Concentration of Heavy Metals in Tissue Samples of Catla catla from Aurangabad Region, Maharashtra

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Abstract **- Determination of concentration of heavy metals viz. As, Cr, Cu, Ni, and Zn in the tissue samples of freshwater fish Catla catla, using Atomic Absorption Spectroscopy (Thermo fisher - model AA-303). The concentration observed in this study when compared with national and international standard given by WHO and FAO, it was found that some of them are of great concern and exceeds the limit given by WHO/FAO, this is might be due industrial effluents, agricultural influx and some anthropogenic activities.**

Index Terms **- Heavy Metals, Catla catla, AAS, WHO, FAO**

I.INTRODUCTION

Water pollution is one of the greatest problems that we are facing today, Water is regarded polluted when it changes its composition or quality either naturally or by human activities and becomes less suitable for life. Extensive industrialization and urbanization have increased the concentration of heavy metals in the aquatic environment which affect the survival, reproduction and growth of organisms including fish [14]. Heavy metals are kept under environmental pollutant category as they are indestructible and have toxic effects and are devoted to the widespread contaminants of terrestrial and freshwater components. Among all other environmental pollutants, Heavy metals are of particular concern, due to their potential toxic, bio-accumulative and non-biodegradable properties [15]. These Heavy metals enter the aquatic medium through anthropogenic activities such as mining, discharged of agricultural, smelting operation, municipal, residential, Industries such as tanneries, textiles, metal finishing, mining, dyeing and painting industries, Ceramic and pharmaceutical industries etc.[26] and also from wastewater treatment plants [9,11,12 and 13]. It is found that one-third of the total water pollution in India comes in the form of industrial effluent discharge, solid wastes, and other hazardous wastes untreated or allegedly treated industrial effluents. Fishes are considered to be most significant bio-monitors in aquatic systems for the estimation of heavy metal pollution World Health Organization [25], As they are the most widely distributed organisms in the aquatic environment and, being susceptible to heavy metal contamination, they offer several specific advantages in describing the natural characteristics of aquatic systems and in assessing changes to habitats [24]. In addition, fishes are located at the end of the aquatic food chain and may accumulate metals and pass them to human beings through food causing chronic or acute diseases. As a result, large scale mortality of fishes has been observer due to discharge of heavy metals in natural water resources [24].

The accumulation of heavy metals in tissues thus causes many physiological, histological, and biochemical changes in fishes and freshwater fauna by influencing the activities of several enzymes and metabolites [2]. Studies from the field and laboratory works showed that accumulation of heavy metals in a tissue is mainly dependent on concentration of heavy metal in water and its exposure period; although some other environmental factors such as water temperature, oxygen concentration, pH, hardness, salinity, alkalinity and dissolved organic carbon may affect and play significant roles in metal's accumulation and toxicity to fish [9 and 16]. Toxicity tests are used to evaluate the adverse effects of a chemical on living organisms under standardized, reproducible conditions, which permits a comparison with other chemical tested. Evaluation of toxicity of a chemical could help in knowing its potentiality, so that new and more powerful formulations could be derived. The concentration of heavy metals in fish body is related to feeding habits, tropic status, food availability,

biomagnifications, metallothionines and other detoxifying proteins in the body of animals [18]. In biological systems, heavy metals have been reported to affect cellular organelles and components such as cell membrane, mitochondrial, lysosome, endoplasmic reticulum, nuclei, and some enzymes involved in metabolism, detoxification, and damage repair [15]. Metal ions have been found to interact with cell components such as DNA and nuclear proteins, causing DNA damage and conformational changes that may lead to cell cycle modulation, carcinogenesis, or apoptosis [1, 15 and 17]. As bioaccumulation is a major route, thought which increased levels of the pollutants are transferred across food chain or food web creating public health problems [19, 21, 22 and 23]. Wherever man is involved in the food chain therefore, it is important to analyze the concentration of heavy metals in fresh water bodies as well as in the various fish organs, in order to assess potential risk to human health [19] The present work has been carried out to study the concentration of heavy metals Like As, Cr, Cu, Ni, and Zn in the selected fish organs viz. Gills, Skin, liver, and muscle of the freshwater fish Catla catla, the samples were collected once in a month from different fresh water bodies of Aurangabad Region, Maharashtra Shown in table-1. During the period of November 2017 to May 2018.

II.MATERIALS AND METHODS

Collection of water samples: water samples were collected using class container and brought to laboratory for analysis of Physico-chemical parameter.

Collection of fish samples: freshwater fish Catla catla, were Collected with the help of local fishermen (samples weing of about 250-300gm). The collected and preserved samples were brought to laboratory for further analysis.

Table No.I. Fresh Water Bodies from Aurangabad Region used for water and fish collection.

Sampling Sites	Status of Water Body	Area of Sample Collection
Godavari river (S1)	Large river	Kaigaon Toka, Aurangabad.
Harsul Dam (S2)	Percolation tank	Harsul, Aurangabad.
Jayakwadi Dam (S3)	Irrigation Dam	Paithan, Aurangabad.

Digestion of Organ/ tissues samples: Wet Organ/ Tissue samples of *Catla catla,* were taken viz. Gill, skin, Liver and Muscle, normally we used about 5 gm of each samples for one replicate. Sample were placed in digestion vessel (Beaker) and about 10 ml of Concentrated Nitric acid (HNO3, 69-70%) were poured in to the vessel, if possible put a watch glass at the mouth of the vessel. Then vessel was placed on a hot plate. Heating process should start at 40 ^{0}C for 1 Hour (to prevent vigorous reaction) and increases to 140 ^{0}C for another 3 hours. Once the digestion completed (all tissue samples dissolved completely in the acid) all digested samples left to cool at room temperature. Purified Double distilled water should be added into the vessel to fix the volume to 50 ml. the samples then filtered by using Whatman filter paper (No.1 grade) the filtrates is ready for the analysis. Filter can be stored in refrigerator, temperature 4^{0}C until the analysis.

Instrumental Analysis: The Concentration of heavy metals were determined using atomic absorption spectroscopy (Thermo fisher model AA-303), using the appropriate hollow cathode lamp and reassurance wavelength for the particular Heavy metal.

III.RESULTS AND DISCUSSION

Table No.II. Results of physico-chemical parameter of water samples:

Parameter	Sampling Site			Water Quality Standards
	S1(X±SD)	S2(X±SD)	S3(X±SD)	
Turbidity (NTU)	0.2±0.1	0.4±0.1	0.2±0.1	5-25
pH (pH Unit)	7.5±0.75	6.8±0.50	7.2±0.50	6.5-8.5
Temperature (^{0}C)	27±2	27±2	27±2	--
DO (mg/L)	--	--	--	--
BOD (mg/L)	182±2	175±2	181±2	--
Hardness (mg/L)	375±10	400±20	378±15	300-600
Chloride	105±5	126±5	110±7	250-1000
Alkalinity (mg/L)	209±7	218±10	213±7	300-60

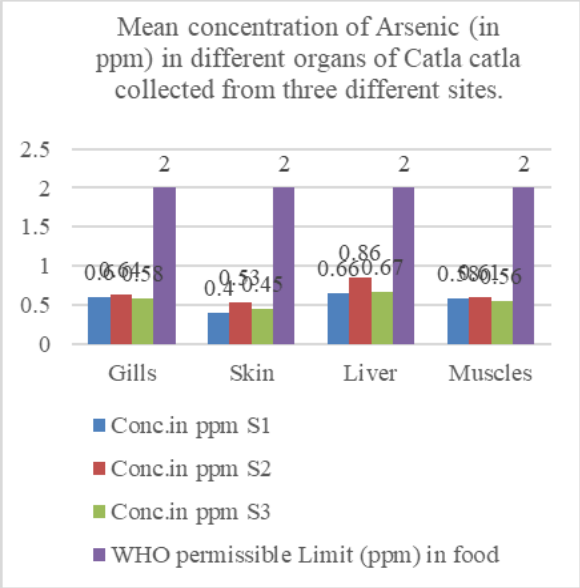
[Each value indicates the mean (X±SD) of the seven estimations]

Table No III: Mean concentration of Arsenic (in ppm) in different organs of *Catla catla* collected from three different sites.

Organ Wet Weight 5gm each	Godavari river (S1), (X±SD)	Harsul Dam (S2), (X±SD)	Jayakwadi Dam (S3) (X±SD)	WHO permissible Limit (ppm) in food
Gills	0.60±0.89	0.64±0.89	0.58±0.89	2.00
Skin	0.40±0.19	0.53±0.06	0.45±0.19	2.00
Liver	0.66±0.59	0.86±0.16	0.67±0.59	2.00
Muscles	0.58±0.91	0.61±0.91	0.56±0.91	2.00

[Each value indicates the mean (X±SD) of the seven estimations]

Graph No.I: Graphical Presentation of Arsenic Conc. In different organs of *Catla catla.*



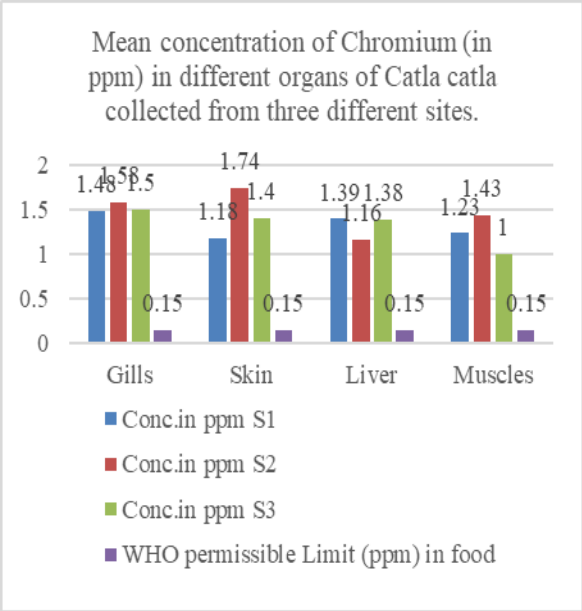
When we compare the concentration of Arsenic present in the organ sample of Catla catla it is found that the concentration is higher in liver of fish collected from sampling site S2 as compared to S1 and S3. Concentration in tissue samples follows the Pattern as Liver>Gills>Muscles > and Skin. The concentration present in tissue does not exceeds the limit prescribed by WHO for fish food, but its chronic effect may be of great concern as its level increases by the process of bioaccumulation as we move at higher level in the food chain.

Table No IV: Mean concentration of Chromium (in ppm) in different organs of Catla catla collected from three different sites.

Organ Wet Weight 5gm each	Godavari river (S1), (X±SD)	Harsul Dam (S2), (X±SD)	Jayakwadi Dam (S3) (X±SD)	WHO permissible Limit (ppm) in food
Gills	1.48±0.89	1.58±0.63	1.50±0.59	0.15
Skin	1.18±0.90	1.74±0.76	1.40±0.19	0.15
Liver	1.39±0.13	1.16±0.55	1.38±0.16	0.15
Muscles	1.23±0.41	1.43±0.24	1.0±0.91	0.15

[Each value indicates the mean (X±SD) of the seven estimations]

Graph No.II: Graphical Presentation of Chromium Conc. in different organs of Catla catla.



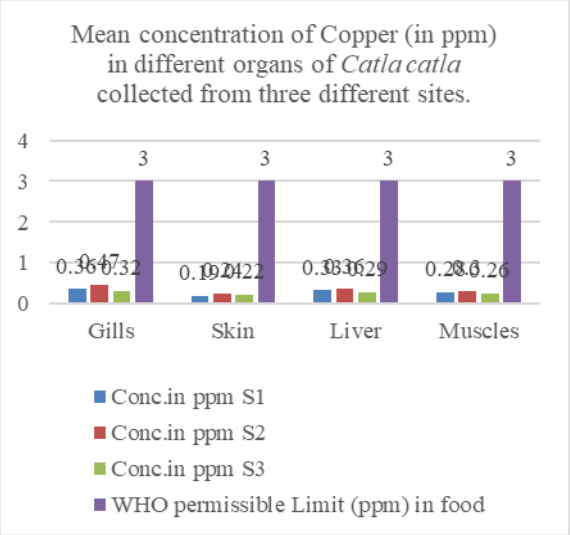
It is well known that Cr is a cancer-, mutation-, and malformation-causing agent classified as a Group I carcinogen by the International Agency for Research on Cancer [19, 21, 22 and 23].The concentration of chromium found in the organ samples in the study is of great concern as it exceeds the permissible limit prescribed by WHO for fish food. Collected from all the sampling site i.e. S1, S2 and S3. The maximum concentration was found in Skin of fish collected from source S2 which is 1.74ppm, concentration in organs follows the pattern as Skin>Gills>Muscles and >Liver.

Table No V: Mean concentration of Copper (in ppm) in different organs of Catla catla collected from three different sites.

Organ Wet Weight 5gm each	Godavari river (S1), (X±SD)	Harsul Dam (S2), (X±SD)	Jayakwadi Dam (S3) (X±SD)	WHO permissible Limit (ppm) in food
Gills	0.36±0.07	0.47±0.01	0.32±0.01	3.00
Skin	0.19±0.03	0.24±0.05	0.22±0.04	3.00
Liver	0.33±0.04	0.36±0.02	0.29±0.07	3.00
Muscles	0.28±0.036	0.30±0.08	0.26±0.05	3.00

[Each value indicate the mean (X±SD) of the seven estimations]

Graph No.III: Graphical Presentation of Copper Conc. In different organs of Catla catla.



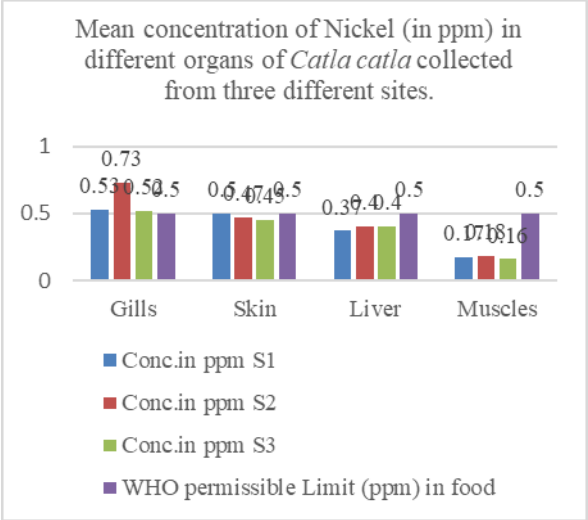
The concentration of copper found in organ samples does not exceeds the permissible limit in all samples collected from sampling site S1 to S3. The highest amount was found in Gills of fish collected from sampling site S2 and follows the accumulation pattern in organ as Gills>Liver> Muscles and >skin. But the chronic effect of sub-lethal concentrations of copper on fish and other creatures is damage to gills, liver, kidneys and the nervous system. It also interferes with the sense of smell in fish [19].

Table No VI: Mean concentration of Nickel (in ppm) in different organs of Catla catla collected from three different sites.

Organ Wet Weight 5gm each	Godavari river (S1), (X±SD)	Harsul Dam (S2), (X±SD)	Jayakwadi Dam (S3) (X±SD)	WHO permissible Limit (ppm) in food
Gills	0.53±0.04	0.73±0.03	0.52±0.01	0.50
Skin	0.50±0.04	0.47±0.03	0.45±0.06	0.50
Liver	0.37±0.02	0.40±0.07	0.40±0.03	0.50
Muscles	0.17±0.04	0.18±0.01	0.16±0.05	0.50

[Each value indicate the mean (X±SD) of the seven estimations]

Graph No.IV: Graphical Presentation of Nickel Conc. In different organs of Catla catla.



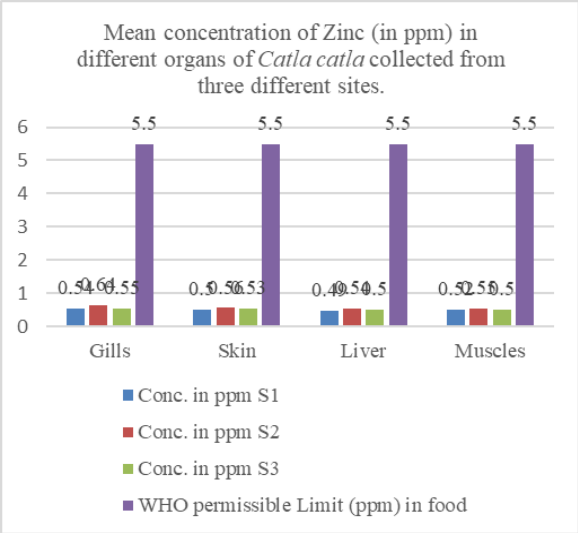
Nickel enters the blood circulation of the fish through the gill or mucous epithelium of the mouth and finally finds their way into different tissues of the body where they affect normal metabolism [19]. The highest concentration of Nickel is found in Gill sample collected from S2 sampling site and exceed the standard limit and lowest in Muscles sample collected from site S3. Nickel shows the great variation in different organs of fish samples collected from three different sampling sites which is of great concern.

Table No VII: Mean concentration of Zinc (in ppm) in different organs of Catla catla collected from three different sites.

Organ Wet Weight 5gm each	Godavari river (S1), (X±SD)	Harsul Dam (S2), (X±SD)	Jayakwadi Dam (S3) (X±SD)	WHO permissible Limit (ppm) in food
Gills	0.54±.035	0.64±.058	0.55±.058	>5.50
Skin	0.50±.058	0.56±.058	0.53±.058	>5.50
Liver	0.49±.058	0.54±.058	0.50±.058	>5.50
Muscles	0.52±.058	0.55±.058	0.50±.058	>5.50

[Each value indicate the mean (X±SD) of the seven estimations]

Graph No.V: Graphical Presentation of Zinc Conc. In different organs of Catla catla.



The concentration of Zinc found in all the organ samples of Catla catla was within the safe limit prescribed by WHO for fish food. Zinc comes under the category of essential nutrients that are required for various biochemical and physiological functions. Inadequate supply of these micro-nutrients results in a variety of deficiency diseases or syndromes [5].

IV. CONCLUSION

In the present study, it is observed that, the concentration of Chromium is higher in all the organ sample of fishes collected from S1, S2 and S3 than the limit prescribed by WHO, which is of great concern as it is carcinogenic in nature. Fish, on exposure to high concentration of heavy metals in an aquatic environment, absorb it either through gills and skin or through ingestion of contaminated water or food. The concentration of heavy metals in fish is related to several factors such as the food habits and foraging behaviors of the organism [6]. Tropic status, source of a particular metal, distance of the organism from the contamination source and presence of other ions [3]. Physical and chemical properties of the water and the seasonal changes in the taxonomic composition of the different trophic levels affecting the concentration and accumulation of heavy metals in the body of the fish and the adaptation capacity of the fish to heavy metal load [10]. The concentration of Heavy metals in organ samples of fish observed in the study follows the pattern as Cr>Ni>As>Cu>Zn. In view of the importance of fish as a diet for human, it is necessary that biological monitoring of fish meant for consumption should be done regularly to ensure continuous safety of the fish food. This increased value indicate that the level of pollution in fresh water bodies in Aurangabad region is high, the reason for this higher values, which might be due to the continuous addition of civic wastes and industrial effluents discharging their effluents directly into the river. This is in agreement with the studies done by WHO [26]. Which further increases by the process of bioaccumulation and may have wide range of adverse effect in higher organism present in the food chain including human being. To avoid this heavy metal going into the environment, Safe disposal of domestic sewage and industrial effluents should be practiced and wherever is possible, recycling should be done. This issue is of great concern and it needs the formulation of appropriate remedial action so that this great threat can be tackled.

REFERENCES

[1] Beyersmann D, Hartwig A. (2008) Carcinogenic metal compounds: recent insight into molecular and cellular mechanisms. Arch Toxicol. 82(8): 493–512.

[2] Erkkilä, A.T., A.H. Lichtenstein, D. Mozaffarian and D.M. Herrington, (2004) Fish intake is associated with a reduced progression of coronary artery atherosclerosis in postmenopausal women with coronary artery disease. American Journal of Clinical Nutrition, 80(3): 626-632.

[3] Giesy, J.P and Weiner, J.G. (1977) Frequency distribution of trace metals concentrations in five freshwater fishes.Trans. Am. Fish. Soc. 106: 393-403.

[4] IARC IAFROC (1990), Chromium, Nickel and Welding. Monographs on the Evaluation of Carcinogenic Risks to Human. IARC Scientific Publications 49.

[5] Kabata- Pendia A (2001) 3rd, editor. Trace Elements in Soils and Plants. Boca Raton, FL: CRC Press.

[6] Otitoloju, AA. (2002) Ecotoxicol. Environ. Saf.; 53: 404 -415.

[7] Obasohan, E.E. and Oronsaye, J.A.O.(2004) Bioaccumulation of heavy metals by some cichlids from Ogba River, Benin City, Nigeria. Nigerian Annals of Natural Sciences, 5(2): 11 – 27.
[8] P. U. Singare (2011) Thane lakes high on metal content: Study, Daily Times of India. August 10, Mumbai, India.
[9] Rashed, M.N., (2001) Monitoring of environmental heavy metals in fish from Nasser Lake. Environ. Int., 27.
[10] Shah, S.L. and Attinag, A (2005) Effects of heavy metals accumulation on the 96-h Lc50 values in Tench (Tincatinca L.) 1758. Turk. J. Vet. Anim. Sci. 29: 139-144.
[11] Sin, S. N., Chua, H., Lo, W. & Ng, L. M. (2001) Assessment of heavy metal cations in sediments of Shing Mun River, Hong Kong. Environ. Int, 26: 297-301.
[12] Singare, P. U., Lokhande, R. S., and Pathak, P. P., (2010), Study on Physico-Chemical properties and Heavy Metal Content of the Soil Samples from Thane Creek of Maharashtra, India, Interdisciplinary Environmental Review, 11(1): 38-564. (Erkkilä, A.T., 2004).
[13] Singare, P. U., Lokhande, R. S., and Jagtap, A. G., (2010) Study of Physico-chemical quality of the Industrial Waste Water Effluent from Gove Industrial Area of Bhiwandi City of Maharashtra, India, Interdisciplinary Environmental Re-view, 11(4): 263-273.
[14] Vosyliene, M.Z., (1999). The effect of heavy metals on haematological indices of fish (survey)", Acta Zoologica Lituanica, Hydrobiologia, 9: 76-82.
[15] Wang S, Shi X. (2001) Molecular mechanisms of metal toxicity and carcinogenesis. Mol Cell Biochem. 222: 3–9.
[16] Wu, Y., Hou, X., Cheng, X., Yao, S., Xia, W. & Wang, S. (2007). Combining geochemical and statistical methods to distinguish anthropogenic source of metals in lacostrine sediment: a case study in Dongjiu Lake, Taihu Lake catchment, China.
[17] Yedjou CG, Tchounwou PB (2006) Oxidative stress in human leukemia cells (HL-60), human liver carcinoma cells (HepG2) and human Jerkat-T cells exposed to arsenic trioxide. Metal Ions Biol Med. 9: 298–303.
[18] Yılmaz S, Türe M, Sadıkolu M, Duran A. (2010) Determination of total Cr in wastewaters of Cr electroplating factories in the I. Organize industry region (Kayseri, Turkey) by ICP-AES. Environ. Monit,
[19] ATSDR (1990). Toxicological Profile for Copper. U.S Public Health Service. Agency for Toxic Substances and Disease Registry, Atlanta, G.A
[20] CIW 1997 (Anonymous, Criterions of the Irrigation Water).
[21] EC 1998 (European Community).
[22] Encyclopedia of Analytical Sc. (1995).
[23] EPA 2002. (Environment Protection Agency).
[24] FAO 1993-Food and agriculture organization guideline for Irrigation water.
[25] WHO 1985 and 1993, 1992 (World Health Organization)
[26] http://www.dnaindia.com/mumbai/report_chemicals-make- thane- creek- the-worst- polluted-waterbody_1115439.