GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(**Published By**: Global Institute for Research & Education)
www.gifre.org

ASSESSMENT OF LEAD LEVEL IN COMMON CARPS COLLECTED FROM EAST KOLKATA WETLANDS AND TITAGARH SEWAGE FED AQUACULTURE IN WEST BENGAL, INDIA

Ipsita Mazumdar[1], Adelene Basu[2] & Goswami K[3]
[1]Assisstant Professor, Dept. of Biochemistry, KPC Medical College & Hospital, Jadavpur, Kolkata, India.
[2]Professor, Dept. of Pathology, ESIC Hospital & ODC (EZ), Joka, Kolkata, India.
[3]Professor, Dept. of Pathology, ESIC Hospital & ODC (EZ), Joka, Kolkata, India.

Abstract
The concentrations of lead were determined in four species of common consumable carps (T. mossambicus, C. mrigela, K. katla and L. rohita.) from east Kolkata Wetlands and Titagarh aquaculture ponds, which are associated with industrial and sewage discharges in Kolkata, India. Concentration of lead in these fishes was significantly higher than those cultured at the control site, and also showed significant seasonal trend, being more in the pre-monsoon than the post-monsoon season. Bioaccumulation pattern of lead in different species of fishes was : T. mossambicus >C. mrigela>K. katla >L. rohita.
The total lead concentration in study sites was significantly higher than the control area, which suggested a corelation between lead bioaccumulation and sewage fed aquaculture. The study indicates that increased awareness is needed for monitoring of lead content in fish cultured in sewege aquaculture zones & a safe consumption policy is important to avoid toxicity related to chronic lead poisoning.

Key words: lead toxicity, Edible fish, Bioaccumulation, Sewage fed aquaculture.

Introduction
Increase in global population and industrial development have led to an increase in the contamination of the aquatic environment by heavy metal over the last three decades. Lead is one such heavy metal which is also a major toxic element. There is no known biological function for lead and any absorption may be classified as potentially toxic. Its toxic effects are numerous, including morphological damage to tissues at higher concentrations. The sources of lead are many, but the principal absorptive routes in human are from the diet, drinking water, water used in cooking, and from the air that we breathe. Lead enters the aquatic food chain through direct consumption of water or biota and through non-dietary routes such as epithelial absorption (i.e., through gills in the case of fish). For fish, gills, skin, and digestive tract are potential sites of absorption of water borne chemicals[1].

Fish serve as a valuable dietary component, acting as a rich source of protein in the local diet[2] of people in Kolkata, one of the oldest industrial and commercial cities in the eastern part of India. The city does not have any conventional effluent treatment plant. Waste water recycle zone of East Kolkata Wetlands (88º20’ - 88º35’ E; 22º25’ - 22º40’ N) acts as effluent treatment plant. High BOD load of the sewage is reduced through the existing microorganisms and algae present in the shallow water bodies of this area, where majority of fish are cultivated for consumption. Like this system, Titagarh municipality (22º44’11” N; 88º22’25” E) also cultivate fish in the maturation ponds of their wastewater lagoon system. People who consume significant amounts of contaminated fish from these areas may be at risk of lead toxicity.

In this study we examine the accumulation of lead in some fish commonly consumed by the local people, and also seek to identify whether the weather pattern is responsible for lead contamination in some way.

Materials and Methods
During this study, total 808 sample of equal numbers of Rahu (*Lobio rohita*), Katla (*Katla katla*), Mrigel (*Cirrhinus* mrigela), & Tilapia (*Tilapia mossambicus*) were collected randomly from two sampling sites during both pre and post monsoon seasons between 2010-2012, for determination of lead content in fish muscle tissue. These two sites were East Kolkata Wetlands and Titagarh sewage fed aquaculture ponds respectively. Chandipur village of North 24 Parganas was selected as control site, because no domestic sewage or industrial effluents contaminated the aquaculture ponds of this area.

The samples were cleaned and washed with de-ionized water. The muscle tissues were removed and dried at 65°C in a hot air oven for 48 hours discontinuously. The dried samples were powdered, homogenized and digested using HCL / HNO_3, in accordance with the method of American Society of Testing and Materials (ASTM 1986)[3].

Both standard and control were tested at the beginning of each batch for initial calibration verification with standard calibration curve. All specimens were tested in batches that included blanks. The coefficient of variation on replicate samples ranged from 2-7%. Further quality control procedures included periodic blind analysis of an aliquot from a large sample of known concentrations and blind testing of duplicate samples during the analysis.

The lead concentrations of the samples were read against appropriate blank and standard solutions using Perkin Elmer AAS 2380 apparatus with an oxy-acetylene flame. Appropriate controls and standards and calibration curves were prepared. Duplicate samples were tested and read in triplicate. The samples were blank-corrected and concentration of lead expressed as mg / kg dry weight of fish. Statistical significance was assayed using student's t- test[4]. Results were deemed statistically significant where p< 0.005. Also, statistical analysis was conducted using SAS software[5].

Results and Discussion

Lead concentrations in fish dry weight are presented in Table 1. Lower accumulation was observed in all the tested species collected from control areas and the highest lead accumulation was found in East Kolkata wetlands areas. *T. mossambicus* was the highest accumulator of lead followed by *C. mrigela*, *K. katla* and *L. rohita*.

Table 1: Summary data and lead level in mg/kg dry weight in fishes collected from control area is Chandipur village, 24 Parganas (North), East Kolkata Wetlands and Titagarh respectively.

Sample	**Control area: Chindipur village, 24 Parganas (North) 128**	**Control area: Chindipur village, 24 Parganas (North) 144**	**Site-1; East Kolkata Wetlands 136**	**Site-1; East Kolkata Wetlands 128**	**Site-2: Titagarh 124**	**Site-2: Titagarh 148**
No. of Samples: 808	**Pre monsoon: 32 samples each gp**	**Post monsoon: 36 samples each**	**Pre monsoon: 34 samples each**	**Post monsoon: 32 samples each**	**Pre monsoon; 31 samples each**	**Post monsoon: 37 samples each**
Rohu (*Lobio rohita*)	0.052 ± 0.029	0.036 ± 0.019	0.104 ± 0.022	0.091 ± 0.027	0.096 ± 0.021	0.090 ± 0.026
Katla (*Katla katla*)	0.059 ± 0.026	0.042 ± 0.023	0.109 ± 0.027	0.096 ± 0.024	0.102 ± 0.025	0.099 ± 0.026
Mrigel (*Cirrhinus* mrigela)	0.072 ± 0.020	0.066 ± 0.024	0.296 ± 0.039	0.267 ± 0.032	0.301 ± 0.028	0.290 ± 0.027
Tilapia (*Tilapia mossambicus*)	0.078 ± 0.021	0.069 ± 0.025	0.390 ± 0.029	0.365 ± 0.027	0.357 ± 0.036	0.327 ± 0.024

Values represent Mean ± SD

It was seen in the study that all species of fish from both site 1 & 2 contain significantly higher amount of lead than those from control sites. In fact the lead content in fish collected from the test sites is 3-9 times more than that from the control fish samples[6]. The results are tabulated in Table 2.

Table 2: Significance of difference between Control & Test sites during pre-monsoon & post-monsoon season:-

Sample	**Control area & Site 1**						**Control area & Site 2**					
	Pre-monsoon			**Post-monsoon**			**Pre-monsoon**			**Post-monsoon**		
	Control	**Site 1**	**Diff**	**Control**	**Site 1**	**Diff**	**Control**	**Site 2**	**Diff**	**Control**	**Site 2**	**Diff**
Rohu (*Lobio rohita*)	0.052 ± 0.029	0.104 ± 0.022	<0.0001	0.036 ± 0.019	0.091 ± 0.027	<0.0001	0.052 ± 0.029	0.096 ± 0.021	<0.0001	0.036 ± 0.019	0.090 ± 0.026	<0.0001
Katla (*Katla katla*)	0.059 ± 0.026	0.109 ± 0.027	<0.0001	0.042 ± 0.023	0.096 ± 0.024	<0.0001	0.059 ± 0.026	0.102± 0.025	<0.0001	0.042 ± 0.023	0.099± 0.026	<0.0001
Mrigel (*Cirrhinus* mrigela)	0.072 ± 0.020	0.296 ± 0.039	<0.0001	0.066 ± 0.024	0.267 ± 0.032	<0.0001	0.072 ± 0.020	0.301 ± 0.028	<0.0001	0.066 ± 0.024	0.290 ± 0.027	<0.0001
Tilapia (*Tilapia mossambicus*)	0.078 ± 0.021	0.390 ± 0.029	<0.0001	0.069 ± 0.025	0.365 ± 0.027	<0.0001	0.078 ± 0.021	0.357 ± 0.036	<0.0001	0.069 ± 0.025	0.327 ± 0.024	<0.0001

Values represent mean ± SD & statistical analysis is done by Students't test with significance <0.0001.

In all tested samples more lead accumulation was seen in pre-monsoon than post-monsoon season. Significant differences were observed in the level of lead in samples collected during pre & post-monsoon period in both controls & tests, and the statistical analysis is shown in Table 3.

Table 3: Difference in Lead content in fish (mg/kg dry weight) between pre-monsoon & post-monsoon seasons:-

Sample	Control area: (pre-monsoon)	Control area: (post-monsoon)	Significance of difference	Site-1 (pre-monsoon)	Site-1 (post-monsoon)	Significance of difference	Site-2 (pre-monsoon)	Site-2 (post-monsoon)	Significance of difference
Rohu (*Lobio rohita*)	0.052 ± 0.029	0.036 ± 0.019	<0.0001	0.104 ± 0.022	0.091 ± 0.027	<0.005	0.096 ± 0.021	0.090 ± 0.026	Not significant
Katla (*Katla katla*)	0.059 ± 0.026	0.042 ± 0.023	<0.0001	0.109 ± 0.027	0.096 ± 0.024	<0.005	0.102± 0.025	0.099± 0.026	Not significant
Mrigel (*Cirrhinus* mrigela)	0.072 ± 0.020	0.066 ± 0.024	Not significant	0.296 ± 0.039	0.267 ± 0.032	<0.0001	0.301 ± 0.028	0.290 ± 0.027	Not significant
Tilapia (*Tilapia mossambicus*)	0.078 ± 0.021	0.069 ± 0.025	Not significant	0.390 ± 0.029	0.365 ± 0.027	<0.0001	0.357 ± 0.036	0.327 ± 0.024	<0.0001

Values represent mean ± SD & ststistical analysis is done by Students' t test with significance <0.0001.

Significant differences were observed between pre & post-monsoon samples of: L.rohita & K.katla in control group; all species in test samples from site 1 & T.mossambicus in site 2. This observation is corroborated by a study done in Nigeria by Dake et al, which shows that total lead accumulation in fish from the Azuabie creek in Bonny Estuary was higher in pre-monsoon season[7]. Data analyzed by the present study also resembles the observation on Indian coastal fishes, where lead concentration of fish followed the same seasonal pattern (wet weight)[8].

The highest bio-concentration of lead was observed in *T. mossambicus*, followed by *C. mrigela*, *K. katla* and *L. rohita*. Same pattern of bioaccumulation was observed in both the seasons at all study areas. Biologically, lead concentrates more in aquatic ecosystem and accumulates in higher concentration in top level consumers of the food chain.

Serious concern is shown for health problems related to lead toxicity from land-borne sources, but awareness is lacking for water & marine sources of poisoning[9]. Lead is a neurotoxin that causes functional deterioration in fish within days of exposure to sub lethal concentrations, and these effects can persist after removal of the contaminant[10]. Lead also causes decrease in survival period, growth rates, development and metabolism, in addition to increased mucus formation in fish[11]. Little information is available on the levels of lead in fish muscle that are associated with nervous impairments in the fish themselves, but levels of 50 µg/gm in the diet are associated with reproductive defects in some carnivorous fish consuming smaller contaminated fishes, and dietary levels as low as 0.1 to 0.5 µg/gm are associated with learning deficit and abnormal social behavior in some mammals[12].

The permissible limit of lead concentrations in fish in all seasons is 0.4 mg/kg[13]. High concentration of lead in the water increases its potential to accumulate in the aquatic organisms, as these pollutants enter the fish and micro vertebrates through several routes, though the level & amount of toxic accumulation depends on the nature of the organism. For example, the finding of a study by G S Su et al showed that some aquatic organisms like micro invertebrates are heavily contaminated with lead, while there are also some organisms which show less than the standard allowable concentrations for lead[14].The accumulation of lead in the fish muscle was relatively low in the present study and was below the normal standards for the permissible lead concentrations in fish. But, the low level chronic lead exposure influences the progression of renal insufficiency with hepatic function abnormalities in mammals.

Conclusion

The present study showed that the lead concentration in fish cultivated in waste water recycle zones is significantly high in all seasons, more so during the pre-monsoon times. These regions serve as very important sources of cultivated fish which is a major dietary component of local diet. But both awareness & published data is lacking for sensitization of the general mass regarding this very important but often unseen source of chronic lead exposure which, unchecked, may lead to serious health hazards. This study may help to generate awareness regarding preparation of a suitable consumption policy for fish in local diet, and will also be of help in further follow-up studies.

References

1. Brezonik,P.K., King. S.O. and Mach C.E. (1991). The influence of water chemistry in trace metal bioavailability and toxicity in aquatic organisms. In “Metal Ecotoxicology” (M.D. Newman and A.W.McIntosh, Eds.) Lews. Boca Raton, Fl.

2 Darnton-Hill I, Hassan N, Karim R, Duthie M.R. (1988). Tables of nutrient composition of Bangladeshi foods. English version with particular emphasis on vitamin A content. Helen Keller International, Dhaka, Bangladesh.

3 American Society for Testing and Materials ASTM (1986). Annual book of ASTM standards, 11.01.03559-85, Philadelphia PA 19103.

4 Chatterjee C.C. (1983) Human Physiology Vol II. P10-11 Medical Allied Agency, India.

5 SAS Institute Inc., SAS Version 6.12. Cary: SAS Institute, Inc., 1996.

6 Goswami K (March 2001) Environment Pollution of Lead: An Update Review, Res. J. Chem. Environ, 5(1). pp 76-78.

7 Erema R. Daka, Calista A. Ekeh and Meebaka Moslen (2008). Cadmium and lead levels in some fish species from Azuabie creek in the Bonny Estuary, Nigeria., African Journal of Biotechnology 7 (1), pp 063-064.

8 Mitra A, Mitra S, Hazra S, Chaudhuri A, (2000). Heavy Metal Concentrations in India Coastal Fishes. Res. J. Chem. Environ. 4 (4) pp 12-15.

9 Basu A, Mazumdar I, Goswami K, (2013) Accumulation of Lead in vegetable crops along major highways in Kolkata, India, Int J Adv Biol R, 3(1):pp 131-133.

10 Clark RB (1997). Marine Pollution. Fourth Edition. Oxford University Press, Oxford.

11 Eisler R (1988) Lead hazards to fish, wildlife, and invertibrates: A synoptic review; Biological Report 85 (1.14); Contaminant Hazard Reviews 14; pp191.

12 Laurel, MD, (1988). Contaminant Hazard Reviews 14; U.S.Fish and Wildlife Services; pp196.

13 Uluozlu O, Tuzen,M, Mendil D, and M. Soylak (2007.) Trace metal content in nine species of fish from the Black and Aegean Seas, Turkey, Food Chemistry 104; pp835-840.

14 Su Gs, martillano KJ, Alcantara TP, (2009)Assessing heavy metals in the waters, fish and macroinvertebrates in Manila Bay, Philippines.Journal of Applied Sciences in Environmental Sanitation 4(3)pp187-195.