Research Article

Effects of Fish Oil on Growth Performance, Carcass Characteristics, Blood Parameter, and Cost Efficiency of Broiler Chicken

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Abstract | Fish oil (FO) is an excellent source of omega-3 fatty acids, which helps broilers gain weight and improve their immunity. The current study was done with special emphasis on establishing the impact of FO on improving the feed-conversion-ratio (FCR) and decreasing the rearing cost of broilers by feeding a commercial broiler-feed. A total of 120 unsexed commercial broilers (Ross-308) were randomly assigned to four treatment groups that contained 1%, 2%, and 3% FO in regular drinking water, as well as a control group. All of the birds were given enough commercial broiler-feed and water. The performance gained by broilers after 30 days of rearing from all supplemented groups complied with the standards. Observed parameters like live weight, feed intake, weight gain, and FCR of broilers were significantly higher in the 2% and 3% FO-supplemented groups. Data for cost-benefit analysis revealed significantly increased net profit in FO-treated groups. However, abdominal fat increased linearly with increasing levels of FO supplementation. The serum HDL level was increased, whereas cholesterol, LDL, and triglyceride levels were significantly decreased with increasing levels of FO in the broiler diets. It was concluded that supplying 2% or 3% would be effective in both increasing market weight and improving the profit of commercial broiler farming.

Keywords | Broiler, chicken, Fish oil, Performance, Profit.

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INTRODUCTION

Poultry is a substantial contributor to the food supply so it has successfully become a leading industry (Ali and Hossain, 2012). This growing industry is developing the utilization of local ingredients to minimize feed costs with better performance. Feeding poultry with diets that contain fat can counter several economic advantages by providing increased energy levels and fatty acid composition (Newman et al., 2002). Fish oil contains high levels of omega-3 fatty acids (FA) such as eicosa-pentaenoic acid (EPA) and docosa-hexaenoic acid (DHA), which are highly unsaturated and improve health-related factors **(**Saleh et al., 2009). FO has a favorable influence on the fatty acid profile by enhancing the lipid content of the meat (Crespo et al., 2002). Dietary FO reduces the levels of total cholesterol, low-density lipoprotein, and triglycerides (Crespo, 2003). Therefore, the fatty acid composition of oils used in poultry rations is reflected in animal products (Scaife et al.,1994).

If diets with similar energy and protein are compared, chickens fed with rations that contain oil showed better performance than birds-fed diets without the inclusion of oil (Sanz et al., 2000; Lopez-Ferrer et al., 2001). Omega-3 FAs play an important role in improving the immunity, performance, and lipid profile of broilers (Jameel, 2014). Broiler meat's lipid content can be altered by adding linoleic and linolenic acids (Lopez et al., 1999). It is feasible to raise the amounts of long-chain n-3 FA in poultry meat by supplementing their diets with fish meals or oils (Pinchasov and Nir, 1992). Broiler diets supplemented with small amounts of fats and oils have also been found to improve meat consistency and palatability while also stimulating growth (Leeson and Summers, 2001). According to Navidshad (2009), the inclusion of FO in the diet had no negative impact on the animals' productivity.

Fasting growth with better production and low rearing costs is the main intention of the poultry industry. This research looked into the effectiveness of FO and verifies the level of FO that gives maximum profit in commercial broiler farming. The findings of this study will assist poultry nutritionists in properly rationing FO. The objective of this study was to evaluate the effect of addition fish oil in drinking water of broiler chicken on growth performance, carcass characteristics, blood parameter, and cost efficiency.

MATERIALS AND METHODS

Based on a Completely Randomized Design (CRD), 120 unsexed day-old chicks (Ross 308) were distributed in four nutritional treatment groups ($T_{0,}$ $T_{1,}$ $T_{2,}$ and T_3) with three replications for each treatment. All the procedures of this experiment were approved by university ethics committee (CVASU/admin/EC/2017/29). These broiler groups were treated either without FO, 1%, 2%, or 3% FO in their regular drinking water. Each treatment group had 30 birds, whereas each replication had 10 birds. The purchased chicks' average body weight was 40.5g/bird, with uniform size and no anomalies. Fresh and dust-free FO was supplemented with regular drinking water throughout the experiment. Banana essence was also used to remove the FO's unpleasant odor. To dissolve oil with water, an emulsifier was used. A considerable amount of broiler drinking water was added to this mixture. The floor space for each bird was 0.17sq.ft (2.38ft x 2.08ft for 20 birds) in a brooding box and 0.57sq.ft (3.5ft x 1.63ft for 10 birds) in the cage.
The birds were fed commercially available premade broiler feed from *C.P Bangladesh®* at three different growth stages: starter (day 0 to 12th), grower (day 13th to 24th), and finisher (day 25th to 30th). Table 1 shows the nutrient composition of the used feed. Dry mash feed and water were supplied *ad-libitum* to the birds daily three times. All of the birds had been appropriately vaccinated against Newcastle Disease (ND) and Infectious Bursal Disease (IBD). The observed parameters were live weight, weight gain, feed intake and feed-conversion-ratio (FCR) of broilers at different ages of broilers.

Table 1: Estimated chemical composition (DM basis) of commercial broiler feed

Parameter	Starter	Grower	Finisher
Metabolizable Energy (Kcal/kg)	2981	3075	3148
Crude Protein (g/100g)	22.79	21.92	20.64
Crude Fiber (g/100g)	4.07	3.79	3.67
Calcium (g/100g)	0.94	0.87	0.89
Phosphorous (g/100g)	0.68	0.66	0.65
Lysin (g/100g)	1.38	1.29	1.05
DL Methionine (g/100g)	0.53	0.52	0.47

Throughout the trial, data on parameters were recorded at weekly intervals. These data were collected from 5 birds randomly in every replication (10 birds). The blood samples were collected from a total of 24 birds (2 birds from each replication) at the 15th and 30th days of age after random selection. Serum lipid parameters were determined using standard kits (*BioMereux*, France) and an automatic analyzer (Humalyzer 300, *Merck®*, Germany). The weights of visceral organs were measured after the de-feathering of 24 birds, chosen at random from each replication on day 30. The data were analyzed using the one-way ANOVA test. Statistical significance was defined as a p-value of <0.05, <0.01 or <0.001.

RESULTS AND DISCUSSION

Different parameters were recorded to observe the effect of fish oil on growth and production performance of broilers when basal diet with 1%, 2%, and 3% fish oil or without fish oil in drinking water. Live weights of the experimental birds were recorded weekly basis throughout the whole experimental period. Results indicated that weekly average live weight differed highly significantly ($p<0.01$) in 2nd and significantly ($p<0.05$) at 3rd weeks but was insignificant at the 1st & 4th week of age (Table 2). The highest weekly average live weight (2232.33 g/bird/week) was recorded in the T_3 group and the lowest average live weight 1784.33 g/bird was recorded in the T_0 group in the 4th week. The weight gain of the experimental birds revealed that significant levels of variations were not found during the 1st, 3rd, and 4th weeks (Table 2). Considering the data on 2nd week, live weight gains differed significantly ($p<0.05$) among the

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Table 2: Growth parameters of the birds (g/bird/week) supplemented with or without fish oil

Parameter	Age of birds (wk)	Treatment (Mean±SD)				P value
		T_0	T_1	T_2	T_3	
Live weight	1st	176.63±7.42	194.37±2.30	202.33±3.49	204.73±3.88	0.15
	2nd	585.53±10	656±8.19^c	705.67±11.06^b	735.53±8.38^a	<0.01
	3rd	989.33±12.34	1078.67±13.01^c	1182.33±32.13^b	1221.33±30.83^a	<0.05
	4th	1784.33±36.02	1994.67±42	2121.33±107.75	2232.33±80.65	0.09
Weight gain	1st	136.47±7.13	153.87±1.85	162.13±3.20	164.17±3.64	0.14
	2nd	408.90±2.72	461.63±5.97^c	503.33±7.85^b	530.80±5.74^a	<0.05
	3rd	403.80±5.07	422.67±5.51	476.67±21.46	485.80±22.48	0.13
	4th	795±24.06	916±29	939±76.54	1011±52.85	0.17
Feed intake	1st	166.67±11.55	180±0.01	186.67±2.89	185±5	0.47
	2nd	545±5	575±8.66^c	608.33±7.64^b	633.33±5.78^a	<0.05
	3rd	571.67±10.41	555±8.66	591.67±27.54	590±26.46	0.71
	4th	1226.67±35.12	1240±40	1223.33±100.17	1266.67±68.07	0.76
Feed Conversion Ratio (FCR)	1st	1.22±0.02	1.17±0.01	1.15±0.01	1.12±0.01	0.10
	2nd	1.33±0.01	1.24±0.01	1.20±0.01^b	1.19±0.01^a	<0.05
	3rd	1.41±0.01	1.31±0.01	1.24±0.01^{ab}	1.21±0.01^a	<0.01
	4th	1.54±0.01	1.35±0.01^c	1.30±0.01^b	1.25±0.01^a	<0.001
	0»4th	1.38±0.01	1.27±0.01^c	1.22±0.01^{ab}	1.19±0.01^a	<0.001

[T_0 = water without fish oil; T_1= water containing 1% fish oil; T_2 = 2% fish oil; T_3 = 3% fish oil; SD=Standard Deviation; a, b and c = Means having different superscript in the same row differ significantly.]

Table 3: Serum parameters of the experimental broiler birds fed water supplemented with or without fish oil at 15th and 30th day of age

Parameter	Days	Treatment (Mean±SD)				P value
		T_0	T_1	T_2	T_3	
Cholesterol (mg/dl)	15th	152.03±2.30	145±2.62	134±3.08^b	127.16±1.98^a	<0.01
	30th	130.1±3.01	123.96±2.06	116.63±2.30^b	110±2.28^a	<0.05
HDL (mg/dl)	15th	39.10±1.17	43.36±1.10^c	45.83±1.80^b	51.33±2.02^a	<0.05
	30th	37.10±1.51	42.43±0.65	48.13±1.72^{ab}	53.50±1.44^a	<0.01
LDL (mg/dl)	15th	76.10±1.74	70.23±1.51	68.66±1.72	66.16±1.48	0.13
	30th	85.83±3.68	74.83±1.93	69.26±1.12^a	65.33±2.50	<0.05
TG(mg/dl)	15th	97.40±0.70	93±1.60	86.06±3.17^b	76.23±1.45^a	<0.05
	30th	56.23±2.17	52.46±0.70	49.06±1.15	44.76±2.24	0.19

[T_0 = water without fish oil; T_1= water containing 1% fish oil; T_2 = 2% fish oil; T_3 = 3% fish oil; SD=Standard Deviation; a, b and c = Means having different superscript in the same row differ significantly.]

treatment groups. In terms of weight gain, the T_3 group performed better than other groups and finally, highest average weight gain (1011g/bird/week) was found in the T_3 group. It was observed that the weight gain of the T_0 group was lowest at 4th week of age. Weekly average live weight differed highly significantly in the 2nd and significantly in the 3rd week. Weight gains differed significantly in 2nd week. However, the highest result in the T_3 group and the lowest in the T_0 group agree with the results reported by Jameel (2013), Al-Zuhairy and Alasadi (2013), and Sahib (2013). But disagree with the result of Hulan et al. (1988). Navidshad (2009) showed that 2 and 4% FO in the diets of broilers decreased weight gain. The results of increasing weight gain with the addition of omega-3 PUFAs like FO in the diet of broilers are in agreement with many previous findings (Jameel and Sahib, 2014; Al-Zuhairy and Jameel,

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2014).

Similar to weight gain, feed intake differed significantly ($p<0.05$) in 2nd week within all the water treatment groups. At the 1st, 3rd, and 4th weeks of age feed intake of birds there was no significant difference. The highest feed intake (1266.67 g/bird/week) was recorded in the T_3 group and the lowest feed intake (1226.67 g/bird/week) was recorded in T_0 group at the 4th week of age. These results agreed with the results of Mansoub (2011) and Das et al. (2014a). Navidshad (2009) mentioned that FO (2 and 4%) did not affect feed intake, But Alparslan and Özdogan (2006) reported that 2 and 4% FO results in lower feed intake in the final period. FO-containing diet to broilers caused lower feed intake (Hulan et al., 1988; Huang et al., 1990; Azar et al., 2008).

FCR of the experimental birds varied regularly during the entire experimental period. It was revealed that, FCR differed significantly ($p<0.05$) at the 2nd, 3rd, and 4th week of age within the treatment group. FCR improved gradually at the 3rd & 4th week of age and varied in highly significant ($p<0.01$) & ($p<0.001$) at the 3rd and 4th week respectively. It was observed that, the highest FCR (1.38) was recorded T_0 group and the lowest FCR (1.19) was recorded in the T_3 group considering the 4th week of the trial period. The final FCR (0 to 4th week) also improved in high significantly ($p<0.001$). Similar findings of better FCR were recorded by (Azar et al., 2008; Saleh et al., 2009; Das et al., 2014a). There are several discrepancies between the current findings with certain authors' findings (Pesti et al., 2002; Abas et al., 2004; Navidshad, 2009). FCR of broilers fed fish oil differed substantially.

Cholesterol levels (mg/dl) differed significantly on the 15th day ($p<0.01$) and 30th day of age ($p<0.05$). The highest average value of serum cholesterol (152.03) was recorded in the T_0 group on the 15th day whereas the lowest value (110) was found in the T_3 group on 30th day during the experimental period. The lower cholesterol and triglyceride level in the FO-treated group was also consistent with other investigations (Saleh et al., 2009; Mansoub and Bahrami, 2011; Das et al., 2014b). However, Alparslan and Özdogan (2006) found no discernible effect on serum cholesterol levels by using dietary FO. This difference may be attributed to genetic, sex and dietary factors. Decreased cholesterol and triglyceride content in serum can result in the presence of PUFAs or conversion from precursors by the de-novo synthesis in the liver and tissue.

Serum HDL (High-density lipoprotein) level (mg/dl) also differed significantly ($p<0.05$) on the 15th & high significantly ($p<0.01$) on the 30th day of age. The highest average value of serum HDL (53.50 mg/dl) was recorded in the T_3 group on the 30th day whereas the lowest value (37.10 mg/dl) was found in the T_0 group on the 30th day during the experimental period (Table 3). T_2, and T_3 group recorded good results. Low-density lipoprotein (LDL) level (mg/dl) differed significantly ($p<0.05$) on the 30th day although it was statistically similar ($p>0.05$) on the 15th day. The highest average value of serum LDL (85.83 mg/dl) was in the T_0 group whereas the lowest LDL value (65.33 mg/dl) was in T_3 at the 30th day of age during the experimental period. Triglyceride levels differed significantly ($p<0.05$) on the 15th day of age but did not differ significantly on the 30th day of age (Table 3). The maximum average TG level (97.40 mg/dl) was found in the T_0 group on the 15th day; whereas the minimum level of TG (44.76 mg/dl) was found in the T_3 group on the 30th day. The trend of increased HDL and a lower LDL level of broilers with soybean and fish oil groups compared to palm oil was also recorded by Das et al. (2014b). The inclusion of oil in a low-energy diet caused an increased HDL level in the serum of broilers (Monfaredi et al., 2011). Omega-3 fatty acids reduce blood VLDL levels, acting to lower the circulating free LDL concentration.

The carcass parameters significantly differed ($p<0.05$) in terms of the neck, head, and abdominal fat weight at 30 days. Highly significance was also observed in the liver, spleen ($p<0.01$), and gizzard ($p<0.001$). However, though other parameters (dressing percentage, drumstick, wing, thigh, heart, proventriculus, breast, and back weight) differed numerically they did not differ significantly amongst dietary treatments. Other carcass parameters were statistically similar ($p>0.05$) throughout the entire experimental period (Table 4). Highly significant also observed in the liver, spleen, and gizzard. The improved dressing percentage of FO-treated broiler did not agree with Navidshad (2009). However, Huang et al. (2006) observed that when body weight improved, edible meat yields increased. Increased breast meat by adding FO acquiesces in Farhoomand and Checaniazer (2009). A significant difference in the head, and neck weight and lower abdominal fat with a large spleen of FO-treated broilers was also revealed by Chekaniazaret al. (2007). FO can affect abdominal fat which assents to Beckford et al. (2017) and Panda et al. (2017). But Navidshad (2009) elicited that FO had no superiority in abdominal fat pad reduction. On the other hand, highly significant changes in the liver, spleen, and gizzard were also revealed by Paddy et al. (2005). Overall, there was a good carcass characteristic in the 2 and 3% fish oil supplementations.

The cost-benefit analysis of the total experiment was done which shows us that the net profit differed significantly ($p<0.001$). The highest net profit of 37.91 BDT (Bangladesh Taka) per broiler was found in the T_3 group and

Table 4: Carcass characteristics of the experimental birds fed water supplemented with or without fish oil at 30th day of age

Parameter (%)	Treatment (Mean±SD)				P value
	T_0	T_1	T_2	T_3	
Dressing	63.86±0.87	64.35±1.15	65.60±1	66.33±2.08	0.22
Drumstick	12.43±0.85	12.16±0.31	16.38±0.61	18.35±0.58	0.12
Neck	2.48±0.02	2.65±0.03	2.8±0.04^b	2.99±0.08^a	<0.05
Head	2.51±0.03	2.64±0.02^c	2.82±0.04^b	2.98±0.05^a	<0.05
Wing	5.81±0.11	6.48±0.34	6.98±0.26	7.2±0.36	0.17
Breast wt	19.90±0.14	21.08±0.30	21.91±0.17	22.85±0.40	0.09
Thigh	15.63±0.41	18.06±0.47	21.76±0.42	24.43±0.85	0.10
Back wt	10.48±0.27	10.90±0.02	11.33±0.27	11.76±0.20	0.06
Abdominal fat	2.87±0.02	2.89±0.03	2.94±0.13^a	2.95±0.3^b	0.06
Heart	0.57±0.01	0.62±0.01	0.68±0.02	0.73±0.02	0.07
Liver	2.21±0.01	2.44±0.02	2.62±0.01^a	2.76±0.02^b	<0.01
Gizzard	2.03±0.06	2.23±0.02^c	2.46±0.01^b	2.60±0.01^a	<0.001
Proventriculus	0.48±0.01	0.54±0.01	0.57±0.01	0.60±0.01	0.09
Spleen	1.56±0.02	1.64±0.01^c	1.74±0.02^b	1.89±0.02^a	<0.01

Table 5: Cost-benefit analysis (in BDT) of broiler fed water supplemented with or without FO

Parameter	Treatment (Mean±SD)				P Value
	T_0	T_1	T_2	T_3	
Chick cost	41	41	41	41	
FO, essence cost (kg)	0	11.1	11.8	12.4	
Live weight (kg)	1.78±0.04	1.99±0.04	2.12±0.01	2.23±0.08	0.10
FCR (0-4th)wk	1.38±0.01	1.27±0.01^c	1.22±0.01^{ab}	1.19±0.01^a	<0.001
Total feed cost (kg)	45	45	45	45	
Total feed cost (bird)	113±3	115.3±2.08	118±6.55	120.66±4.5	0.52
Management and other cost	65	65	65	65	
Total cost (bird)	219±3	232.43±2.08	235.8±6.55	239.06±4.50	0.18
Market selling price (kg)	145	145	145	145	
Total selling price (bird)	258.58±5.09	289.03±6.53	307±16.14	323.83±11.63	0.10
Net profit (bird)	39.56±2.11	56.6±4.63^c	71.6±9.59^{ab}	84.76±7.12^a	<0.05
Net profit (kg)	22.18±0.74	28.37±1.68^c	33.67±2.8^{ab}	37.91±1.83^a	<0.05

[T_0 = water without fish oil; T_1= water containing 1% fish oil; T_2 = water containing 2% fish oil; T_3 = water containing 3% fish oil; a, b and c = Means having different superscript in the same row differ significantly.]

N.B. Management and other cost included vaccine, medicine, labor and electricity cost. The total cost included total feed cost, fish oil, the essence of banana, chick, management and other costs. 1$ = 78 BDT (approx.)

the lowest net profit of BDT 22.18 was found in the T_0 group (Table 5). The cost-benefit analysis of adding fish oil was evaluated with the aim of suggesting the findings of this experiment for usage under producer conditions. The highest net profit per bird was found in the T_3 group. The FO-enhanced group also had satisfactory accuracy as well. Similar results have been found by Alparslan and Ozdogan (2006), who found that the 2% FO group had the largest gross margin among the treatment groups.

CONCLUSIONS

It is identified that adding 2% or 3% FO to broiler drinking water improves live weight and FCR in commercial

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broilers more than in the control. These groups likewise demonstrated improved carcass features, with considerably higher HDL and lower cholesterol, LDL, and triglyceride levels in the blood. So it may be excellent news for meat lovers. It can be determined that using 2% or 3% FO in regular drinking water can help broiler farmers increase market weight and profitability. Broiler meat with more than 2% FO can have a fishy smell, however, this varies. To make an economically beneficial ration, it may be recommended that 2% FO be added to the regular drinking water of broilers.

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CONFLICT OF INTEREST

All authors declare that there are no conflicts of interest.

NOVELTY STATEMENT

The study was to assess the comparative effectiveness of three different treatments of fish oil on broiler production, carcass quality, and blood parameters. This study examined the amount of fish oil that produces the highest yields in commercial broiler farming. The result of the study will support the commercial use of fish oil in poultry diets. The study on fish oil treatments that make commercial broiler farming economically viable sets it apart from other types of studies.

AUTHORS CONTRIBUTION

All authors contributed equally.

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