day 35. The results revealed that OEO_{-3} treatment had a significant impact on the body weight, feed intake, and feed conversion ratio of broilers. A considerably increased dressing percentage was observed in the OEO_{-3} group. The findings indicated that OEO-supplemented groups significantly influenced both high-density lipoprotein (HDL) and low-density lipoprotein (LDL) levels, especially OEO_{-3}, which showed higher HDL and lower LDL levels compared to other treatment and control groups. However, no significant effect was observed on total blood cholesterol and triglyceride concentrations in the experimental broilers. Incorporating OEO into the diet suggested that the higher doses (500 mg/kg) enhanced growth efficiency, increased HDL cholesterol, and decreased LDL and triglycerides in the blood of broiler chickens.

Keywords: Blood parameter, Broiler chicken, Feed conversion ratio, Growth efficiency, Oregano oil

INTRODUCTION

Poultry production is a key component of animal husbandry, which is facing new challenges and requires innovative strategies to maintain sustainability (El-Hack et al., 2022). Regardless of age or religion, chicken meat is a widely accessible and affordable animal protein, favored across all social classes. Meat and eggs from poultry are essential components of the human diet (Regar et al., 2019). To increase productivity and prevent disease, the majority of Bangladesh's rural chicken producers regularly use antibiotics on everything from day-old chicks to market-ready chickens (Haque et al., 2020). Nonetheless, the extensive application of antibiotic growth promoters (AGP) contributes to antibiotic resistance as well as the residues of antibiotics in animal-derived products. These antibiotic residues pollute the natural environment through excrement and feces, which pose a hazard to community health security (Suresh et al., 2018; Chen et al., 2022). Due to health concerns, the application of antibiotics to promote growth in the animal breeding sector has already been outlawed, and in many countries, using antibiotics as a growth promoter is forbidden.

Drug-resistant bacteria may proliferate as a result of the protracted and unchecked abuse of antibiotics in chicken farms (Simitzis, 2017; Egbule, 2022). But

To cite this paper: Islam MS, Mir DA, Nazir ME, Islam S, Hossain SMI, Hasan MI, Zaman S, Swar DK, and Sultana S (2025). Effects of Supplementation of Oregano Essential Oil on the Growth Efficiency and Blood Biochemical Parameters of Broiler Chickens. *J. World Poult. Res.*, 15(2): 184-193. DOI: https://dx.doi.org/10.36380/jwpr.2025.19

customers now demand healthier alternatives to traditionally raised broiler meat, which has driven a global transition towards antibiotic-free broiler meat production (Haque et al., 2020). Since the widespread acceptance of broiler meat as a healthier substitute, which contains lower fat and higher protein than other meats, as well as its economic value, it has high demand among consumers. In addition to advancements in genetics and management, numerous feed additives have been used to increase productivity and other qualities to meet the demands of the broiler sector (Hussein et al., 2020). The use of essential oils has been demonstrated to be an efficient and promising alternative to antibiotics for both pre- and post-harvest antibacterial methods (Micciche et al., 2019). According to the study by Nehme et al. (2021), plant-based essential oils are beneficial for the physical state of pigs (Chen et al., 2024), chickens (Gopi et al., 2014), with large/small ruminants, such as cattle and goats (Wells, 2023). It is known that the primary ingredients of Oregano Essential Oil (OEO), extracted from origanum plants, are thymol and carvacrol (Oniga et al., 2018). When given to broiler chickens, oregano oil has been demonstrated to possess antimicrobial, antioxidant, antiviral, anti-parasitic, and immune-modulatory properties (Alagawany et al., 2018). Moreover, oregano may enhance productivity (Ding et al., 2020) and stimulate the immune system (Rashidian et al., 2021). The aromatic plant oregano (*Origanum spp.)* has been used in poultry feed in place of pharmaceutical antibiotics due to its abundance of active ingredients such as carvacrol, thymol, rosmarinic acid, flavonoids, terpenes, and caffeic acid, among others (Oniga et al., 2018). Several studies demonstrated that supplementing oregano essential oils to chicken diets increases body weight and feed conversion ratio, enhances digestion, reduces disease incidence, boosts productive performance, and diminishes economic loss (Alagawany et al., 2018). Recently, many efforts have been devoted to studying the cholesterol-decreasing function of essential oil or plant-based extracts (Cross et al., 2003) along with their immune stimulatory effects (El-Faham et al., 2015). The present study lies in its investigation of OEO as a potential growth promoter in the dietary supplementation for poultry, especially in the production of broiler chicken. Therefore, this study was designed to evaluate the effects of OEO on the growth performance and blood biochemical indicators of broiler chickens.

MATERIALS AND METHODS

Ethical approval

All the chicks used in this experiment were treated and managed under the rules outlined by the Bangladesh Veterinary Council Act 2019, Government of the People's Republic of Bangladesh. Broiler care instructions and use regulations established by the institutions and countries have been followed strictly. All precautionary measures were taken into consideration to reduce pain and distress during the experimental period.

Experimental birds' selection

In the present study, a total of 200-day-old, unsexed broiler chicks (Hubbard Classic, with a mean initial body weight of 42.79 g) were utilized, which were purchased from a commercial hatchery in the Gazipur district of Bangladesh. Strict selection criteria were implemented prior to purchase to ensure consistent body size and the absence of visible deformities. These criteria included evaluation of physical characteristics, such as feather condition, leg structure, and general alertness of chickens.

Study location and experimental framework

The experimental poultry house of the Department of Poultry Science, Khulna Agricultural University, Khulna, Bangladesh, was utilized to conduct the feeding trial. Firstly, all the chicks were weighed, and then they were randomly allocated to four feeding treatments, each with five replicates, each containing 10 broiler chicks, using a completely randomized design (CRD). Figure 1 shows how the experiment is designed. The following four treatment groups were included in the experimental design. In the first group, chickens were fed a basal diet without any supplement (OEO_{-0}). In the second group, chickens were fed a basal diet supplemented with 300 mg/kg of oregano essential oil (OEO_{-1}). While in the third group, chickens were fed a basal diet supplemented with 400 mg/kg of oregano essential oil (OEO_{-2}). Finally, in the fourth group, chickens were fed a basal diet supplemented with 500 mg/kg of oregano essential oil (OEO_{-3}).

Housing and management of chicks

The experimental chickens were housed in an open-sided broiler rearing facility with rice husks used as bedding on a deep litter floor system. Following the manufacturer's guidelines, a phenyl solution was used to clean and disinfect housing areas, feeders, drinkers, heaters, and other relevant equipment. During the first week, the brooding temperature was maintained at 33°C, after which it was reduced by 2°C per week until it reached 24°C at the end of the trial. A relative humidity of 65% was regulated throughout the farm. Continuous lighting was provided for 24 hours a day during the entire experimental period. As a preventive measure, all chickens were administered the recommended vaccinations against Newcastle Disease (ND) on days 5 and 22, while chickens received the routine vaccination against Infectious Bursal Disease (IBD) on days 10 and 17, and these vaccines are produced in Bangladesh. Throughout the investigation, the chickens were managed according to standard husbandry practices following the breeder's instructions.

Experimental diets

The birds were fed with a mix bought from the nearby market, primarily consisting of corn and soybean meal, along with other ingredients. A starter diet, containing 22.08% crude protein and 3003.82 kcal ME/kg, was given during the first 14 days of the trial, and a ration for growing chicks was provided from day 15 to day 35, containing 21.05% crude protein and 3102.32 kcal ME/kg. The experimental diets were free from growth promoters, antibiotics, or anti-coccidial drugs. Throughout the study period, chickens had ad libitum access to fresh and clean water. The ingredients, compositions, and nutrient profiles of basal diets were formulated to meet the nutritional requirements at the growing stages and are presented in Table 1. The proximate composition of the basal diet was formulated according to AOAC (1990). All chickens were allowed unrestricted access to feed and water during the trial.

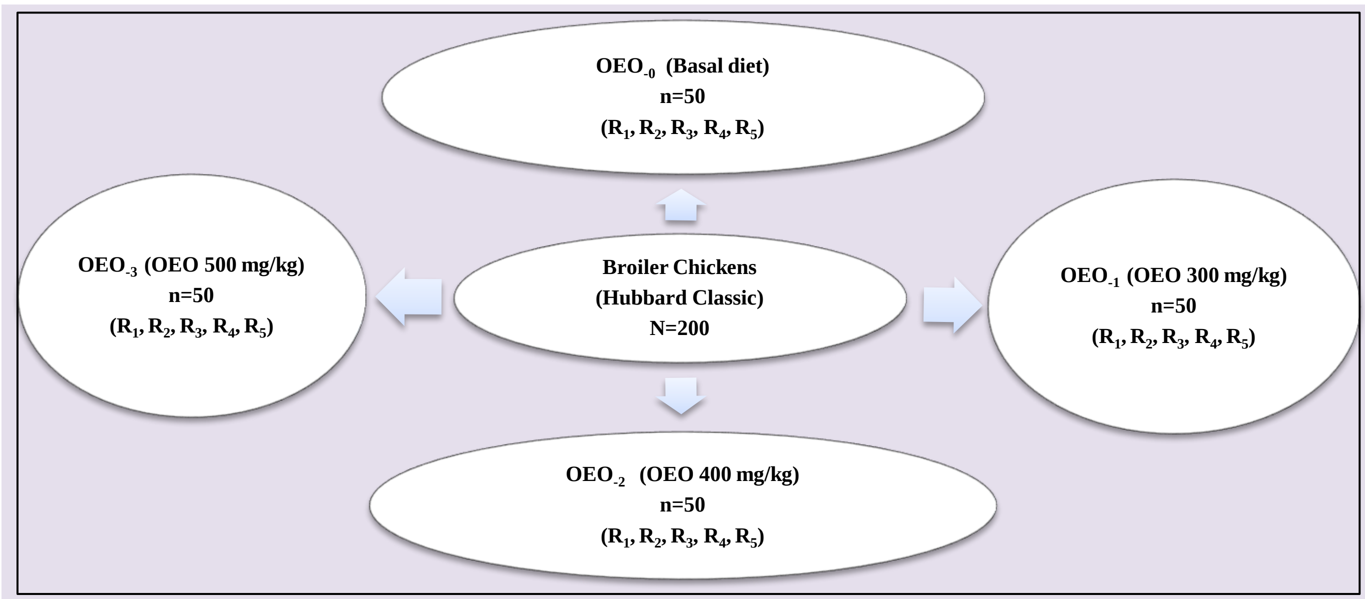

Figure 1. An overview of the experimental design with the Hubbard Classic breed of broiler chicken from September 2022 to June 2023.
***** OEO_{-0}: Basal diet; OEO_{-1}: Oregano essential oil (300 mg/kg); OEO_{-2}: Oregano essential oil (400 mg/kg); OEO_{-3}: Oregano essential oil (500 mg/kg); mg: Unit at milligram; kg: Kilogram**;** R: Replicates; n: Number of experimental chickens; N: Total number of experimental samples

Table 1. Feed ingredients and compositions of nutrients supplied to broiler chickens

Ingredients	**Starter (0-14 days) (%)**	**Grower (15-35 days) (%)**	**Ingredients**	**Starter (0-14 days) (%)**	**Grower (15-35 days) (%)**
Maize	57.80	58.00	Meat and bone meal	3.00	2.40
Wheat bran	0.00	2.26	Fish meal	0.60	1.00
Rice polish	1.80	2.00	Limestone	0.80	0.90
Full-Fat Soybean	2.00	2.00	Di-calcium phosphate	0.49	0.10
Vegetable oil	2.00	3.00	Common salt	0.25	0.20
Molasses	1.00	0.70	Vitamin mineral premix	0.20	0.01
Soybean meal	28.00	26.20	L-Lysine	0.02	0.01
Protein concentrate	2.00	1.20	L-Methionine	0.03	0.01
Antioxidant	0.01	0.01	Total metabolic energy (kcal/kg)	3003.82	3102.32
Calculated composition (%)					
CP (Crude Protein)	22.08	21.05	Ash	4.28	4.14
CF (Crude Fat)	3.54	3.72	Lysine	1.33	1.24
EE (Ether Extract)	5.39	6.36	Methionine	0.35	0.33
Available phosphorus	0.78	0.69	Calcium	1.08	0.92

*CP: Crude protein; CF: Crude fiber; EE: Ether extract

Experimental essential oil

The oregano essential oil (*Origanum vulgare)* utilized in this study was sold as Orego-Stim® powder. It is made up of more than thirty chemicals in a complex and natural matrix. It was purchased from the local market. Carvacrol (82%) and thymol (2.4%) are the two phenolic chemicals that account for over 85% of the makeup (Calislar et al., 2009).

Growth performance parameters

As soon as the day-old broiler chickens arrived at the experimental farm, each bird was weighed separately, and their weight was recorded. Thereafter, until the completion of the experiment, weekly records of body weight (BW), body weight gain (BWG), and feed intake (FI) in grams (g) were made in order to determine the feed conversion ratio (FCR) for each replicate within each treatment.

Body weight

To evaluate the effects of diet on body weight and growth patterns, the broilers were weighed at the start of the experiment and then weekly, in the morning before being given access to feed or water.

Feed intake

The daily feed consumption per chick was calculated by subtracting the weight of the leftover feed after 24 hours from the amount of initially provided feed, then dividing the difference by the total number of chickens in each group. The supplied feed weight was taken in the morning, and the leftovers were measured at night.

$$\text{Feed Intake (FI)} = \frac{\text{Weight of feed supplied (g) - Weight of leftover feed (g)}}{\text{Number of chickens in each group}}$$

Feed conversion ratio

The feed conversion ratio (FCR) was calculated by dividing the chickens' total weekly feed consumption (g) by their corresponding body weight gain (g). Improved efficiency is indicated by a decreased FCR, which means that birds need less feed to achieve one unit of body weight. The following formula by Dissanayake and David (2017) was used for calculating the FCR in Broiler chickens:

$$\text{FCR} = \frac{\text{Feed intake (g) / Chicken/week}}{\text{Body weight (g) / Chicken/week}}$$

Body weight gain

The body weight gain of the broiler was calculated by finding the difference between the final and initial body weight at a specific period of time.

Carcass characteristics

Five chickens per treatment were randomly selected at the end of the trial and fasted for 12 hours before slaughter. Studies have indicated that a fasting period of 8 to 12 hours is ideal for reducing the risk of contamination while maintaining carcass yield (Schneider and Gewehr, 2023). Slaughter was performed using the Halal method, following local religious practices. The carcass dressing percentage was then calculated using the following formulas provided by Wu et al. (2020).

$$\text{Dressing percentage} = \frac{\text{Carcass weight (g) / bird}}{\text{Live body weight (g) / bird}} \times 100$$

Analysis of blood biochemical parameters

By the end of the 35-day experiment, a sterile plastic syringe (5 ml) was used to aseptically collect 3 ml of blood from the wing veins of five randomly selected broilers in each group. To extract the serum, the blood samples were centrifuged immediately for 20 minutes at a velocity of 3000 rpm. Following that, the separated serum samples were transferred to 1.5 ml cryovial tubes (red top) and stored at -20 °C until they were analyzed. Total cholesterol, HDL, LDL, and triglyceride concentrations in the serum were assessed using commercially available standard kits (BioMereux, France) and an automatic analyzer (Humalyzer 300, Merck®, Germany), following the guidelines provided by the manufacturer.

Statistical analysis

All the performance data were entered into a spreadsheet program of Microsoft Office Excel 2010. Using the Statistical Package for the Social Sciences (SPSS) Version 26, the data management and analysis were performed using one-way analysis of variance (ANOVA). To ascertain whether the treatment variations were significant, Duncan's Multiple Range Test was employed. The Means±Standard Error of the Means (M±SEM) were used to express the results. If the probability Value was less than 0.05 ($p < 0.05$), it was considered statistically significant.

RESULTS

The impact of adding OEO to the diet on the growth efficiency measures of broiler chickens is displayed in Table 2. The results of this investigation demonstrated that oregano essential oil (OEO) decreased the feed conversion ratio (FCR) of broiler chicks and improved growth efficiency compared to the control group ($p < 0.05$).

Throughout the experiment, broiler chickens fed varying amounts of dietary OEO exhibited a significant increase in feed intake compared to the control group on days 14, 21, 28, and 35 ($p < 0.05$). Notably, chickens supplemented with 500 mg/kg of OEO consumed significantly more feed than birds in all other dietary treatments, including the control group.

Table 2. Effects of dietary supplementation of oregano essential oil on the growth performance parameters of broiler chickens

Age (weeks)	Dietary treatments (Mean ± Standard Error of the Mean)				P-Value
	OEO_{-0}	OEO_{-1}	OEO_{-2}	OEO_{-3}	
Feed intake (g)					
1	$184.51^{a}\pm4.82$	$196.52^{a}\pm4.20$	$233.54^{b}\pm6.18$	$219.86^{b}\pm5.16$	<0.01
2	$546.32^{a}\pm8.29$	$578.72^{a}\pm10.20$	$613.15^{b}\pm14.03$	$629.76^{b}\pm9.95$	<0.01
3	1132.31±18.26	1180.75±21.50	1228.07±31.87	1237.91±36.70	0.062
4	$2048.79^{a}\pm19.77$	$2114.35^{ab}\pm42.61$	$2145.66^{b}\pm27.14$	$2195.16^{b}\pm22.93$	0.020
5	$2590.33^{a}\pm16.72$	$2679.84^{b}\pm28.23$	$2723.22^{b}\pm36.12$	$2753.17^{b}\pm23.68$	0.004
Body weight (g)					
1	$197.31^{a}\pm2.61$	$238.30^{bc}\pm3.96$	$234.93^{b}\pm3.66$	$247.56^{c}\pm4.85$	<0.01
2	$494.84^{a}\pm6.98$	$541.35^{b}\pm9.06$	$576.13^{c}\pm8.08$	$592.56^{c}\pm7.98$	<0.01
3	$930.21^{a}\pm18.54$	$1038.67^{b}\pm20.83$	$1051.88^{b}\pm28.95$	$1085.57^{b}\pm14.40$	<0.01
4	$1387.81^{a}\pm14.00$	$1473.28^{b}\pm21.31$	$1527.18^{b}\pm31.70$	$1548.13^{b}\pm26.93$	<0.01
5	$1558.61^{a}\pm21.53$	$1677.60^{b}\pm14.01$	$1734.79^{bc}\pm15.28$	$1775.83^{c}\pm27.43$	<0.01
Dressing yield (%)	$69.76^{a}\pm0.73$	$71.36^{a}\pm0.80$	$71.87^{a}\pm0.72$	$74.77^{b}\pm1.35$	0.013
Body weight gain (g)					
1	$154.52^{a}\pm2.61$	$195.51^{bc}\pm3.96$	$192.14^{b}\pm3.66$	$204.77^{c}\pm4.85$	<0.01
2	$297.53^{a}\pm5.48$	$303.05^{a}\pm6.49$	$341.20^{b}\pm5.97$	$344.99^{b}\pm7.43$	<0.01
3	435.36±24.94	497.32±22.90	475.74±34.04	493.01±20.59	0.352
4	457.59±14.84	434.61±11.90	475.30±14.74	462.55±38.17	0.645
5	170.80±23.15	204.31±17.14	207.61±37.95	227.70±48.84	0.702
Feed conversion ratio					
1	$0.94^{bc}\pm0.036$	$0.82^{a}\pm0.025$	$0.99^{c}\pm0.030$	$0.89^{ab}\pm0.032$	0.011
2	1.10±0.012	1.07±0.030	1.06±0.032	1.06±0.012	0.654
3	1.21±0.033	1.13±0.019	1.17±0.053	1.14±0.029	0.389
4	1.47±0.024	1.43±0.042	1.40±0.020	1.42±0.026	0.423
5	$1.66^{b}\pm0.027$	$1.59^{ab}\pm0.018$	$1.56^{a}\pm0.021$	$1.55^{a}\pm0.021$	0.014

* OEO_{-0}: Basal diet; OEO_{-1}: Oregano essential oil (300 mg/kg); OEO_{-2}: Oregano essential oil (400 mg/kg); OEO_{-3}: Oregano essential oil (500 mg/kg); g: Unit at gram; ^{a,b,c} Means within the same row with different superscript letters are significantly different ($p < 0.05$).

The results of this investigation demonstrated that the OEO decreased the FCR of broiler chicks and improved the growth efficiency compared to the control group ($p < 0.05$). Throughout the experiment, broiler chickens fed varying amounts of dietary OEO exhibited a significant increase ($p < 0.05$) in feed intake in comparison to the control group on days 14, 21, 28, and 35. Notably, chickens supplemented with 500 mg/kg of OEO consumed significantly more feed than birds in all other dietary treatments, including the control group. The body weight of the experimental birds is shown in Table 2. At the end of 35-day experiment, the group OEO_{-3} receiving 500 mg/kg of oregano essential oil in their diet exhibited a considerably higher final body weight compared to the control group, followed by the groups OEO_{-2} and OEO_{-1} that received 400 mg/kg and 300 mg/kg of OEO in their diets, respectively. On the other hand, the treatment with OEO_{-3} showed the highest weekly body weight gain of 493.01±20.59 g during 3rd week of age in broiler chicken, followed by OEO_{-2} (475.74±34.04 g) and OEO_{-1} (497.32±22.90 g). However, in the control group (OEO_{-0}), the highest average body weight gain of 457.59±14.84 g was found at the 4th week of age. An increasing trend in body weight gain at 1st, 2nd, and 3rd weeks was observed in all treatments (OEO_{-3}, OEO_{-2}, and OEO_{-1}) and also in the control group (OEO_{-0}). Additionally, the significant differences ($p < 0.01$) were observed only in terms of weekly average body weight gain (g) at the 1st and 2nd weeks of age in broiler chickens. At the 3rd, 4th, and 5th weeks of age, no significant differences were observed between treatment and control groups, indicating body weight gains across all dietary treatments by the later weeks (3rd to 5th) neither increased nor decreased remarkably. Furthermore, Table 2 demonstrates the impact of adding OEO to the diet and the FCR of broiler chickens. The findings of the current study indicated that the feed conversion ratio (FCR) of broiler chicken from day 1 to 35 was significantly reduced ($p < 0.05$) in the oregano essential oil (OEO) treated groups compared to the control group. However, chickens in the treatment OEO_{-3} group (500 mg/kg) exhibited the lowest FCR at day 35 compared to both the control (OEO_{-0}) and other OEO supplemented groups. Additionally, the data presented in the table showed that average feed intake was higher in the OEO supplemented chickens compared to the control group. In the control group, the feed intake was 184.51 g in the first week, which was increased to 219.86 g in the OEO_{-3} treatment group. In the last week, the average feed intake was 2590.33 g in the control group, followed by 2679.84 g in OEO_{-1}, 2723.22 g in OEO_{-2}, and 2753.17 g in the OEO_{-3} group. The chicken's body weight was 197 g at the first week and 1558.61 g at the fifth week of age in the control group of chickens, whereas in the treatment group OEO_{-1}, it was about 238.30 g and 1677.60 g in the first and fifth week, respectively. In addition to this, in the OEO_{-2} group, the growing weight of the broiler was 247.56 g and 1775.83 g recorded during the first and fifth week of age. Additionally, the OEO_{-3} treatment group showed the best growth performance in comparison to the control, OEO_{-1}, and OEO_{-2} groups. Regarding feed conversion ratio (FCR), the lowest value was observed in the OEO_{-3} group (1.55), and the highest FCR (1.66) was found in the control group. The highest dressing percentage was found in the OEO_{-3} group (74.77%), followed by OEO_{-2} (71.87%), OEO_{-1} (71.36%), and the control group (69.76%). Some of the blood biochemical parameters are displayed in Table 3. Based on the data from this investigation, OEO was not shown to have any influence on total cholesterol ($p > 0.05$). In contrast with the control group, the total serum cholesterol concentration was up in the OEO_{-2} and OEO_{-3} treatment, whereas it was decreased in the OEO_{-1} group. The total HDL cholesterol level was lowest in the control group (63.74 mg/dl) and highest in the OEO_{-3} group (77.52 mg/dl). LDL levels decreased from 74.85 mg/dl in the control group to 59.19 mg/dl in the OEO_{-3} group. In addition, the triglyceride level also declined in the treatment group at 41.69 mg/dl in OEO_{-1}, 38.27 mg/dl in OEO_{-2}, and 37.18 mg/dl in OEO_{-3}, whereas in the control group, it was about 44.25 mg/dl. In the present study, the overall cholesterol level was 131.86 mg/dl in the control group and 133.28 mg /dl in the treatment group OEO_{-3}. Furthermore, broilers supplemented with oregano essential oil (OEO) showed a significant increase in HDL levels compared to the control group at 35 days of age ($p < 0.05$). On the other hand, supplementing the diet with OEO caused a substantial reduction in LDL in comparison to control chickens ($p < 0.05$). However, the inclusion of different doses of OEO to the regular diet decreased the serum triglyceride levels, indicating the increased triglycerides (mg/dl) levels at OEO_{-1} (300 mg/kg) and gradually decreased in OEO_{-2} (400 mg/kg) and OEO_{-3} (500 mg/kg) groups. Although these decreasing levels were not statistically significant compared to the control group ($p > 0.05$).

Table 3. Effects of oregano essential oil supplementation in the diet of broiler chickens on the blood biochemical parameters at 35 days of age

Blood parameters	Dietary treatments (Mean ± Standard Error of the Mean (SEM))				P-value
	OEO_{-0}	OEO_{-1}	OEO_{-2}	OEO_{-3}	
Total cholesterol (mg/dl)	131.86±5.19	126.89±4.85	137.06±8.67	133.28±7.61	0.765
HDL (mg/dl)	63.74^{a}±3.39	68.65^{a}±2.10	71.37^{ab}±2.38	77.52^{b}±2.94	0.020
LDL (mg/dl)	74.85^{b}±2.88	67.45^{ab}±2.60	65.54^{ab}±4.03	59.19^{a}±1.96	0.015
Triglycerides (mg/dl)	44.25±1.50	41.69±2.49	38.27±1.86	37.18±3.36	0.188

OEO_{-0}: Basal diet; OEO_{-1}: Oregano essential oil (300 mg/kg); OEO_{-2}: Oregano essential oil (400 mg/kg); OEO_{-3}: Oregano essential oil (500 mg/kg); HDL: High density lipoprotein; LDL: Low density lipoprotein; mg/dl: Milligrams per deciliter $*^{a,b}$ indicates within the same row with different superscript letters are significantly different ($p < 0.05$).

DISCUSSION

In the current study, broiler performance was demonstrated by a considerable gain in BW and a decline in FCR following dietary OEO supplementation. Numerous studies have reported that oregano extract improves the growth efficiency of broiler chickens, consistent with the outputs of the present investigation (Amer et al., 2021; Irawan et al., 2021; Zhang et al., 2021). When compared to control chickens, Roofchaee et al. (2011) reported that broiler diets supplemented with 600 mg/kg of oregano during the grower stage considerably boosted ($p < 0.05$) body weight gain. In the opinion of Zaazaa et al. (2022) and Zhang et al. (2023), the broilers treated with 350 mg/kg and 700 mg/kg of oregano oil had the lowest FCR and considerably higher BW than the control group. When broiler chickens were treated with a mixture of oregano and thyme essential oil at 100+100 mg/kg, 200+200 mg/kg, and 300+300 mg/kg of diets, they showed increased body weight and reduced Feed Conversion Ratio (FCR) (Razaq et al., 2023). At the seventh week of life, broilers supplemented with 6% oregano had the heaviest BW, while broilers without the supplementation had the lowest BW (Marcos et al., 2020). Similarly, broilers that were given a supplement of EO at a dosage of 300-600 mg/kg of feed demonstrated a significant improvement in FCR, daily body weight gain, and average daily feed consumption (Peng et al., 2016). These findings support the results of the present study. Jamroz et al. (2005) demonstrated that supplementing the diet with OEO greatly enhanced the digestive system's chymotrypsin activity and improved crude protein digestibility. This, in turn, stimulates the digestive system to produce more digestive enzymes (Ciftci et al., 2005). Zhang et al. (2021) state that oregano essential oils act as an antioxidant, enhance intestinal health through improving gut micro flora and boosting the immune status, which are the major factors for improving the growth performance of broilers. Nevertheless, a few contradictory studies revealed that the incorporation of OEO as a dietary supplement had no appreciable impact on the broiler chicks' growth performance (Avila-Ramos et al., 2012; Kirkpinar et al., 2014; Hernandez-Coronado et al., 2019).

In the current investigation, the supplementation of OEO in the broiler feed did not have an impact on blood cholesterol concentrations. However, the inclusion of various levels of oregano essential oils in the diet decreased the serum triglyceride levels at 35 days of age. The study on poultry has yielded comparable findings, indicating that serum triglyceride concentrations decrease when oregano oil concentration is increased to 200 mg/kg (Mendoza-Ordonez et al., 2020). According to Kolodziej-Skalska et al. (2022), serum triglyceride and cholesterol concentrations decreased when they were supplemented with different levels of oregano oil. The primary constituent of oregano oil is carvacrol, which lowers plasma triglycerides (Lee et al., 2003). One probable explanation is that the functional chemicals in oregano essential oil influence lipid metabolism systems, as Abo Ghanima et al. (2020) ascribe one of the bioactive constituents in oregano essential oil, thymol, to reduce the synthesis of cholesterol. According to Moghrovyan et al. (2019), the plasma HDL concentrations of birds fed OEO were considerably higher ($p < 0.05$) compared to the control chickens. Flavonoids are additional chemical components found in OEO, just like essential oils. In comparison with results from the current study, Mendez-Zamora et al. (2017) observed that 400 mg of Mexican oregano oil/kg of feed raised the HDL and LDL levels in broiler blood. Haryanto et al. (2016), who fed broilers banana peel meal as a supplement, reported that the flavonoids derived from OEO increased the apolipoprotein A_1 production, which could be one reason for an increase in HDL. However, according to Kirkpinar et al. (2011), oregano oil in the diet did not affect the blood triglycerides or cholesterol of broiler chickens. Different inclusion rates, feeding schedules, or essential oil manufacturing techniques could be the cause of variations in cholesterol levels between the present study and earlier studies (Lim et al., 2006).

CONCLUSION

In conclusion, the findings from the current study suggest that OEO enhances the growth efficiency in broiler chicken. Specifically, adding 500 mg/kg of OEO to the basal diet showed a tendency to improve growth performance parameters and promote the carcass traits of broiler chickens. To completely investigate the mechanism of action of OEO on the growth performance of broiler chickens and to increase the efficiency of its application in broiler feed, more research on different supplementation amounts of OEO in different ingredients of diets is required.

DECLARATION

Ethical considerations

The authors have examined ethical issues, including plagiarism, permissions to publish, misconduct, and duplicate publishing, for publishing this scientific research in the Journal of the World's Poultry Research.

Author's contribution

Md. Sahidul Islam contributed to the conceptualization, formal analysis, investigation, methodology, software development, supervision, validation, visualization, and the writing of the original draft, as well as the review and editing process. Dilruba Akter Mir was involved in the investigation, supervision, validation, and visualization. Md. Emran Nazir focused on validation and visualization. Syidul Islam participated in the conceptualization, methodology, validation, visualization, and review and editing of the writing. S. M. Iqbal Hossain contributed to the methodology, supervision, and validation. Sharmin Zaman and Dabobrata Kumar Swar were responsible for visualizing the original draft and reviewing and editing the writing. Sharmin Sultana engaged in writing the original draft and the review and editing process. Md. Iftakharul Hasan worked on conceptualization, methodology, validation, visualization, and the review and editing of the writing. All authors have reviewed and approved the final version of the study.

Availability of data and materials

The data are available upon reasonable request from the corresponding author.

Acknowledgments

The authors would like to thank the Department of Poultry Science, Faculty of Veterinary, Animal and Biomedical Sciences, Khulna Agricultural University, Khulna-9100, Khulna, Bangladesh, and all its members for their kind assistance and collaboration in helping to complete this research work.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing of interests

The authors declare no conflict of interest.

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