VERSITA
DOI 10.2478/msd-2013-0008

EXAMINATION OF THE CONCENTRATIONS OF SOME HEAVY METALS IN THE ORGANS OF TWO FISH SPECIES (*PHOXINELLUS ANATOLICUS* HANKO, 1924, *CYPRINUS CARPIO* LINNEAUS, 1758) TAKEN FROM SUĞLA LAKE

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ABSTRACT: This research has been conducted to determine the heavy metal (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) accumulation in the fish species Carp (Cyprinus carpio Linneaus, 1758) and Fatty fish (Phoxinellus anatolicus Hanko, 1924) taken from Suğla Lake, which is one of the most important water sources of Konya. In this research, conducted in 2009-2010, the heavy metal accumulation was examined in the time span of one year seasonally. And it has been concluded at the end of the research that the heavy metal accumulations show statistical dramatic differences between the seasons ($p<0,05$).
KEY WORDS: Konya, Suğla Lake, Carp, Cyprinus carpio, Fatty fish, Phoxinellus anatolicus

1. INTRODUCTION

Environmental problems come at the top of significant dangers, which threaten the ecological balance of the universe in today's conditions. Environmental pollution, which emerged after urbanisation, has increased in the parallel direction with the industrial development. The increasing environment pollution in the second half of the twentieth century, as a result of the rapid increase in population, in recent years has resulted in the pollution of life sources and, as a result, the breakdown of the ecosystem has dramatically taken a serious shape (Kaya et al., 1998; Yarsan et al., 2000).

In proportion with their concentration, metals have the toxic effect on the life of the living beings in their excretion areas. Among these matters, even trace amount of which might be dangerous, the most important group named heavy metals consists of elements such as Sb, Ag, As, Be, Cd, Cr, Cu, Pb, Mn, Hg, Ni, S, Zn. Thus, in this research to examine the pollution degrees of some heavy metals (Co, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn) in the samples of Carp and Fatty fish taken from Suğla Lake seasonally and thereby to determine the elements, which cause the pollution are aimed.

2. MATERIAL AND METHOD

As fish material, Fatty fish (*Phoxinellus anatolicus* Hanko, 1924) and Carp (*Cyprinus carpio* Linneaus, 1758) samples were provided from the lake during the eight-month-period in July, October and January, by representing the summer, fall and winter seasons, excluding the months (March - June), in which hunting is prohibited.

Fish samples provided from the lake were brought to the laboratory within the same day, so that their height and weight measurements could be done. The fish samples had been kept in the deep freezer at – 18 C till they were analysed. For the tissues to be analysed; while 2 gr samples were taken for the muscle, as for the liver, if the fish were small, their whole liver was taken, and if the fish were big, the amount similar to the whole liver of the smaller fish was taken. Besides, 2 pieces of strings were taken from the left and right gills of the fish. After that, the wet weight of the tissue samples had been measured with 0,001 g precision scales, and their tare had been determined, they were put into porcelain crucible and they were fired at 650 °C in the ash stove for the period of 12 hours (Yazkan et al., 2002). After they had been taken from the ash stove in the form of white ashes, 2 ml HNO3 were added in the samples in the amount of 65% (Ünlü and Gümgüm, 1993). Till the samples became clear, they were heated in the füme hood on, and during the time till the samples were clear, an equal amount of HNO3 was added to each sample. After the cleared samples had been cooled, they were filtered with 100 mm blue band filter and then their volume was made to reach to 25 ml with the deionised water (Salim et al., 2003). The standard range of elements (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were determined for the fish samples prepared for analysis. After the calibration, the samples were read by using the ICP-AES apparatus.

In the statistical calculations, SPSS 15 program was used. To determine the differences between the tissues provided from the fish samples, One-Way Anova Post-Hoc test (Duncan) was applied.

3. FINDINGS

3.1. Heavy Metal Concentrations in the Samples of Fatty Fish (*Phoxinellus anatolicus*)

Average amount of the Cr, Cu, Fe, Mn, Pb and Zn heavy metals in the muscle, liver and gill tissues of the fish samples are given in the Table 1. While Cu, Fe, Mn and Zn were found in all the tissues in each season, Cr and Pb were found in the liver and gill in each season. As the amount of Cd, Co and Ni were determined under the level of measuring range (<0.028), these materials are not included in the Table. In general, the accumulation of metal in the liver is more than those in the muscle tissue and gill.

Table 1. The amount of heavy metals in some tissues of Fatty fish (mg/kg)

Season	Tissue	Cr	Cu	Fe	Mn	Pb	Zn
Summer	Muscle	ÖSA*	0.51±0.16a	4.04±0.76a	0.18±0.01a	ÖSA	7.77±1.66a
	Liver	0.32±0.14a**	2.24±0.37a	30.16±1.77a	2.67±0.26a	0.23±0.01a	44.14±2.37a
	Gill	0.15±0.05a	1.25±0.11a	32.86±3.68a	2.56±0.33a	0.22±0.03a	54.76±4.61a
Fall	Muscle	ÖSA	0.73±0.07b	3.86±0.44a	0.25±0.06b	ÖSA	9.88±0.66b
	Liver	0.13±0.07b	2.90±0.38b	32.73±3.17b	2.50±0.49a	0.14±0.02b	56.68±4.56b
	Gill	0.12±0.01b	1,84±0.22b	26.72±1.69b	2.85±0.57a	0.19±0.02b	67.80±9.69b
Winter	Muscle	ÖSA	0.83±0.05c	3.28±0.35b	0.14±0.04c	ÖSA	6.93±0.24a
	Liver	0.14±0.008c	3.39±0.13c	38.43±2.13c	3.37±0.31b	0.12±0.005b	33.39±4.66c
	Gill	0.11±0.009c	1.73±0.12b	31.58±1.54a	2.79±0.26a	0.17±0.01b	39.89±5.83c

*ÖSA: Under the Limit of Analysis** In each parameter column, the differences among the values shown with the same letters are unimportant at the level of 0.05

Average Cr amount determined in the summer season of the year 2009, is 0.32 mg/kg in the liver and 0.15 mg/kg in the gill tissue. Cr was not found in the muscle tissue in this season. Besides, the amount of Cr reached the maximum level in the liver and gill tissue in this season. The amount of Fe reached the maximum level in the muscle and gill tissue in this season. Pb was not found in the muscle tissue in this season. Besides this, in the liver and gill tissue, Pb reached the maximum level in this season.

When compared to the 2009 summer season, in the 2009 fall season, while there were increases in the amount of some metals, there were decreases in the amount of the others. Cr was not found in the muscle tissue in this season. In the gill tissue, the amount of Cu reached the maximum level in this year. In the muscle and gill tissue, Mn reached the maximum level in this season. In this season, Pb was not found in the muscle tissue. Zn reached the maximum level in this season in the liver and, muscle and gill tissues.

When compared to the 2009 fall season, in the 2009 winter season, while there are some increases in the degrees of some metals, there are decreases in the others. Cr was not found in this season in the muscle tissue. In the muscle and gill tissues, the amount of Cu reached to the maximum level in this season. The amount of Fe in the liver reached the maximum level in this season. The amount of Mn in the liver tissue reached the maximum level in this season. Pb was not found in the muscle tissue in this season.

Table 2. The amount (mg/kg) of some heavy metals in some carp samples.

SEASON	TISSUE	Cr	Cu	Fe	Mn	Ni	Pb	Zn
SUMMER	Muscle	0.03±0.006a**	0.31±0.09a	9.43±0.08a	0.22±0.08ab	ÖSA *	ÖSA	11.58±1.01a
	Liver	0.20±0.06a	3.82±1.04a	92.05±4.67a	4.21±0.74ab	0.08±0.01a	0.12±0.03a	94.34±3.49a
	Gill	0.22±0.13a	0.90±0.14a	62.15±1.82a	5.53±0.86a	0.07±0.009a	0.11±0.02a	89.06±3.03a
FALL	Muscle	0.07±0.006b	0.30±0.06a	9.25±1.88a	0.23±0.03a	ÖSA	ÖSA	9.83±1.78b
	Liver	0.15±0.05b	2.77±0.36b	71.31±12b	5.20±1.01a	0.07±0.02b	0.11±0.01b	96.21±1.65b
	Gill	0.20±0.04ab	0.55±0.04b	61.43±5.08a	5.01±0.66ab	0.04±0.02b	0.10±0.02a	92.81±2.79b
WINTER	Muscle	0.04±0.003a	0.36±0.02a	6.74±0.43b	0.17±0.03b	ÖSA	ÖSA	10.87±0.56ab
	Liver	0.22±0.02c	3.02±0.14c	67.11±3.13c	3.53±0.03b	0.04±0.008b	0.13±0.01b	69.33±1.84c
	Gill	0.13±0.01b	1.92±0.06c	55.10±1.55b	4.53±0.39b	0.03±0.004b	0.12±0.01a	98.41±2.65c

*ÖSA: Under the limit of Analysis ** In each parameter column, the differences among the values shown with the same letter are unimportant at the level of 0.05

The average amount of Cr found during the 2009 summer season is 0.03 mg/kg in the muscle tissue, 0.20 mg/kg in the liver and 0.22 mg/kg in the gill tissue. The amount of Cr in the gill tissue reached the maximum level in this season. In the liver tissue, the amount of Cu reached the maximum level in this season. In the muscle, liver and gill tissue, the amount of Fe reached the maximum level in this season. The amount of Mn in the gill tissue reached the maximum level in this season. Ni was not found in the muscle tissue in this season. Besides, in the liver and gill, Ni reached the maximum level in this season. Pb was not found in the muscle tissue in this season. In the muscle tissue, Zn reached the maximum level in this season.

When compared to the 2009 summer season, in the 2009 fall season, while there is an increase in the amount of some metals, there is a decrease in the amount of the others. In the muscle tissue, Cr reached the maximum level in this season. In the muscle and liver tissues, the amount of Mn reached the maximum level in this season. The amount of Ni is 0.07 mg/kg in the liver and 0.04 mg/kg in the gill tissue. Ni was not found in the muscle tissue in this season. Pb was not found in the muscle tissue in this season. In the liver tissue, the amount of Zn reached the maximum level in this season.

When compared with the 2009 fall season, in the 2009 winter season, while there is an increase in the amount of some metals, there is a decrease in the amount of the others. In the liver, Cr reached the maximum level in this season. In the muscle and gill tissue, Cu reached the maximum level in this season. Ni was not found in the muscle tissue in this season. In the liver and gill tissue, Pb reached the maximum level in this season. Besides, Pb was not found in the muscle tissue in this season. In the gill tissue, the amount of Zn reached to the maximum level in this season.

4. ARGUMENTS AND RESULTS

As fish are in the upper steps of the food chain in the aquatic environment, they accumulate heavy metals such as Pb, Cd, Cr, Hg, Zn and Fe in their bodies. Besides that, the chemical characteristics of the water and organic compounds, and biological factors such as habitat selection, nourishment manner and the amount of growth, affect the concentrations of the heavy metals in fish (McFarlane and Franzin, 1980; Campbell and Stokes, 1985; Bradley and Morris, 1986; Dallinger et al., 1987; Sprenger et al., 1988; Iivonen et al., 1992).

In the results of the heavy metal analyses done in some tissues and organs of the Carp and Fatty fish living in Suğla Lake, Cu, Fe, Mn and Zn have been found in all the tissues of both of these fish. While Cr was found in all tissues in Carp in each season, it was found in the liver and gill tissues in each season in Fatty fish. While Ni was seen in the liver and and gill tissues in each season in Carp, it was not seen in the Fatty fish. Pb was seen in the liver and gill tissues in each season in Crap and Fatty fish. Cd and Co were not seen in both of these fish species.

In the research that Doğan (2004) had done with the fresh water taken from four sources in Hatay (Asi River, Yenişehir Lake, Kırıkhn Gölbaşı Lake and Tahta Köprü Dam), the levels of heavy metal in the muscle, liver, gill and skin tissues of yellow-spotted (*Carasobarbus luteus* HECKEL, 1843) were examined. In the average numbers in Hatray, it was seen that the heavy metal concentrations of *Carsobarbus luteus* was changeable depending on organs. In general, it was stated that liver and gill had more heavy metal accumulation than the muscle tissue, and the accumulation in the muscle was under the limit of consumption determined for the aquatic products.

Göksu et. al. (2003) determined the accumulation of Fe, Zn, and Cd in the eatable parts of Mirror Carp (*Cyprinus carpio* L., 1758) and Zander (*Stizostedion lucioperca* L., 1758), taken from Seyhan Reservoir. They found the accumulation rank as Fe>Zn>Cd. In this study it was found that the amount of Cd metal in the eatable part of Carp (*Cyprinus carpio* L., 1758) and Fatty fish (*Phoxinellus anatolicus*) was under the measurable limit value. The accumulation of Fe and Zn metals were determined as Zn>Fe, respectively.

According to the analysed data resulting from the research done on Carp and Fatty fish samples taken from Suğla Lake, it has been found that in both of these species the liver is the organ in which the heavy metal accumulation was observed abundantly. The liver is followed by gill and muscle tissues, respectively. Moreover, it was found out that the heavy metal accumulation in the muscle tissue is within the limits of consumption standards for the aquatic products, and it was found that there is no risk in using it as a consumption product.

In the research conducted in Argentina, Marcovecchio (2004) determined the total Hg, Cd and Zn concentrations in the eatable muscle tissues and liver of *Micropogonias furnieri* and *Mugil liza* that he had hunted in La Plata River. And he also determined that the highest accumulation of these three metals was found in the liver and it was also found that all the metal levels were low in the muscle tissues.

In the research that Akköz et. al. (2012), determined the effect of seasonal variations on fatty acid composition of muscle tissues of yag fish and carp living in freshwater. They found out that the effect of Oleic acid contents of carp muscle oil ranged between 34.53 % (July 2009) and 37.50 % (March 2010). Palmitic acid contents of yag fish oil changed between 23.08 % (November 2009) and 30.08 % (March 2010). While oleic acid contents of carp are found at high levels, palmitic acid was determined high in yag fish oil. At the same time, in yag fish oil contained palmitoleic acids (19.11-26.11 %) at high levels.

In this study, it was determined that in all the seasons, the lowest metal accumulation was in the muscle. While Cu, Fe, Mn and Zn metals were observed in the muscle tissues of Fatty fish, in the muscle tissue of Carp, Cr, Cu, Fe and Zn metals were found.

As a result, it has been determined that the heavy metal concentrations in the eatable muscle tissues of Carp (*Cyprinus carpio* Linneaus, 1758) and Fatty fish (*Phoxinellus anatolicus* Hanko, 1924), provided from Suğla Lake and consumed as nourishment in the area, are under the limits acceptable for EPA, and thereby there is no risk in their consumption.

REFERENCES

1. Kaya, S., Pirinçci, I. ve Bilgili, A., *Science of Environment and Environment Toxicology*, Medisan Press Series, Press No:36, (1998)
2. Yarsan, E., Bilgili, A. ve Türel, İ., *Heavy Metal Levels in the Samples of Mussel (Unio stevenianus krynicki) taken from Van Lake*. Turk J Vet Anim Sci.,24: 93–96, (2000)
3. Yazkan, M. , Özdemir, F. ve Gölükçü, M., *The Content of Cu, Zn, Pb and Cd in Some Fish Species Fished in Antalya*. Türk J Vet. Anim Sci., 26:1309-1313, (2002)
4. Ünlü, E. ve Gümgüm, B., *Concentrations of Copper and Zinc in Fish and Sediments From the Tigris River in Turkey*. Chemosphere, Vol.26, No:11, pp 2055-2061, (1993)
5. Salim, A., Hassanin, M.A. and Zohair, A., *A Simple Procedure for Reducing Lead Content in Fish*. Food and Chemical Toxicology, 41, pp 595-597, (2003)
6. McFarlane, G, A., Franzin, W, G., *An Examination of Cd, Cu and Hg Concentrations in Livers of Northern Pike, Esox lucius and White Sucker, Catostomus commersoni, from Five Lakes Near a Base Metal Smelter at Flin Flon, Manitoba*. Can. Aquat. Sci. 37, 1573-1578, (1980)
7. Campbell, P, G, C., Stokes, P, M., *Acidification and Toxicity of Metals to Aquatic Biota*. Can. J. Fish Aquat. Sci. 42, 2034-2049, (1985)
8. Bradley, R, W., Morris, J, R., 1986. *Heavy Metals in Fish from A Series of Metal- Contaminated Lakes Near Sudbury, Ontario*. Water Air Soil Pollut. 27, 341-354.
9. Dallinger, R., Prosi, F., Senger, H., Back, H., *Contaminated Food and Uptake of Heavy Metals by Fish (A Review and Proposal for Further Research)*. Oecologia (Berlin). 73, 91-98, (1987)
10. Sprenger, M, D., McIntosch, A, W., Hoenig, S., *Concentrations of Trace Elements in Yellow Perch (Perca flavescens) from Six Acidic Lakes*. Water Air Soil Pollut. 37, 375-388, (1988)
11. Iivonen, P., Piepponen, S., Verta, M., *Factors Affecting Trace-Metal Bioaccumulation in Finnish Headwater Lakes*. Environ. Pollut. 78, 87-95, (1992)
12. Doğan, M., *Heavy Metal Levels in the Samples of Fish (Carasobarbus luteus, HECKEL, 1843) and Water Taken from the Water Sources in Hatay*. Mustafa Kemal University, Institute of Physical Sciences, MA Thesis, Hatay. s 60, (2004)
13. Göksu M.Z.L., Çevik, F., Fındık F. ve Ercan Sarıhan, E., *Determination of the Levels of Fe, Zn and Cd in Mirror Carp (Cyprinus carpio L., 1758) and Zedan (Stizostedion*

lucioperca L.,1758) in Seyhan Reservoir E.U. Journal of Fishering and Aquaculture vol 20, issue (1-2): 69 – 74 ISSN, (2003)

14. Marcovecchio, J.E., *The Use of Micropogonias furnieri and Mugil liza as Bioindicators of Heavy Metals Pollution in La Plata River Estuary, Argentina*. Science Of The Total Environment, 323: 219-226, (2004)
15. Akköz, C.,Kalyoncu, L., Özcan, M.m.,Kalyoncu, H., Ünver, A., and Kanbur, G. *The Effect of Seasonal Variations on Fatty Acid Composition of Muscle Tissues of Yag Fish and Carp Living in Freshwater*. Analytical Chemistry Letters (ACL 2) (2) pp. 129 – 132 (2012)