

Full Length Research Paper

Influence of different levels of n-3 supplemented (fish oil) diet on performance, carcass quality and fat status in broilers

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An experiment was conducted to evaluate fish oil as n-3 fatty acids source on some performance, carcass and serum parameters in broilers. One-day old Ross strain male broiler chickens (n = 120) were randomly arranged in four dietary treatments (0, 1.5, 3 and 4.5 percent fish oil), with three replicates for each treatment. Mean live weight and feed intake at the end of starting, growing and finishing periods in fourth treatment was lower than other treatments. All treatments containing fish oil significantly decreased feed conversion ratio compared to control treatment. There were no significant differences on percent of carcass to live weight and abdominal fat percentage to carcass weight in T2, T3 and T4, but there were significant differences between control diet and the others. Serum triglycerides, cholesterol, LDL-c and VLDL-c concentrations were significantly reduced by fish oil treatments than the control diet, but serum HDL-c concentrations were significantly increased by using of diets containing fish oil. The results of this experiment indicated that dietary supplementation of fish oil improved feed conversion ratio, carcass quality and HDL-c concentration in serum, but it decreased serum triglycerides, cholesterol, LDL-c and VLDL-c concentrations in serum of broiler chickens.

Key words: Fish oil, serum cholesterol, carcass quality, broiler.

INTRODUCTION

The world wide diets tend to contain more meat and its products. Broiler meat and its products are the most accessible in all nations. The search for new procedures to improve the quality of food of animal origin is an unquestionable tendency in animal production. Modern breeding broilers selected for rapid growth exhibit higher body fat deposition. Meat quality is highly dependent on its fat content and composition. In this respect, much fat deposition can depress feed efficiency in birds (Sadeghi and Tabiedian, 2005). Oils have commonly been used as energy sources in the diets. It has been shown that further consumption of n-3 polyunsaturated fatty acids (PUFA), in particular, eicosapentaenoic acid (EPA) and

docosahexaenoic acid (DHA) will result in more incorporation into energy metabolism and elevation of PUFA in their carcasses (Halle, 2001, Basmacioglu et al., 2003). The success of broiler meat production has been strongly 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 broiler chickens was strongly related to the dietary fatty acid (FA) profile. It has been reported by researchers that broiler chickens fed with diets containing high levels of PUFA had less abdominal fat pad (AFP) accumulation than those chickens fed with diets containing high levels of saturated fatty acids (SFA) or monounsaturated fatty acids (MUFA). In this regards, several studies showed that enrichment of chicken meat with PUFA, through the addition of PUFA containing fats to the diet, improved feed efficiency and meat composition by increasing n-3 fatty acids in carcass (Lopez-Ferrer et al., 1999). Fish oils which are rich in (n-3) PUFA, (EPA and DHA) have been

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postulated to be beneficial in fighting against several diseases such as atherosclerosis, hypertension and arthritis (Clarke, 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). There are several kinds of fish oil for use in broiler diets, but there were not any reports about effects of kilka fish oil and different levels of it on performance and carcass quality in broiler chickens. Therefore, the aim of this study was to compare the effects of different levels of kilka fish oil supplementation on the performance, carcass quality and some blood parameters.

MATERIALS AND METHODS

One-day old male broiler chicks (120 birds) Ross strain randomly arranged in a completely randomized design in the four dietary treatments as follows: T1 or control diet (without fish oil), T2, T3 and T4 containing 1.5, 3 and 4.5 percentage of fish oil respectively were used for this study. Each treatment was *ad-libitum* in the commercial mash form and formulated for starting, growing and finishing periods from 1 to 42 days. All of the nutrients were the same in the experimental diets (Table 1). Performance parameters were determined as follows.

Feed intake (FI) was determined weekly and chickens were weighed at the end of each period (starting, growing and finishing). Furthermore, feed conversion ratio (FCR) was calculated for each period and the whole periods for each group. At the end of the experimental period (42 days), chickens were weighed, killed and eviscerated. After weighing the eviscerated carcasses, they were apportioned into commercial cuts as back, two leg-thigh and breast. Breast was obtained after removing wings and by cutting through the ribs, thereby separating the breast from the back. The resulting cut pieces (breast meat and thighs with drumsticks) were then weighed. After quartering, breasts and thighs were separated and cutting through the shoulder joint slaughtered carcass with and without skin, thighs and breast, abdominal fat, liver were weighted separately. Serum parameters values were determined as follows: TCH (spectrophotometrically using CHOD-PAP method according to the Zist-Chimi company instructions), TG (Neri and Frings 1973), FFA (Soloni and Sardinal, 1973), HDL-c (Enzymatic method according to the Zist-Chimi company instructions), LDL-c (Wilson et al., 1985) and VLDL-c (Friedwald, 1985). The performance, carcass and serum parameters data obtained were analyzed by variance analysis using the procedure described by the SAS Institute (1994). The Duncan mean separation test (Duncan, 1955) was used to determine significant differences between mean values obtained during different treatments.

RESULTS AND DISCUSSION

The results of performance of broiler chickens fed with the experimental diets are shown in Table 2. Mean live weight at the end of starting, growing and finishing periods and total feed intake for the whole periods in T4 were lower than in other treatments ($P < 0.05$). Nevertheless, total feed intake for the whole periods in T2 was higher than that of T3. These results are in agreement

with reports of Lopez-Ferrer (1999), Aydin (2007) and Alparslan and Özdoğan (2006). Lower feed intake in high dietary fish oil levels (T4) could be due to unpleasant specific flavor compounds of fish oil, but this specification was not cause of low level of fish oil. Baiao and Lara (2005) reported similar findings. All treatments containing fish oil significantly decreased FCR compared to control treatment, which does not have. However, the birds that were fed with T4 have the best FCR than those fed with T2 and T3. It may be that the developmental effects of fish oil fatty acids (unsaturation fatty acids) on absorption and metabolism of other nutrients caused a better FCR in these treatments. These results are in agreement with Alparslan and Ozdoğan (2006), but in contrast to the adverse effects observed by Mirghelenj et al. (2009). The effect of type of fat on feed efficiency could be related to degree of unsaturation, because some authors (Zolisch et al., 1996) have reported that digestibility of fat increases as the degree of unsaturation increases. There were not any significant differences on percent of carcass to live weight in T2, T3 and T4, but there were significant differences among control diet and the others (Table 3). Mirghelenj (2009) reported similar results of percent of carcass to live weight when diets were supplemented with fish oil during the 42 days. The birds that were fed with T4 significantly have the least abdominal fat percent to carcass weight compared the birds that were fed with T2 and T3. These results are in agreement with LO'Pez-Ferrer (1999) and Cortinas et al. (2005). Fish oil is rich in polyunsaturated fatty acids (PUFA) and it is demonstrated that PUFA has been known to uniquely suppress lipid synthesis. Clark (2001) demonstrated that PUFA (particularly n-3) accomplishes this by coordinating an up-regulation of lipid oxidation and a down-regulation of lipid synthesis. There was significant difference on liver percent to carcass weight between the treatments containing fish oil and that of control diet ($P < 0.05$). There are some reports that demonstrated expression of a number of hepatic enzymes involved in glucose metabolism and fatty acid biosynthesis; these are gluco-kinase, pyruvate kinase, glucose-6-phosphate dehydrogenase, citrate lyase, acetyl-CoA carboxylase, fatty acid synthase, stearoyl-CoA desaturase and the D-6 and D-5 desaturases, and n-3 fatty acids that can regulate their activities (Ikeda et al., 1997). Therefore in the treatments, synthesizing and storage of lipid was lower in the control treatment, so liver percent to carcass weight in treatments containing fish oil was lower than that of control group. The results showed that all treatments did not have any significant difference in breast percent to carcass weight. Furthermore, the birds that were fed with control diet significantly have the best leg-thigh percent to carcass weight ($P < 0.05$), and in this case the T4 significantly has the least leg-thigh percent to carcass weight than that of T2 and T3 ($P < 0.05$). Other reports demonstrated that using PUFA in broilers diet reduced synthesizing and storage of lipid in carcass (Cortinas et al., 2005).

Table 1. Ingredients and nutrients compositions of experimental diets.

Feeds (%)	T1			T2			T3			T4		
	Starter	Grower	Finisher	Starter	Grower	Finisher	Starter	Grower	Finisher	Starter	Grower	Finisher
Soybean meal	14.90	10.30	15.33	22.71	18.12	21.98	30.53	25.94	28.51	38.35	33.76	33.15
Corn Grain	63.19	68.68	70.15	58.65	64.14	66.07	54.11	59.60	62.01	49.57	55.06	57.84
Gluten Meal	16.68	15.89	10.27	12.13	11.34	6.50	7.59	6.80	3.00	3.04	2.25	0.00
Fish Oil	0.00	0.00	0.00	1.50	1.50	1.50	3.00	3.00	3.00	4.5	4.50	4.50
DCP ^a	1.58	1.80	1.60	1.54	1.75	1.57	1.49	1.71	1.53	1.00	1.66	1.51
Limestone	1.68	1.35	1.28	1.64	1.32	1.25	1.60	1.28	1.22	1.57	1.25	1.19
D-L methionine	0.18	0.17	0.01	0.22	0.21	0.04	0.26	0.25	0.07	0.30	0.28	0.1
L-lysine	0.83	0.85	0.29	0.64	0.66	0.13	0.46	0.47	0.00	0.27	0.28	0.00
Sodium bicarbonate	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Salt	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.21	0.20	0.2	0.20	0.1
V premix ^b	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
M premix ^c	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Chemical analysis of diets												
ME(Kcal/Kg)	2950	3000	3200	2950	3000	3200	2950	3000	3200	2950	3000	3200
Crud protein (%)	22.00	20.50	19.50	22.00	20.50	19.50	22.00	20.50	19.50	22.00	20.50	19.50
Calcium (%)	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Ap ^d (%)	0.42	0.45	0.45	0.42	0.45	0.45	0.42	0.45	0.45	0.42	0.45	0.45
Theronine (%)	0.79	0.71	0.68	0.80	0.71	0.68	0.80	0.71	0.68	0.80	0.71	0.68
Met+Cys (%)	0.99	0.90	0.89	0.99	0.90	0.89	0.99	0.90	0.89	0.99	0.90	0.89
Lysine (%)	1.3	1.20	1.00	1.3	1.20	1.00	1.3	1.20	1.00	1.3	1.20	1.00

^a Dicalcium phosphate.

^b Vitamin premix the following per kg. of complete feed: vitamin A, 4500 IU (retinyl acetate); cholecalciferol, 1000 IU; vitamin E, 25 IU; vitamin B12, 0.02 mg; menadione, 1.5 mg; riboflavin, 3 mg; thiamin 1.5 mg; pantothenic acid, 5 mg; niacin 0.5 mg; and pyridoxine, 2.5 mg.

^c Mineral premix supplied the following per kg. of complete feed: manganese, 60 g; zinc, 40 mg; iron, 80mg; copper, 8 mg; selenium, 0.2 mg; iodine, 0.8 mg and cobalt, 0.4 mg.

^d Available phosphorous

So it seems that fat content in thigh tissue was reduced by using of different levels of fish oil and then mean thigh weight percent in these groups was less than that of control treatment. Also, the results showed that all treatments did not have any significant difference in breast percent to carcass weight. Alparslan and Ozdogan (2006) showed that breast percent in different levels of

fish oil was not significantly different, and this is agreement with our result. The results shown in Table 4 indicated that serum triglycerides, cholesterol, LDL-c and VLDL-c concentrations were significantly reduced by fish oil treatments, but serum HDL-c concentrations were significantly increased by using of diets containing fish oil. However, serum triglycerides, VLDL-c and HDL-c

concentrations of broilers fed with T3 and T4 significantly have better quality than that of T2 ($P < 0.05$). The T1 and T4 significantly have the highest and least serum cholesterol concentration among other treatments respectively ($P < 0.05$). It is well established that fish oils containing high concentrations of the n-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid

Table 2. Performance of broiler chickens fed the experimental diets (from 1 - 42) (mean \pm SD).

Variable	T1	T2	T3	T4
Starter weight (g)	284.63 \pm 25.26 ^a	300.50 \pm 31.66 ^a	283.08 \pm 17.50 ^a	271.42 \pm 22.55 ^b
Grower weight (g)	580.16 \pm 37.80 ^b	655.50 \pm 50.43 ^a	616.92 \pm 51.07 ^a	558 \pm 46.06 ^b
Final Live Weight (g)	2005.33 \pm 106 ^b	2126.9 \pm 174 ^a	2042.50 \pm 128 ^b	1884 \pm 139 ^c
Total Feed intake(g)	4167 \pm 277 ^a	4232 \pm 160 ^a	4065 \pm 252 ^a	3831 \pm 263 ^b
Total Feed conversion ratio	2.07 \pm 0.16 ^c	1.99 \pm 0.06 ^b	1.98 \pm 0.14 ^b	1.93 \pm 0.07 ^a

Table 3. Carcass yield parameters of broiler chicks fed the experimental diets (from 1 - 42 days) (mean \pm SD).

Variable	T1	T2	T3	T4
Carcass weight (g)	1664.17 \pm 88 ^a	1765.20 \pm 161 ^a	1682.24 \pm 134 ^a	1563.42 \pm 115 ^b
Carcass weight (without skin/g)	1536 \pm 79.5 ^a	1655.3 \pm 60 ^a	1595.2 \pm 130 ^a	1512.7 \pm 107 ^b
Carcass percent	82.28 \pm 0.02 ^b	82.99 \pm 0.02 ^a	82.72 \pm 0.04 ^a	82.98 \pm 0.02 ^a
Breast percent	22.14 \pm 1.93 ^a	22.58 \pm 0.85 ^a	23.06 \pm 1.80 ^a	21.55 \pm 3.3 ^a
leg-thigh percent	28.16 \pm 1.15 ^a	26.32 \pm 1.43 ^b	26.73 \pm 1.56 ^b	25.74 \pm 3.05 ^c
Abdominal fat weight percent	2.15 \pm 0.14 ^c	1.45 \pm 0.24 ^b	1.34 \pm 0.26 ^b	1.28 \pm 0.21 ^a
Liver weight percent	2.85 \pm 0.24 ^b	2.02 \pm 0.22 ^a	2.13 \pm 0.37 ^a	1.97 \pm 0.29 ^a

Table 4. Serum profile parameters of broiler chicks fed the experimental diets (from 1-42 days).

Variable	T1	T2	T3	T4
TG	185.58 \pm 4.2 ^c	145.2 \pm 1.7 ^b	119.75 \pm 6.4 ^a	114.7 \pm 3.81 ^a
VLDL-c	38.50 \pm 1.05 ^c	28.36 \pm 1.20 ^b	23.47 \pm 0.85 ^a	22.30 \pm 0.9 ^a
HDL-c	70.50 \pm 0.85 ^c	90.43 \pm 1.11 ^b	96.20 \pm 0.90 ^a	97.30 \pm 0.93 ^a
LDL-c	111.26 \pm 2.35 ^c	56.90 \pm 2.17 ^b	44.32 \pm 3.86 ^b	35.53 \pm 1.85 ^a
Tch	223.30 \pm 3.63 ^c	175.68 \pm 4.85 ^b	162.75 \pm 6.17 ^b	125.83 \pm 4.23 ^a
FFA	0.4 \pm 0.07 ^a	0.43 \pm 0.08 ^b	0.48 \pm 0.08 ^c	0.45 \pm 0.11 ^b

Values are given as mmol/l and are the means \pm SD.

The items under variable are triglyceride (TG), very low density lipoproteins (VLDL), high density lipoproteins (HDL), low density lipoproteins (LDL), total cholesterol (Tch) and free fatty acids (FFA).

(DHA) are very potent at lowering plasma triglycerides. But the actual mechanism- how n-3 fatty acids decrease the level of triacylglycerols in the serum is unknown (Aydin, 2005). Although some authors have reported that the mechanism, fish oil caused reduction in cholesterol, triglycerides and lipoproteins include reduction of hepatic synthesis and secretion of triglycerides by decreasing activity of synthetic enzymes, increasing proximal beta oxidation, increasing in the expression of hepatic receptor for LDL (Belzung et al., 1993). On the other hand, Salma et al. (2007) have shown that cholesterol concentration in skeletal muscle of the broilers had a positive correlation with the changes of the cholesterol contents in serum. Thus, it is expected that with decreasing of serum cholesterol, the amount of meat cholesterol is tending to decrease too. Therefore, these results led to the conclusion that there were similar improvements on performance (a reduction in abdominal fat and triglyceride,

cholesterol, LDL and VLDL levels in serum) of birds fed with diets supplementation of fish oil and their products performance was improved better than birds fed with control diet. In addition to, these supplementation diets can help in reducing the occurrence of cardiovascular heart diseases in broilers meat consumers. So for these effects we proposed adding 3 percent fish oil in broilers diet.

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