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The effect of adding cod liver oil to the diet on the productivity and blood parameters of broiler chickens

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ABSTRACT

The experiment was performed to evaluate the production performance and blood parameters of broiler chicken fed on cod liver oil enriched feed. A cohort of 96 day-old chickens was allocated at random into four treatment groups, denoted as T0, T1, T2, and T3. Each treatment group consisted of three replicates. In contrast to each replication consisting of eight birds, each treatment group comprises 24 birds. Experimental birds in T1, T2, and T3 were fed rations enriched with cod liver oil at 0.5%, 1%, and 2% by weight, respectively, whereas T0 received only standard feed and was designated as the control group. The findings of this research demonstrated that the final live weight and live weight gain of the birds in group T3 which was provided with feed enriched with 2% cod liver oil was significantly greater ($p<0.05$) than the other treatment groups. According to the findings of this research, the best feed conversion ratio was found in T3 group. With regard to blood parameters, treatment groups differed significantly and it was within the normal range. The highest RBC, WBC, PCV and Hb were found in T3 and lowest in T0 group. The optimum net profit was found in T3. On the basis of the findings, it is possible to conclude that the addition of 2% cod liver oil to broiler chicken feed has the potential to stimulate growth.

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Introduction

The poultry industry in Bangladesh is one of the most prospective and vital industrial sectors for the country's economic growth. Poultry assumes a critical function within the subsistence economy of Bangladesh, contributing 1.6% to the country's Gross Domestic Product (SAEDF, 2008). Rural women and unemployed adolescents can generate income rapidly through broiler farming, according to Hossain et al. (2010).

Despite the abundance of protein sources, meeting the growing demands of the population without broilers is problematic. Protein is derived from the meats of broilers. Farm proprietors also receive a rapid return on their investments. The detrimental impact on health is minimal, and there are no religious prohibitions regarding the consumption of grill meat. As a result, individuals of all ages, genders, and castes enjoy it, which contributes to the proliferation of poultry farms in Bangladesh. The majority of producers in our nation lack formal education and

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inadequate training in grill production. Pharmaceutical companies are taking advantage of this circumstance. They are attempting to persuade the producers to administer medication to the chickens. Huge quantities of chemical agents are consequently found in broiler meat. Antibiotic residues that penetrate the human body through the consumption of these broilers may cause severe health complications in humans (Kibria et al., 2009). Exploiting the potential of particular dietary supplements to improve poultry performance and feed conversion represents a novel challenge in the poultry industry. Presently, there is an increased consumer inclination towards functional foods that are fortified with advantageous natural constituents, to enhance their long-term health goals (Sloan, 2004). Polyunsaturated fatty acids (PUFA), specifically Omega-3 (n-3) fatty acids (FA), are among the numerous vital nutrients that must be included in the daily diet of humans. Among these, PUFA significantly contribute to the prevention of diseases such as cardiovascular, hypertension, diabetes, arthritis, and autoimmune disorders (Adkins & Kelley, 2010). In human nutrition, alpha-linolenic acid and its long-chain metabolites docosahexaenoic and eicosapentaenoic acids are the most essential n-3 fatty acids. Although ALA (α-linolenic acid)) can be used as a precursor in the synthesis of EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), research has shown that this conversion is limited in the human body (Keten, 2019). Therefore, it can be hypothesised that omega-3 fatty acids, which are essential for health protection, can be deposited in the human body through the consumption of chicken meat (Bharath et al., 2017). A commercial diet, both supplemented and unsupplemented, was provided for the animals' 21-day diet, and water was available for their adlibitum consumption. To the commercial diet for supplemented animals, 0.5–0.8 g of omega-3 derived from the cod population was added daily.

As a result, omega-3-enriched poultry products may represent a feasible alternative within the production system. ALA can be converted by grill chickens into docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), which are subsequently deposited in the meat. Nevertheless, the conversion efficiency is restricted (Kralik et al., 2008; Zuidhof et al., 2009). Particularly abundant in n-3 long-chain PUFA are EPA and DHA in fish oil (Koreleski and Swiatkiewicz, 2006). The lipid profile of grill meat is enhanced by dietary omega-3 PUFA (Schreiner et al., 2005). Peroxidation is initiated when free radicals attack polyunsaturated fatty acids, which makes them susceptible to oxidation (Scislowski et al., 2005; Estevez, 2015). The byproducts of lipid oxidation contribute to degradation. At present, there is a surge in the attention given to natural antioxidants due to their perceived safety in comparison to synthetic antioxidants and their potential for enhancing the palatability, stability, acceptability, and shelf life of meat products (Park and Kim 2008; Laila et al. 2019).

The utilization of oils in poultry diets offers several benefits, including enhanced hydrolysis and absorption of the lipoproteins that provide fatty acids, as well as a decrease in feed particles (Nobakht et al., 2011). With the maximum caloric content of all dietary nutrients, oils also serve as the primary energy source for the birds. Additionally, they can optimize the utilization of ingested energy, enhance the palatability of diets, and facilitate the absorption of fat-soluble vitamins. Furthermore, by decreasing the rate at which food traverses the gastrointestinal tract, the absorption of all dietary nutrients can be enhanced (Poorghasemi et al., 2013). Cod liver oil is considered a source of significant energy. It has been demonstrated that feed efficacy and growth are enhanced by high-energy diets (Hosseini-Vashan et al., 2010; Sahito et al., 2012).

Hence, the objective of this research endeavour was to ascertain the optimal concentration of cod liver oil-enriched feed meal that would impact growth performance, calculate the cost-benefit analysis of broiler poultry production, and estimate blood parameters.

Material and Methods

Ethical approval: Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur-5200,Bangladesh[Approval code: HSTU/VAS/ASN/ EA/011], gave their approval for the trial.

Location and Period: The trial was carried out from July 2019 to December 2019 at Malek's Poultry Farm, located in Karnai, Dinajpur.

Table 1. The layout of the experiment

Dietary Groups		Number of Broilers in each replication			Total
		R_1	R_2	R_3	
Control (without liver oil)	T_0	8	8	8	24
0.5% Cod liver oil	T_1	8	8	8	24
1% Cod liver oil	T_2	8	8	8	24
2% Cod liver oil	T_3	8	8	8	24
Total No. of broilers		32	32	32	96

Experimental birds: A total of 96 Cobb 500 day-old broiler chicks were bought from CP Limited in Sadar, Dinajpur, Bangladesh.

Layout of the experiment: For seven days, the day-old chicks were raised in a brooder house to acclimate to their environment. Following a period of seven days, the chicks were assigned at random to one control group and three (3) dietary treatment groups, with eight birds per replication (Table 1).

Procurement of feed ingredients: The experimental regimens will be prepared using feed ingredients procured in the necessary quantities from the local market in Dinajpur town (Table 2).

Table 2. Composition of basal diets

Ingredients (%)	Starter (8-16 d)	Grower (17-35 d)
Corn	54.87	61.78
Soybean meal	36.72	26.36
Fishmeal	1.31	4.50
Vegetable oil	3.00	4.00
Limestone	1.15	1.05
Dicalcium phos-phate	1.94	1.49
Vit. and min.premix1	0.50	0.50
Salt	0.30	0.30
DL-methionine	0.21	0.02
Total	100.00	100.00
Calculated chemical composition		
ME(kcal/kg)	2900	3100
CP (%)	21.44	19.37
Calcium (%)	1.05	1.00
Phosphorus (%)	0.16	0.50
Sodium (%)	1.41	0.14
Arginine (%)	1.41	1.23
Methionine+Cystine (%)	0.91	0.69
Lysine (%)	1.20	1.10
Tryptophan (%)	0.31	0.26

Source: Isalm et al., 2017

Collection, processing and storage of Cod liver oil: Dinajpur, Bangladesh, is the location where cod liver oil is purchased locally. The purchased cod liver oil was preserved in a plastic container.

Preparation of the experimental diet: In this investigation, the formulated feed was utilized. Initially, the prescribed quantity of the formulated feed ingredients was determined using a digital weighing balance. Two phases comprised the experimental period: broiler-starter and broiler-grower. The broiler chickens were provided with a broiler starter for a duration of 0 to 10 days, followed by a broiler grower from 11 to 35 days.

Immunization: On the first day, the company vaccinated all birds against Ranikhet Disease and Infectious Bronchitis, which affect newborn chicks. The birds were administered the Ranikhet and Infectious Bursal (Gumboro) vaccines following the subsequent evening schedule (Table 3).

Management of the experimental birds: Individual chick weights were recorded as initial body weights on the first day of the experiment. In the current study, cages measuring 120 cm by 76 cm on each floor of the experimental home were considered. The enclosures underwent thorough cleaning, washing, and bleaching powder disinfection. The room was disinfected with Virkon solution (50 ppm) after 15 days. Concurrently, every essential piece of equipment was meticulously cleansed and laundered. Garbage was encased in fresh newspaper for a duration of seven days, after which the newspaper was removed as it became soiled. Following that time, the birds were confined to a floor strewn with rice husks, which reached a depth of 4 cm. Before the application of refuse, calcium carbonate was dispersed across the floor. The upper portion of the litter containing the droppings was routinely removed after the first week and agitated three times per week until the conclusion of the experiment. Every other day, the refuse was disinfected with Virocid® solution. The litter was agitated at the conclusion of each week in order to disrupt its compaction and supply it with adequate moisture. After the second and third weeks of life, the litter was cleared of droppings. From the initial week of age, until the chickens acclimated to the ambient temperature of the house, the incubation temperature was maintained at 34°C. Subsequently, it was progressively reduced until the final temperature of 23°C was reached at the conclusion of the experiment. An additional source of heat was provided by placing a 100-watt incandescent bulb in the centre of pen, 12 inches above the ground level, away from the 7-day-old chicks. The daily room temperature (°C) was monitored using a thermometer every six hours. Throughout the experiment, each bird was subjected to a daily cycle of nineteenth hours of continuous illumination followed by an hour of darkness. During the initial week, the birds were fed on clean newspapers every three hours for the first three days. Round plastic pitchers and linear feeders were utilized during the brooding phase. The linear feeder was subsequently substituted with the circular plastic

Table 3. Vaccination program

Diseases	Day	Vaccine	Route	Time
Ranikhet	4	BCRDV	Eye	Evening
Gumboro	10	Gumborovac	Eye	Evening
Gumboro	16	Gumborovac	Eye	Evening
Ranikhet	21	ND Lasota	Eye	Evening

tumbler. In the treatment groups, feeds were administered thrice daily (in the morning, at midday, and again at night) and were weighed using a measuring balance.

Mortality, live weight, feed intake, and feed conversion ratio were all monitored for the duration of the 35-day rearing period. In order to estimate the dressing yield, one bird was removed from each replication and blood samples were obtained at the moment of slaughter for hematological parameter analysis.Blood samples from two broilers in each replicate randomly were collected from the wing vein in a test tube with EDTA anticoagulant. Hematological parameters such as RBC, WBC, PCV and Hb were determined by Complete blood count (CBC) test at Update Laboratory in Rangpur, Bangladesh.

Statistical analysis: Analysis of variance (ANOVA) was performed on the data pertaining to various variables within a Completely Randomised Design (CRD) as described by Steel and Torrie (1980). The analysis of variance (ANOVA) table was utilized to determine the significance of the differences among the treatment means. Every analysis was conducted using the "IBM SPSS Statistics 22" software.

Results and Discussion

Effect of cod liver oil on live weight (g) of broilers : According to the data presented in Table 4, cod liver oil influences the live weight of broilers. There was no statistically significant (P>0.05) difference in live weight between the treatment groups on the first and seventh day of the experiment, according to the findings of the present study. By the 7th day of the trial, the body weight of the various dietary treatment groups was nearly identical. The treatment groups exhibited significant differences in live weight (P<0.05) on the 14^{th}, 21^{st}, 28^{th}, and 35^{th} days of age. Upon the conclusion of the experiment, it was observed that T3 (1692.9 ± 7.940) containing 2% cod liver oil mixed with feed had the maximum body weight compared to T2 (1602.9 ± 4.588), T1 (1550.4 ± 22.331), and T0 (1494.9 ± 28.283).

Birds in diet group T0 had the lowest live weight (P<0.05), while birds in diet group T3 had the highest live weight (P<0.05). The growth of dietary group T3 was enhanced through the administration of a 2% mixture of cod liver oil and feed.

A study conducted by Elzobier et al. (2016) observed a significant (P<0.05) rise in the live weight of chickens that were administered a diet containing up to 3% Fish Oil (FO), in comparison to the control group.

Table 4. Effect of cod liver oil on live weight (g) in different dietary treatment groups of broiler

Age (Day)	Live weight (g)				Level of significance
	T_0	T_1	T_2	T_3	
Initial BW	39.2 ± 2.10	38.7 ± 1.10	38.2 ± 1.80	38.9 ± 2.90	NS
7^{th}	187.9 ± 7.978	182.5 ± 1.847	185.3 ± 2.810	196.1 ± 2.862	NS
14^{th}	347.5 ± 17.859^{a}	384.7 ± 19.637^{ab}	437.8 ± 24.260^{b}	453.5 ± 29.266^{b}	*
21^{th}	742.0 ± 9.246^{a}	761.9 ± 10.664^{ab}	771.0 ± 7.725^{b}	798.4 ± 4.101^{c}	*
28^{th}	1117.2 ± 16.803^{a}	1136.6 ± 16.208^{ab}	1187.3 ± 9.429^{b}	1249.7 ± 22.056^{c}	*
35^{th}	1494.9 ± 28.283^{a}	1550.4 ± 22.331^{ab}	1602.9 ± 4.588^{b}	1692.9 ± 7.940^{c}	*

Legends: BW =Body weight, T0= Control diet,T1= Control diet + 0.5% cod liver oil,T2= Control diet + 1% cod liver oil ,T3= Control diet + 2% cod liver oil, ±= Standard error, abc means having different superscript in the same row differed significantly (P<0.05), *= P ≤ 0.05, NS= Non significant

Table 5. Effect of cod liver oil on body weight gain (g) and mortality in different dietary treatment groups of broiler

Age (Day)	Body weight gain (g/day)				Level of significance
	T_0	T_1	T_2	T_3	
Initial BWG	39.2 ± 2.10	38.7 ± 1.10	38.2 ± 1.80	38.9 ± 2.90	NS
7th	148.7 ± 7.97	143.8 ± 1.84	147.1 ± 2.81	157.2 ± 2.86	NS
14th	159.4 ± 10.65^{a}	202.2 ± 20.34^{ab}	252.1 ± 25.98^{b}	257.3 ± 30.59^{b}	*
21st	394.5 ± 20.61	377.2 ± 11.01	333.5 ± 16.78	344.9 ± 32.83	NS
28th	375.2 ± 17.11	374.6 ± 17.83	416.3 ± 17.14	451.3 ± 26.09	NS
35th	377.7 ± 12.49^{a}	413.8 ± 35.17^{b}	415.9 ± 4.80^{b}	443.1 ± 21.77^{c}	*
Final BWG	1455.5 ± 15.40^{a}	1511.7 ± 17.83^{b}	1565.0 ± 18.40^{c}	1653.9 ± 16.92^{d}	*
Mortality (%)	00.0	00.0	00.0	00.0	NS

Legends: BWG =Body weight gain, T0= Control diet, T1= Control diet + 0.5% cod liver oil, T2= Control diet + 1% cod liver oil , T3= Control diet + 2% cod liver oil, ±= Standard error, abcd means having different superscript in the same row differed significantly (P<0.05), *= P ≤ 0.05, NS= Non significant

Table 6. Feed intakes (g) in different dietary treatment groups at different ages of birds

Age (Day)	Feed intakes (g)				Level of significance
	T_0	T_1	T_2	T_3	
7th	167.9 ± 7.96	158.1 ± 2.56	163.3 ± 3.01	178.7 ± 5.28	NS
14th	222.0 ± 14.35^{a}	267.0 ± 24.19^{b}	289.0 ± 29.43^{c}	306.0 ± 43.90^{d}	*
21st	593.3 ± 35.10	523.1 ± 15.41	462.7 ± 25.55	481.8 ± 46.50	NS
28th	610.1 ± 15.80	551.1 ± 30.43	613.6 ± 29.53	607.2 ± 38.88	NS
35th	725.4 ± 54.57b	736.1 ± 60.80c	730.4 ± 2.492bc	635.2 ± 25.45a	*
Total FI	2318.8 ± 127.78^{d}	2235.6 ± 133.39^{b}	2259.1 ± 90.012^{c}	2209.1 ± 160.01^{a}	*

Legends: FI= Feed intake, T0= Control diet, T1= Control diet + 0.5% cod liver oil, T2= Control diet + 1% cod liver oil , T3= Control diet + 2% cod liver oil, ±= Standard error, abcd means having different superscript in the same row differed significantly (P<0.05), *= P ≤ 0.05, NS= Non significant

Effect of cod liver oil on body weight gain: The impact of cod liver oil on broiler body weight gain is illustrated in Table 5. Based on the findings of the current study, it was determined that at seven days of age, the body weight gain of the various dietary treatment groups were nearly identical. At the end of the trial, the body weight gain was significantly (P<0.05) higher in T3 comparison to the other groups. The body weight gain of group T3 was increased by supplementing 2% mixture of cod liver oil in a basal diet.

In line with the results obtained in the current investigation, Lopez-Ferrer et al. (2001) documented a statistically significant (P<0.05) elevation in weight gain among chickens that were administered a 4% Linseed Oil(LO) diet as opposed to the control diet. The authors also documented comparable outcomes when using a diet with the maximum Fish Oil (FO) content (4%) in comparison to the control diet. That is to corroborate the current research findings. In regards to body weight gain, the current research result was further corroborated by Bharath et al. (2017).

Effect of cod liver oil on feed intake: Table 6 demonstrates the impact of cod liver oil on the feed consumption of broiler chickens. At the 35th day of age, the dietary treatment group T3 had the lowest feed intake, whereas the dietary group T0 had the maximum feed intake. Farrell (1995) found that the feed intake of feed mixed with cod liver oil might vary, sometimes being lower and other times higher. In addition, Alparslan and Özdogan (2006) conducted a study which found that the consumption of feed combined with 2% fish oil is greater. The findings of the present study have been validated by Crespo and Esteve-Garcia (2001) as well as Alparslan and Özdogan (2006).

Effect of cod liver oil on feed conversion ratio: Table 7 shows the Feed Conversion Ratio (FCR) of the birds that were tested during the trial. The FCR did not show any significant differences (P>0.05) across the various treatment groups throughout the first 7 days of age. A statistically significant difference (P<0.05) in FCR was seen in the rest of the experimental period. The dietary treatment group T3 exhibited the lowest but best FCR in comparison to other treatment groups. The administration of cod liver oil demonstrated superior FCR when compared to the control group.

The results of this study align with previous research conducted by Crespo and Esteve-Garcia (2001), Farhoomand and Checkaniazer (2009), Newman et al.

Table 7. Feed Conversion Ratio (wt gain/feed intake) of different birds of different dietary treatment groups

Age (Day)	Feed Conversion Ratio (weight gain/feed intake)				Level of significance
	T_0	T_1	T_2	T_3	
7^{th}	1.13 ± 0.01	1.10 ± 0.01	1.11 ± 0.01	1.13 ± 0.02	NS
14^{th}	1.39 ± 0.01^{c}	1.32 ± 0.02^{b}	1.14 ± 0.01^{a}	1.19 ± 0.02^{b}	*
21^{st}	1.49 ± 0.03^{b}	1.38 ± 0.01^{a}	1.38 ± 0.01^{a}	1.39 ± 0.01^{a}	*
28^{th}	1.62 ± 0.01^{b}	1.47 ± 0.01^{a}	1.47 ± 0.01^{a}	1.44 ± 0.00^{a}	*
35^{th}	1.91 ± 0.09^{b}	1.78 ± 0.02^{b}	1.75 ± 0.02^{b}	1.44 ± 0.03^{a}	*
Final FCR	1.59 ± 0.03^{c}	1.47 ± 0.02^{b}	1.44 ± 0.02^{b}	1.34 ± 0.02^{a}	*

Legends: FCR= Feed conversion ratio, T0= Control diet, T1= Control diet + 0.5% cod liver oil, T2= Control diet + 1% cod liver oil , T3= Control diet + 2% cod liver oil, ±= Standard error, abc means having different superscript in the same row differed significantly (P<0.05), *= P ≤ 0.05, NS= Non significant

Table 8. Live weight and carcass weight of broilers of different dietary treatment groups

Parameters	Dietary groups				Level of significance
	T_0	T_1	T_2	T_3	
Live weight (g)	1494.9 ± 28.28^{a}	1550.4 ± 22.33^{ab}	1602.9 ± 4.58^{b}	1692.9 ± 7.94^{c}	*
Carcass weight (g)	1052.6 ± 8.10^{a}	1158.8 ± 18.41^{a}	1150.7 ± 52.58^{a}	1288.6 ± 34.81^{b}	*

Legends: T0= Control diet,T1= Control diet + 0.5% cod liver oil,T2= Control diet + 1% cod liver oil ,T3= Control diet + 2% cod liver oil, ±= Standard error, abc means having different superscript in the same row differed significantly (P<0.05), *= P ≤ 0.05

Table 9. Hematological parameters of broiler

Parameters	Dietary groups				Level of significance
	T_0	T_1	T_2	T_3	
Hb (mg/dl)	9.51 ± 0.176^{a}	10.1 ± 0.278^{ab}	11.1 ± 0.379^{bc}	12.1 ± 0.581^{c}	*
PCV (%)	27.3 ± 0.888^{a}	32.2 ± 0.318^{b}	32.6 ± 0.370^{b}	35.2 ± 0.160^{c}	*
WBC ($1x10^3/mm^3$)	18.5 ± 0.405^{a}	19.9 ± 0.081^{b}	20.6 ± 0.356^{b}	23.9 ± 0.071^{c}	*
RBC ($1x10^6/mm^3$)	4.5 ± 0.289^{a}	5.08 ± 0.068^{ab}	5.8 ± 0.306^{b}	7.3 ± 0.584^{c}	*

Legends: T0= Control diet,T1= Control diet + 0.5% cod liver oil,T2= Control diet + 1% cod liver oil ,T3= Control diet + 2% cod liver oil, ±= Standard error, abc means having different superscript in the same row differed significantly (P<0.05*= P ≤ 0.05

(2002), Alparslan and Ozdogan (2006), and Bharath et al. (2017). These studies also found that adding LO and FO to the diet of broilers improves feed conversion efficiency.

Effect of cod liver oil on carcass weight: The impact of cod liver oil on the weight of the carcass is shown in Table 8. The results indicate that there were significant differences (P<0.05) in live weight (g) and carcass weight (g) among the different nutrition treatment groups. The treatment group T3 had the highest carcass weights than the other treatment groups. Consistent with the results of the current study, Lopez-Ferrer et al. (2001), Chekani-Azar et al. (2007), and Bharath et al. (2017) also found that the inclusion of FO (3-4%) in the diet has a significant (P<0.05) impact on relative carcass metrics.

Effect of cod liver oil on blood profile: The hematological parameters of cod liver oil-treated broilers are detailed in Table 9. In comparison to the control group, all groups supplemented with cod liver oil exhibited significantly (P<0.05) higher levels of hematological parameters (Hemoglobin, Packed Cell Volume, White Blood Cell, and Red Blood Cell). The normal ranges of the haematological parameters in chickens are RBC: 2.5-3.5 $x10^6$ µl, PCV: 22-35 %, Hb: 7-13 g/dl and WBC: 12-30 x 10^3 µl (Bounous & Stedman, 2000). The findings suggest that 2% cod liver oil significantly increases RBCs, WBCs, PCV, and Hb (P<0.05). We concur with the findings of several studies (Bond et al., 1997; Kadhim, 2010; Radwan et al., 2012; Jameel, 2013; Al-Zuhairy and Alasadi, 2013; Jameel and Sahib, 2014) that omega-3 fatty acids significantly increased Hb, WBCs, and RBCs.

Table 10. Data showing the economics of broiler production per bird kept under different treatment groups from day old chick to 35 days of age

Parameters (Tk.)	T_0 control	T_1 0.5% cod liver oil	T_2 1% cod liver oil	T_3 2% cod liver oil
Chick cost (Taka)	17	17	17	17
Average feed consumed (Kg)/chicks/35 days	2.31	2.23	2.25	2.20
Cost of medicine, Vaccine and cod liver oil (Taka)	11	16	22	28
Feed (price/kg)	35	35	35	35
Miscellaneous cost (Taka)	14	14	14	14
Total feed cost/broiler (Taka)	80.8	78.0	78.7	77
Total cost /broiler (Taka)	122.8	125.0	131.7	136
Average live weight (kg/broiler)	1.49	1.55	1.60	1.69
Sale price Tk./kg live wt. (Taka)	120	120	120	120
Sale price /broiler (Taka)	179	186	192	203
Net profit /broiler (Taka)	56.1	60.9	60.2	67

Legends: T0= Control diet, T1= Control diet + 0.5% cod liver oil, T2= Control diet + 1% cod liver oil , T3= Control diet + 2% cod liver oil

Cost benefit analysis: The prices of several bird groups are shown in Table 10. According to the data provided in Table 10, the mean expenses associated with broiler chicken rearing in treatment groups T0, T1, T2, and T3 were 122.85, 125.05 taka, 131.75 taka, and 136 taka, respectively. Based on the results of cost-benefit production the highest net profit was found in the T3 group and the lowest in T0.

Conclusion

The findings of the research indicate that when broilers were supplemented with 2% cod liver oil per kilogram of feed, their body weight, body weight gain, feed intake, feed conversion ratio (FCR), and blood parameters (RBC, WBC, PCV, and Hb) all improved. Additionally, the carcass weight and performance parameters exhibited no detrimental effects. As a result, 2% cod liver oil can be utilized as a growth promoter in the diet of broilers.

Authors' contributions

MAH, MNA, US, MB, and SHS conceived and designed the experiment. MB, MAH, and MNA performed the study, MB conducted lab analyss. MAH and MNA supervised and coordinated the experiments. MB performed statistical analyses of the experiental data. MB and MAH prepared the draft of the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript and also approved the final version.

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