academicJournals

Vol. 6(2), pp. 16-19, February, 2014
DOI: 10.5897/IJFA11.051
ISSN 1991-637X ©2014 Academic Journals
http://www.academicjournals.org/IJFA

International Journal of Fisheries and Aquaculture

Full Length Research Paper

The comparison of total cholesterol and cholesterol types of cultured rainbow (*Oncorhynchus mykiss*, Walbaum, 1972) and brook trouts (*Salvelinus fontinalis*, Mitchill, 1815) cultivated under the same water conditions

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Accepted 22 January, 2014

The aim of this study was to compare serum total cholesterol and cholesterol types of cultured rainbow trout (CRT) (*Oncorhynchus mykiss*) and cultured brook trout (CBT) (*Salvelinus fontinalis*) cultivated under the same water conditions. Fishes used in the research were randomly captured from pools and five pieces (five replication) were used for each group. The average weight of fish is 80 g for CRT and is 120 g for CBT. CRT and CBT have been fed with feed with 45 to 50% crude protein twice a day. The levels of serum samples excluding high density lipoproteins (HDL) obtained from the CBT were found to be higher ($p<0.05$) than that of CRT. Finally, higher serum samples in CBT could have resulted from difference of growth and size, species, age, the cycle of sexual maturity of fish.

Key words: Rainbow trout, brook trout, total cholesterol, high density lipoproteins (HDL), low-density lipoproteins (LDL), very-low-density lipoprotein (VLDL).

INTRODUCTION

Blood parameters such as hematology and biochemistry are essential in assessing the physiological and pathological changes of fish (Satheeshkumar et al., 2012). The values determined by the researchers for the blood parameters are based on the species of the fish, the size, and the dietary pattern. (Xiaoyun et al., 2009). The analysis of hematological parameters is considered to be important as it gives information about acute and chronic stress as well as metabolic disorders before adaptation of fish to ambient conditions (Bahmani et al., 2001). Parameters such as hematology and biochemistry are crucial in determining the response of fish to both general health conditions and environmental conditions (De Pedro et al., 2005). Environmental factors such as management, stress and diseases have significant effects on hematology and biochemical blood parameters (Cnaani et al., 2004; Chen et al., 2005; Svobodova et al., 2008; Satheeshkumar et al., 2012). For instance, it has been determined that hypoxia stress has significant effects on blood cholesterol levels (Skjervold et al., 2001). Stress is considered to have important effects on levels of cortisol and glucose (Lermen et al., 2004). Fish size, water quality, nutritional status and stocking density may have profound effects on blood

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values (Coz-Rakovac et al., 2005). Cholesterol, triacylgycerols and other lipids classified according to increasing density are transported in blood by lipoproteins such as cyclomicrons, very low density lipoproteins (VLDL), low- density lipoproteins (LDL) and high density lipoproteins (HDL). Very-low-density lipoprotein (VLDL) is a type of lipoprotein made by the liver. VLDL is one of the five major groups of lipoproteins (chylomicrons, VLDL, low- density lipoprotein, intermediate-density lipoprotein, high- density lipoprotein) that enable fats and cholesterol to move within the water-based solution of the bloodstream. VLDL is assembled in the liver from triglycerides, cholesterol, and apolipoproteins. VLDL is converted in the bloodstream to low-density lipoprotein (LDL). VLDL delivers endogenously synthesized triacylglycerols to adipose tissue. The residue is transformed into LDL, which are rich in cholesterol esters. The role of LDL is to transport cholesterol to peripheral tissues and regulate de novo cholesterol synthesis at these sites. HDL are synthesized by the liver and it are rich in terms of phospholipids and cholesterol. HDL is the major class of lipoproteins their content in trout is 3 – 5 fold higher than in man. The most important role of HDL is transport cholesterol from peripheral tissues to the liver (Atamanalp and Solak, 2004; Wikipedia, 2013).

Cholesterol has a number of functions. It is a structural component of cell membranes. The cholesterol content of a membrane varies with the tissue and with specific membrane function. The ratio of cholesterol to polar lipids affects the stability, permeability, and protein mobility of a membrane. Membranes with high ratios have high stability and relatively low permeability; their major function is a protective barrier. Membranes of intracellular organelles such as mitochondria have low cholesterol ratios and are consequently fluid and permeable. They serve primarily in synthetic and degradative reactions and in energy production. The outer membranes of most cells have intermediate cholesterol-polar lipid ratios and have both protective and metabolite-transport functions. Cholesterol is also the precursor of steroid hormones such as progesterone, testosterone, estradiol and cortisol (Karagül et al., 2000; Mustonen et al., 2002; Atamanalp and Solak, 2004).

In this study, we compared the levels of total cholesterol and cholesterol types of cultured rainbow (*Onchorhynchus mykiss* Walbaum, 1972) and brook trouts (*Salvelinus fontinalis* Mitchill, 1815) cultivated under the same water conditions.

MATERIALS AND METHODS

Characteristics of the water

The water in which the fishes are captured is an artesian water that has a flow rate of 1L per in second and has a temperature of 10.3°C, contains dissolved oxygen of 10.3 mg / L, has a pH value of 7.3 to 7.7.

Fish material and blood serum

Cultured rainbow trout (CRT) and cultured brook trout (CBT) reared in the same conditions were obtained from the Fisheries Faculty at Atatürk University in Erzurum. The average weights of fish were 80±3.6 g for CRT group and 120±6.5 g for CBT group. Fish were reared in the same pool during four month. Fish sample were randomly caught from pool, and five fish (five replications) were used for each group. CRT and CBT were fed with commercial trout feed (crude protein 45 to 55%, fat 17%, ash 10%, gross energy 3448 kkcal) twice a day.

To obtain blood samples, fish were, quickly taken out from the water and held firmly on a bench with a cloth covering the head and blood samples were withdrawn from caudal vessels by a vacuum syringes and then samples were taken anticoagulant tubes. Handling time of fish was less than 1 min to minimize stress effects. (Atamanalp et al., 2002a, b; Atamanalp and Yanık, 2003; Hedayati and Hosseini, 2013). Blood samples taken to serum separation tubes waited for 20 min clotting. Blood samples clothed were centrifuged at 3.000 rpm for 10 min and serum was separated. The separated serum samples were analyzed HDL concentration by autoanalyzer Cobas C501 by using commercial kits.

Statistical analyses

To evaluate statistically significant differences between groups research, Duncan test was applied to all groups. For this purpose, the 11.5 version of SPSS program was used (SPSS Inc, Chicago, USA). For the comparison of data, $p<0.05$ was considered statistically significant (SAS, 1996).

RESULTS

In this study, we were compared to blood cholesterol values of CRT and CBT. The results that observed from the present study and the results of statistical analyses are given Table 1 fed by extrude feeds (twice in a day) respectively. Total cholesterol, LDL and VLDL levels in CBT are found to be 1.57, 3.48 and 1.85 times higher than the ones present in CRT, respectively. However, HDL level in CBT are found to be 1.82 times lower than the one present in CRT (Table 1).

DISCUSSION

Total cholesterol

Cholesterol is carried through the bloodstream attached to two different compounds called lipoproteins: low-density lipoproteins (LDL) and high-density lipoproteins (HDL). Cholesterol also serves as a precursor for the biosynthesis of steroid hormones, bile acids, and vitamin D. Cholesterol is the principal sterol synthesized by animals; in vertebrates it is formed predominantly in the liver. It is almost completely absent among prokaryotes (that is, bacteria), although there are some exceptions such as Mycoplasma, which require cholesterol for growth (Hanukoglu, 1992). In present study, total

Table 1. The general results of experiment.

Biochemical parameter (mg/dl)	CBT	CRT	Important levels
Total cholesterol	401.3±59.6[a]	254±31.5[b]	**
HDL	25.9±2.9[a]	47.3±3.5[b]	*
LDL	75.3±5.2[a]	21.6±1.9[b]	**
VLDL	316.9±33.8[a]	170.6±21.3[b]	**

Results are given as mean ± standard deviation. There is significant difference between parameters given as different superscripts (p<0.05). N:25, **very important p<0.01 *: important p<0.05.

cholesterol values were found as 401.3±59.6 mg/dl for CBT (the higher value) and 254±31.5 mg/dl for CRT (the lower value). There is significant difference between groups (p<0.01). The total cholesterol values may be change depending on size and species of fish. For example, in *Ctenopharyngodon idella* 10.19 ± 0.49 mg/g (Shakoori et al., 1991); 10.55 ± 0.47 mg/g (Mughal et al.,1993); 8.29 ± 0.38 mg/g (Shakoori et al., 1994) in *Heteropneustes fossilis* 340.9 ± 1.50 mg/100 ml (Srivastava et al., 1995) in *Cyprinus carpio* 173 ± 21 mg/100 ml (Shimeno et al., 1997) and in *Leuciscus cephalus* 420 ± 137 mg/dl (Haşiloğlu et al., 2002).

LDL

LDL is commonly known as the "bad" cholesterol because it transports cholesterol from the liver throughout the body, and potentially allows it to be deposited in artery walls. LDL values of groups were found to be 75.3±5.2 mg/dl and 21.6±1.9 mg/dl in CBT and CRT. The different between groups can be resulted from size of fish. But our study's results was found to be lower than literatures, 1156 mg/100 ml male trout (0.5 to 1.0 kg); 1189 mg/100 ml male trout; 879 g/100 ml (100 to 120 g) immature fish (Leger, 1985). LDL value for rainbow trout was found to be 195 ± 21.20 mg/dl (Atamanalp et al., 2003). The differences between groups were very important (p<0.01).

HDL

HDL, known as the "good cholesterol," picks up cholesterol from the blood and delivers it to cells that use it, or takes it back to the liver to be recycled or eliminated from the body. In this experiment HDL values was found to be 25.9±2.9 mg/dl for CBT, 47.3±3.5 mg/dl for CRT. Comparing with the old reports these results were found low. For example; 1062-2216 mg/100 ml for male trout; >1500 mg/100 ml for 0.7 to 1.9 kg female trout; 2344 mg/100 ml for immature trout; 518 mg/100 ml for 0.5 to 1.0 kg male trout; 331 mg/100 ml for male trout and 1750 mg/100 ml for 1.0 to 1.2 female trout (Leger, 1985). Atamanalp et al. (2003) reported HDL value for rainbow trout 114.00 ± 26.40 mg/dl. The differences between groups were important (p<0.05).

VLDL

VLDL transports endogenous triglycerides, phospholipids, cholesterol, and cholesteryl esters. It functions as the body's internal transport mechanism for lipids (free encyclopedia, 2013). VLDL level in CBT was found 1.85 times higher than the ones present in CRT. VLDL value of the CBT was similar to Leger (1985) who reported VLDL value as 335 mg/100 ml for male trout 100 mg/dl for female trout in ovulation time. But the other value was lower. Some reports were higher than our experiments' results. For example, 673 mg/100 ml for 0.7 to 1.9 kg female trout; 248 mg/100 ml for immature trout; 586 mg/100 ml 0.5-1.0 kg male trout, 335 mg/100 ml for male trout and 650 mg/100 ml for 1.0 to 1.2 kg female trout and 100 mg/dl for female trout in ovulation time (Leger, 1985).

Conclusion

The results could be useful in terms of the evaluation of the biochemical parameters of cultured rainbow trout and brook trout. Differences observed in the levels of total cholesterol and HDL, LDL, VLDL micro elements between the two fish groups (CBT and CRT) may closely related to species, size, sex and sexual maturity. The results obtained from this study were found to be higher/lower than previous studies. The differences between total cholesterol, HDL, LDL and VLDL level the literatures and our study could be related with feeding and environmental conditions, the sexual status of fish.

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