IJAS Iranian Journal of Applied Animal Science

# Effects of Different Levels of Fish Oil Supplementation on Performance of Broilers

Research Article

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Received on: 7 Dec 2013
Revised on: 1 Feb 2014
Accepted on: 15 Feb 2014
Online Published on: Jun 2015

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Online version is available on: www.ijas.ir

## ABSTRACT

Six hundred day old unsexed broiler chicks were used in a 42-d trial at Chittagong Veterinary and Animal Science University Poultry Farm to compare the effects of different levels of fish oil supplementation on performance of broilers in terms of feed intake, weight gain and feed conversion and carcass characteristics. The chicks were randomly distributed following a completely randomized design in four groups having three replications per group. Each group was composed of 150 chicks and 50 birds per replicate. Four diets were formulated using locally available ingredients as diet without oil, diets containing 2.5%, 3.0% and 3.5% fish oil. Results indicated that, supplementation of diets with different levels of fish oil significantly differed ($P<0.05$) feed intake at 1$^{st}$, 3$^{rd}$, 4$^{th}$ and 6$^{th}$ weeks of age. However, there was no significant ($P>0.05$) effect of fish oil supplementation on feed conversion up to 5$^{th}$ week of age. At the end of 6$^{th}$ week, feed conversion of the broilers of different dietary groups differed significantly ($P<0.05$). Similarly, no significant differences ($P>0.05$) were found among all dietary treatment groups in weight gain up to 3$^{rd}$ week of age except at later stages. Out of eighteen parameters, shank weight, heart weight, thigh bone weight and abdominal fat weight differed ($P<0.05$) due to supplementation of fish oil. It can be concluded that, supplementation of fish oil at 2.5% level results in the best cumulative feed intake and feed conversion of broilers.

KEY WORDS broiler, carcass characteristics, feed conversion, feed intake, fish oil, weight gain.

## INTRODUCTION

Oils have commonly been used as energy sources in poultry diets. It has been shown that intake of n-3 polyunsaturated fatty acids (PUFA), in particular, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) by broilers results in more incorporation into energy metabolism and elevation of PUFA in their carcasses (Halle, 2001; Basmacioglou *et al.* 2003). The success of broiler meat has been related to improvements in growth and carcass yield, mainly by increasing breast proportion and reducing abdominal fat (Zerehdaran *et al.* 2004). It has been argued that reduction in lipid content of broilers was strongly related to the dietary fatty acid (FA) profile. It has been reported by researchers that broiler fed with diets containing high levels of PUFA had less abdominal fat pad (AFP) than those fed with diets containing high levels of saturated fatty acids (SFA) or monounsaturated fatty acids (MUFA). In this regard, several studies showed that enrichment of chicken meat with PUFA, through the addition of PUFA containing fats to the diet, improved feed conversion efficiency and meat composition by increasing n-3fatty acids in carcass (Lopez-Ferrer *et al.* 2001). Fish oil has been shown to reduce hepatic lipogenesis and VLDL-c secretion. The effect

of feed on fatty acids composition (Du and Ahn, 2002; Tabeidian *et al.* 2005), antioxidant capacity and storage stability of meat have previously been investigated (Cortinas *et al.* 2005). The marine fish oil contains the long chain omega 3 fatty acids, which is an important factor in the diet to promote health of man and animals compared to that of other origins (Bezard *et al.* 1994; Scaife *et al.* 1994; Chin *et al.* 1994). There are several kinds of fish oil that are being used in broiler diets. However, in Bangladesh no reports are available on the effects of fish oil on broiler performance and carcass quality. Therefore, the aim of this study was to compare the effects of different levels of fish oil supplementation on the performance of broilers in terms of feed intake, feed conversion ratio, growth and carcass quality.

## MATERIALS AND METHODS

### Birds and housing

Six hundred day old, unsexed, commercial broiler chicks were purchased from the chicken hatchery for the study purpose. A bamboo house (30×20×9 cft) was constructed for rearing broilers. The house was covered with corrugated sheet. One and half feet of the sidewall from floor were made of bamboo and the remaining portion was made of wire net to facilitate proper ventilation. The floor of the house was made of bamboo splits on which fresh dry rice husk was used as litter material at a depth of 4.5 cm. Old litter materials were removed from the pen and new litter was replaced weekly. The floor of the house was divided by wire net into 12 compartments to allow desired replication. Arrangement for rearing broilers was made according to treatments and replications. The compartments were selected in an unbiased way according to treatments and replications for uniform distribution of chicks. The compartments were enclosed with chick guard. Birds were brooded under single-tired electric brooder at 95 ˚F, 90 ˚F, 85 ˚F and 80 ˚F for the 1$^{st}$, 2$^{nd}$, 3$^{rd}$ and 4$^{th}$ week, respectively. The broilers were exposed to continuous lighting. Room temperature and humidity was maintained using 200 watt incandescent lamps and exhaust fans.

### Year and season

The study was carried out in Chittagong, Bangladesh. The area has a latitude of 22 ˚21 'N, longitude 91 ˚49 'E and an elevation of 29 m (95 ft). The area is fairly hot at 25.1 ˚C. Mean monthly temperature has a variation of 9 ˚C. The variation of daily average temperature is 8.8 ˚C. The hottest month is May having a mean temperature of 28 ˚C. The coolest month is January which has a mean temperature of 19 ˚C. The average annual relative humidity within the area is 73.7% and average monthly relative humidity ranges from 58% in January to 86% in August.

Chittagong has an average of 2735 mm of rainfall per year. On average there are 135 days per year with more than 0.1 mm of rainfall. The driest weather is in January when an average of 6 mm of rainfall. The wettest weather is in July when there occurs an average of 598 mm of rainfall. The longest day of the year is 13:22 hour long and the shortest day is 10:37 hour long. The current study was carried out during August to October, 2012.

### Diets

Experimental diets were made of dry mash type. The diets were prepared by hand mixing method. All ingredients were purchased from a local market. Major ingredients were thoroughly mixed at first. Then micro-ingredients were mixed. Birds had unrestricted access to feed and water by plastic hanging feeder and bell type drinker. All diets were prepared with maize, rice polish, soybean oil, soybean meal, protein concentrate and other trace nutrients (Table 1). Four rations designated as $T_0$, $T_1$, $T_2$ and $T_3$ were formulated using locally available ingredients where $T_1$, $T_2$ and $T_3$ were supplemented with 2.5%, 3.0% and 3.5% marine fish oil and $T_0$ was kept without oil group (control). Theses rations were supplied to the four groups of birds randomly. Detailed proportion of the feed ingredients in different rations is given in Table 1. Nutrient density in the experimental diet was maintained according to Singh (1980). Formulated diets were analyzed as per AOAC (1980). The starter diet was fed for the first two weeks and the finisher diet was fed for the remaining periods.

### Medication

The slated floor and cages were cleaned and disinfected properly with phenyl solution. The room was fumigated overnight using potassium permanganate and formaldehyde. Feeders and drinkers were thoroughly cleaned and disinfected with phenyl solution and dried and left for 3 days before the arrival of the chicks.

Foot bath containing potassium permanganate was placed in front of the shed. The birds were vaccinated against Newcastle and Gumboro disease on the 4$^{th}$ and 10$^{th}$ day, followed by a booster dose on 20$^{th}$ and 25$^{th}$ day. No outbreak of infectious diseases was found throughout the whole experimental period.

### Dressing the carcass

At the end of 4$^{th}$, 5$^{th}$ and 6$^{th}$ week of the experiment, broilers from each replication weighing close to the average of the pen was selected and slaughtered for processing. Feeders and drinkers were withdrawn from the pens 12 hours prior to slaughtering to empty the digestive system with less chance of damaging the intestines and contaminating the carcass with fecal material.

**Table 1** Composition of the diets

| Feed ingredient[1] | Dietary treatment[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $T_0$ | | $T_1$ | | $T_2$ | | $T_3$ | |
| | Starter | Finisher | Starter | Finisher | Starter | Finisher | Starter | Finisher |
| Maize | 60.50 | 65.00 | 58.00 | 62.05 | 54.30 | 57.03 | 52.00 | 55.00 |
| Rice polish | 4.66 | 3.16 | 4.66 | 3.61 | 7.36 | 7.63 | 8.36 | 8.36 |
| Fish oil | - | - | 2.50 | 2.50 | 3.00 | 3.00 | 3.50 | 3.50 |
| Soybean meal | 29.00 | 25.50 | 29.00 | 25.50 | 30.80 | 28.00 | 32.55 | 29.55 |
| Protein concentrate[3] | 3.50 | 4.00 | 3.50 | 4.00 | 2.20 | 2.00 | 1.00 | 1.00 |
| Lime stone[4] | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.35 | 1.35 |
| Dicalcium phosphate[5] | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| L-lysine | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| DL-methionine | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| Vitamin A (mIU) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Vitamin $D_3$ (mIU) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Vitamin E (g) | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Vitamin $K_3$ (g) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Vitamin $B_1$ (g) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Vitamin $B_2$ (g) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Vitamin $B_6$ (g) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Vitamin $B_{12}$ (g) | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| Niacin (g) | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Folic acid (g) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Biotin (g) | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| Iron (g) | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| Zinc (g) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Manganese (g) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Copper (g) | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| Iodine (g) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Selenium (g) | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 |
| Antioxidant | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Coccidiostat | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Common salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| **Analytical values** | | | | | | | | |
| Dry matter (DM) (%) | 89.89 | 89.89 | 89.90 | 89.90 | 89.90 | 89.90 | 89.91 | 89.91 |
| Metabolizable energy (ME) (kcal/kg) | 2890 | 2919 | 3022 | 3052 | 3021 | 3052 | 3020 | 3051 |
| Crude protein (CP) (%) | 21.27 | 20.14 | 21.04 | 19.91 | 21.05 | 19.95 | 21.02 | 19.95 |
| Ether extracts (EE) (%) | 3.25 | 3.14 | 5.69 | 5.58 | 6.42 | 6.42 | 6.95 | 6.94 |
| Crude fibre (CF) (%) | 3.41 | 3.19 | 3.38 | 3.13 | 3.17 | 3.50 | 3.37 | 3.50 |
| Ca (%) | 0.89 | 0.90 | 0.89 | 0.89 | 0.83 | 0.81 | 0.85 | 0.85 |
| P (%) | 0.67 | 0.64 | 0.65 | 0.63 | 0.66 | 0.65 | 0.64 | 0.63 |

[1] Unit: % or otherwise stated.
[2] $T_0$: diet without oil; $T_1$: diet containing 2.5% fish oil; $T_2$: diet containing 3.0% fish oil and $T_3$: diet containing 3.5% fish oil.
[3] DM: 92.5%; ME: 2900 kcal/kg DM; CP: 60.0%; CF: 3.0%; EE: 13.0%; Ash: 24.0%; Ca: 6.5%; P: 2.5%; Lysine: 7.0% and Methionine: 2.0%.
[4] DM: 98.9%; Ca: 35.8% and P: 0.02%.
[5] DM: 98.0%; Ca: 24.3% and P: 18.2%.

After bleeding, the slaughtered broilers were immersed in hot water at 50 ˚C for 120 seconds in order to loosen the feathers of the carcasses. After bleeding and removing feathers, broilers were subjected to dissection following Jones (1984) method.

**Design of experiment**

The experiment was carried out following a completely randomized design. A total of six hundred birds were weighed and randomly divided into four treatment groups.

Each treatment was divided into three replicates. Each group had one hundred fifty birds of which fifty birds were used per replicate.

**Statistical analysis**

All birds from all groups were weighed weekly for weight gain, feed intake and feed conversion. Data related to weight gain, feed intake, FCR and carcass characteristics were compiled by using Microsoft excel 2007 and analyzed for ANOVA by using Stata (2009) and SPSS (2007).

Means showing significant differences were compared by Duncan's new multiple range test (Duncan, 1955). Statistical significance was accepted at $P < 0.05$.

## RESULTS AND DISCUSSION

### Feed intake

Data related to feed intake of broilers receiving different levels of fish oil are presented in Table 2. Results indicated that at 1, 3, 4 and 6 weeks of age, feed intake significantly differed for supplementation of diets with different levels of fish oil ($P<0.05$). Higher levels of feed intake in control group were in positive relation with higher live weight of the broilers in this group, particularly in the later stage of growth except only at 5$^{th}$ week. Among the supplemented groups feed intake of birds was also related positively with their live weight gain. The birds of $T_2$ group having 3.0% fish oil consumed higher amount of feeds compared to 2.5% dietary fish oil at least up to 4 weeks of age. The reason might be that at this stage, ability to utilize fish oil might be reduced as the level increased. This is more pronounced in broilers receiving even higher level of fish oil (3.5%), where it was observed that although feed intake was similar or slightly lower than other levels, live weight was significantly lower at later stage of growth. The cumulative feed intake of broilers at different stages of growth with different levels of fish oil is given in Table 2. At all stages of growth, the cumulative feed intake of broilers belonging to supplemented groups werelower than that of control group. These results are in agreement with reports of Lopez-Ferrer *et al.* (2001) and Chashnidel *et al.* (2010). Lower feed intake in high dietary fish oil levels (3.5%) ($T_3$) could be explained due to unpleasant specific flavor compounds in fish oil. Baiao and Lara (2005) reported similar findings.

### Live weight gain

Live weight gain of broilers receiving different dietary levels of fish oil is given in Table 3. Irrespective of age, supplementation of diets with different levels of fish oil improved live weight gain of broiler chickens. No significant differences ($P>0.05$) were found among the groups up to 3 weeks of age. However, differences ($P<0.05$) were evident at the end of 4, 5 and 6 weeks of age. At 4 week, the highest live weight gain was observed at 3.0% level of fish oil ($T_2$) and the lowest weight gain was observed in control group. Among the supplemented groups, 3.5% level showed slightly better results than that of 2.5% level of fish oil. At the end of 5 and 6 weeks of age the highest weight gain was found in the control group. As in the case of live weight gain of broilers up to 3weeks of age, non-significant differences among treatments indicates that at early age supplementation of fish oil at different levels did not affect weight gain of broilers, despite tendency to increased weight gain in the supplemented groups compared to that of control. However, at later stages of growth, particularly at the market age of 28, 35 and 42 days fish oil supplementation ($P<0.05$) affected live weight gain of broilers. It is interesting to note that as the age of the broilers advances live weight gain increases at higher rate than those of supplemented group. Among the supplemented groups, 2.5% fish oil supplementation gave consistently higher growth rate, whereas 3.5% oil supplementation gave consistently lowest growth rate in broilers. The inclusion of fish oil in poultry diets has also been reported to result in significantly higher weight gain of broilers (Huang *et al.* 1990). The results of weight gain of broilers are also in agreement with the findings of Newman *et al.* (1998), Crespo and Esteve-Garcia (2001), Crespo and Esteve-Garcia (2002) and Lopez-Ferrier *et al.* (2001). It can also be noticed that among the supplemented groups of broilers, 3.0% fish oil group showed higher weights at all stages of growth. The results of weight gain of this experiment coincide with reports by Alparasian and Ozdogan (2006). These results also coincide with Chashnidel *et al.* (2010) who reported that weight gain of broilers increased mostly at the level of 3.0% fish oil supplemented diets.

The cumulative live weight gain of broilers fed diets supplemented with 2.5, 3.0 and 3.5% fish oil is presented in the Table 3. Broilers at 4 and 5 weeks of age were not affected by ($P>0.05$) fish oil supplementation at different levels on cumulative live weight gain. However, at 5$^{th}$ week of age, the broilers receiving diet containing 3.0% fish oil gained slightly better live weight compared to those of the other groups. At the age of6weeks, the highest live weight gain was found in control group ($T_0$) and the lowest again in 3.5% fish oil group.

Among the oil supplemented groups, the highest weight gain was observed in 3% fish oil group and the lowest in 3.5% ($T_3$) fish oil group. Non-significantly higher cumulative live weight gain as observed at4and 5 weeks of age of broilers, gives indication that fish oil supplementation resulted in higher cumulative live weight gain than that of control group. However, as the age advanced, cumulative weight gain at 6 weeks was significantly different among the groups and most interestingly the weight gain was the highest in the control group.

### Feed conversion

Feed conversion ratio (FCR) of broiler chickens under different dietary treatments is presented in Table 4. There was no significant effect of different levels of fish oil supplementation in the diets of broilers on FCR up to 5 weeks of age.

**Table 2** Feed intake (g/bird) of broiler receiving different levels of fish oil

| Age (weeks) | Experimental groups | | | | SEM | Sig. |
|---|---|---|---|---|---|---|
| | $T_o$ | $T_1$ | $T_2$ | $T_3$ | | |
| 1st | 168.97[a] | 114.00[b] | 115.96[b] | 123.65[c] | 2.72 | * |
| 2nd | 287.84 | 268.42 | 282.10 | 281.22 | 10.80 | NS |
| 3rd | 761.5[a] | 708.24[b] | 743.40[ab] | 731.96[b] | 22.88 | * |
| 4th | 994.31[a] | 959.45[b] | 967.13[ab] | 935.77[b] | 17.45 | * |
| 5th | 1183.93 | 1133.86 | 1151.06 | 1133.22 | 18.10 | NS |
| 6th | 1256.69[a] | 1205.20[ab] | 1208.64[ab] | 1171.07[b] | 27.46 | * |
| Cumulative feed intake | | | | | | |
| 1 to 4th | 2212.63[a] | 2050.11[b] | 2108.59[b] | 2062.60[b] | 31.27 | * |
| 1 to 5th | 3396.56[a] | 3183.97[b] | 3259.65[b] | 3205.83[b] | 41.07 | * |
| 1 to 6th | 4653.25[a] | 4389.17[b] | 4468.29[b] | 4376.90[b] | 64.96 | * |

$T_0$: diet without oil; $T_1$: diet containing 2.5% fish oil; $T_2$: diet containing 3.0% fish oil and $T_3$: diet containing 3.5% fish oil.
The means within the same row with at least one common letter, do not have significant difference (P>0.01).
NS: non significant.
* (P<0.05).
SEM: standard error of the means.

**Table 3** Weight gain (g/broiler) of broilers receiving different levels of fish oil

| Age (weeks) | Dietary treatments | | | | SEM | Sig. |
|---|---|---|---|---|---|---|
| | $T_o$ | $T_1$ | $T_2$ | $T_3$ | | |
| 1st | 80.87 | 81.07 | 81.45 | 74.82 | 2.43 | NS |
| 2nd | 194.00 | 196.73 | 199.04 | 189.33 | 4.08 | NS |
| 3rd | 329.63 | 342.92 | 341.60 | 331.68 | 3.90 | NS |
| 4th | 390.64[c] | 443.74[ab] | 508.00[a] | 469.32[a] | 22.04 | * |
| 5th | 463.37[a] | 418.98[ab] | 394.94[b] | 377.29[b] | 28.86 | * |
| 6th | 446.61[a] | 367.10[b] | 343.24[b] | 262.26[c] | 46.44 | * |
| Cumulative weight gain | | | | | | |
| 1 to 4th | 995.14 | 1064.46 | 1093.73 | 1065.15 | 34.52 | NS |
| 1 to 5th | 1458.50 | 1483.44 | 1525.04 | 1442.44 | 38.03 | NS |
| 1 to 6th | 1905.12[a] | 1850.54[a] | 1868.27[a] | 1704.70[b] | 42.56 | * |

$T_0$: diet without oil; $T_1$: diet containing 2.5% fish oil; $T_2$: diet containing 3.0% fish oil and $T_3$: diet containing 3.5% fish oil.
The means within the same row with at least one common letter, do not have significant difference (P>0.01).
NS: non significant.
* (P<0.05).
SEM: standard error of the means.

**Table 4** Feed conversion ratio of broilers receiving different levels of fish oil

| Age (weeks) | Experimental groups | | | | SEM | Sig. |
|---|---|---|---|---|---|---|
| | $T_o$ | $T_1$ | $T_2$ | $T_3$ | | |
| 1st | 2.10 | 1.41 | 1.42 | 1.65 | 0.05 | NS |
| 2nd | 1.48 | 1.36 | 1.41 | 1.48 | 0.03 | NS |
| 3rd | 2.31 | 2.17 | 2.18 | 2.21 | 0.08 | NS |
| 4th | 2.55 | 2.17 | 1.91 | 2.02 | 0.12 | NS |
| 5th | 2.57 | 2.74 | 2.95 | 3.03 | 0.17 | NS |
| 6th | 2.86[c] | 3.49[bc] | 3.64[bc] | 4.78[a] | 0.55 | * |
| Cumulative feed conversion | | | | | | |
| 1 to 4th | 2.23[a] | 1.93[b] | 1.94[b] | 1.95[b] | 0.08 | * |
| 1 to 5th | 2.33 | 2.15 | 2.14 | 2.23 | 0.06 | NS |
| 1 to 6th | 2.44 | 2.37 | 2.40 | 2.58 | 0.08 | NS |

$T_0$: diet without oil; $T_1$: diet containing 2.5% fish oil; $T_2$: diet containing 3.0% fish oil and $T_3$: diet containing 3.5% fish oil.
The means within the same row with at least one common letter, do not have significant difference (P>0.01).
NS: non significant.
* (P<0.05).
SEM: standard error of the means.

At the end of 6 weeks, the FCR of the broilers of different dietary groups was significantly (P<0.05) different. At this stage, the FCR of the experimental groups of broilers was significantly lower than that of control group. There were no significant differences in the FCR of broilers among experimental groups ($T_1$ and $T_2$) and control group.

This indicates that broilers can utilize diets supplemented with fish oil with slightly higher efficiency, although this is not statistically meaningful again, this trend continued for up to 4 weeks of age and with advancing age, the result was opposite, highlighting a slightly decreased in feed conversion (FC) in the supplemented groups at 5 weeks and a sig-

nificant decrease at 6 weeks of age. This indicates that at later stages of growth, broilers cannot efficiently utilize feeds supplemented with fish oil.

Among the supplemented groups not much effect on the level of fish oil supplementation was reported on FC, except at 6weeks when it was found significantly lower in the 3.5% fish oil supplemented group. The effect of fat type on feed efficiency could be related to the degree of unsaturation, as other authors (Aloa and Balnave, 1984; Pinchasov and Nir, 1992; Zollitsch *et al*. 1997) have reported that digestibility of fat increases as the degree of unsaturation increases.

The cumulative FCR differed (P<0.05) at 4 weeks of age, where it was found significantly lower in oil treated groups when compared to control group (Table 4).

At 5 and 6 weeks of age, feed conversion did not differ (P>0.05) among different levels of fish oil supplementation. At the end of 5 weeks of age, the best cumulative FCR was found in 2.5% and 3.0% oil supplementation, while a poor cumulative FCR was reported in the control group. However, at 6 weeks of age the best cumulative FCR was found in the 2.5% fish oil supplementation group, while poor cumulative FCR was in exception at 3.5% level containing 3.0% oil.

It was found A trend of improving cumulative FCR with increasing level of dietary fish up the 5 weeks of age was reported.

So, it can be concluded that upto the 3.0% level of fish oil as supplementation to the diet, the best performance of broilers on cumulative FCR is reached at the age of 5 weeks.

**Carcass characteristics**

Out of eighteen parameters, shank weight, heart weight, thigh bone and abdominal fat weight differed (P<0.05) due to supplementation of fish oil, whereas, others parameters were statistically similar among treatments (Table 5). The highest percentage of heart weight, dressed weight, breast meat weight and thigh meat weight were recorded at 2.5% supplementation diet. Others parameters had the lowest values in the control group. Although there was no difference (P>0.05) among different treatment groups for wing meat, the highest proportion was found in the 2.5% fish oil supplemented group and the lowest in the control group. The highest proportion of shank weight, thigh bone weight and heart weight were observed in the 3.0% fish oil supplemented group. Although there were no significant variations among the means, the highest dressed weight and drumstick meat weight were found on the 2.5% fish oil supplemented group. The highest drumstick bone weight, dressed weight, drumstick meat weight and digestive tract weight were found in $T_1$ (2.5% marine fish oil) group but, although this value does not reach statistical meaning. Significantly (P<0.01) higher dressed weight percent in the fish oil supplemented group at 5 weeks of age indicates that fish oil has a positive impact on meat yield. Among the supplemented groups, the 2.5% fish oil group showed the highest meat yield as evidenced by the significantly higher dressed weight, when compared to the other groups. Higher meat yield in broilers supplemented with fish, when compared to control, is also supported by a significantly (P<0.05) higher breast meat weight and thigh meat weight, as well as a significantly (P<0.05) lower digestive tract.

**Table 5** Carcass parameters of broiler at 6 week of age feed diet with various levels fish oil

| Parameter[1] | $T_0$ | $T_1$ | $T_2$ | $T_3$ | SEM | Sig. |
|---|---|---|---|---|---|---|
| Shank weight | 4.50$^{b}$ | 5.37$^{a}$ | 5.06$^{ab}$ | 5.06$^{ab}$ | 0.18 | * |
| Blood weight | 4.22 | 4.63 | 4.63 | 4.63 | 0.53 | NS |
| Feather weight | 6.04 | 5.45 | 6.70 | 6.70 | 1.14 | NS |
| Drumstick bone weight | 2.50 | 2.53 | 2.31 | 2.31 | 0.15 | NS |
| Thigh bone weight | 1.39$^{b}$ | 1.60$^{a}$ | 1.46$^{ab}$ | 1.46$^{ab}$ | 0.05 | * |
| Head weight | 2.49 | 2.83 | 2.69 | 2.69 | 0.15 | NS |
| Heart weight | 0.51$^{b}$ | 0.67$^{a}$ | 0.55$^{ab}$ | 0.55$^{ab}$ | 0.04 | * |
| Neck weight | 2.37 | 2.53 | 2.50 | 2.50 | 0.11 | NS |
| Dressed weight | 58.96 | 58.31 | 58.74 | 58.74 | 0.61 | NS |
| Breast meat weight | 12.32 | 12.69 | 13.51 | 13.51 | 0.40 | NS |
| Thigh meat weight | 7.93 | 7.98 | 7.95 | 7.95 | 0.32 | NS |
| Drumstick meat weight | 6.03 | 6.34 | 6.09 | 6.09 | 0.21 | NS |
| Skin weight | 7.77 | 7.52 | 7.98 | 7.98 | 0.44 | NS |
| Abdominal fat weight | 2.14$^{a}$ | 1.62$^{b}$ | 1.92$^{a}$ | 1.92$^{a}$ | 0.22 | * |
| Digestive tract weight | 9.68 | 9.50 | 8.11 | 8.11 | 0.90 | NS |
| Lung weight | 2.43 | 2.71 | 2.35 | 2.35 | 0.20 | NS |
| Gizzard weight | 2.53 | 2.65 | 3.20 | 3.20 | 0.34 | NS |

[1] Unit: g/100 g live weight.

[2] $T_0$: diet without oil; $T_1$: diet containing 2.5% fish oil; $T_2$: diet containing 3.0% fish oil and $T_3$: diet containing 3.5% fish oil.

The means within the same row with at least one common letter, do not have significant difference (P>0.01).

NS: non significant.

* (P<0.05).

SEM: standard error of the means.

The results from this study of a significantly increased dressed weight of broilers fed with fish oil supplementation, in comparison to control group,is in agreement with the work by Chashnidel *et al.* (2010) who reported that inclusion of fish oil in broiler diet significantly improved dressed weight compared to control group. Among the fish oil supplemented groups, dressed weight of broilers fed a diet with 2.5% fish oil gave significantly higher values other groups, indicating that the supplementation should be kept at a low level (2.5%).

Significantly higher values in broilers of control group at 6 weeks of age, when compared to supplemented broilers, gives indication that fish oil supplementation slightly decrease abdominal fat weight and skin weight. The results related to abdominal fat weight and skin weight in this study are in agreement with Lopez-Ferrer *et al.* (2001) and Cortinas *et al.* (2005).

Finally, the values reported of breast meat weight in the present study coincide with the results by Chashnidel *et al.* (2010) who reported that up to 3.0% inclusion level of fish oil in broiler diet significantly increases breast meat percentage.

## CONCLUSION

Supplementation of fish oil at 2.5% level resulted in broiler higher live weight gain and feed conversion ratio.

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