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Bioaccumulation of heavy metal mercury in *Catla Catla* of Shivnath River of Chhattisgarh, India

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Abstract

Aquatic ecosystem is very sensitive to heavy metals and the matter has received considerable concern due to their toxicity and bioaccumulation. The health implication due to Mercury exposure through food chain is a serious matter of concern for human health. In the present study bioaccumulation of Mercury from Catla catla species collected from four different collection sites of Shivnath River of Chhattisgarh, India was analyzed in various tissue samples viz., muscle, gill and liver by atomic absorption spectrophotometric method. In all tissue samples Mercury was reported significantly higher (F=<0.05 %P) than the recommended permissible limit of European commission. It was reported that muscles having maximum tendency of bioaccumulation followed by gills and liver and maximum bioaccumulation was reported in the month of October-March. The study is significant with respect to the food chain of population from catchment area.

Keywords: Heavy metals, toxicity, bioaccumulation, mercury, Shivnath river, *Catla catla*.

Introduction

Shivnath River is a tributary of Mahanadi, originating from Ambagarh Chowki of Rajandgaon district of Chhattisgarh, and finally terminates into Bay of Bengal. The Shivnath River is considered as life line of many towns and villages of Chhattisgarh state serving for drinking, irrigation, sanitation work etc. A large number of human populations, more than 1000 lakhs are dependent on Shivnath River for their life. The river receives industrial effluent as well as municipal waste at several places. So it is presumed that many heavy metals may be at the bed of river and is a source of contamination of human system through food chain.

Aquatic system comprises many toxic compounds among which most toxic are heavy metals and primarily heavy metal contamination in aquatic system are anthropogenic. It is not only harmful for aquatic life but a primary factor for environmental health also. In general some heavy metals (Zinc, copper, mercury, cadmium, cobalt, chrome, iron, manganese and arsenic) are found in aquatic bodies especially in terrestrial aquatic bodies in high concentration when it cross the permissible limit then causes alter effect on whole aquatic ecosystem in general and on aquatic life in particular[1].

It is notable now a days that aquatic organism absorb heavy metals form water accumulate in their body and transfer it up to human system through food chain, so bio-monitoring is one of the essential aspect for human and animal life, fish is major source of food and thus directly responsible for heavy metal contamination to human population from aquatic pool even life cycle of fish get affected adversely, especially poor growth rate of larvae and fish and thus poor yield of fishery at a toxic effect of heavy metals some benthic organism also accumulate heavy metal and transfer it to human through food chain[2,3].

Eleven fish species from Northern Gulf was examined by Abu Hilal et al[4] for analysis of cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc and wad found accumulated beyond the permissible limit in major organs *viz.* liver, stomach and gill. Banking on different aspects of heavy metal toxicity Mercury have been considered for the study from food chain of Shivnath River of Chhattisgarh, India (Rajnandgaon and Durg districts of Chhattisgarh, India) covers from Latitude 21.1000°N, longitude 81.0300°E in Rajnandgaon district and latitude 21.1900°N, longitude 81.2800°E in Durg district) to evaluate direct contamination of human population of catchment area through liver of *Catla catla*.

Materials and methods

Keeping in mind that food chain influenced human health we have selected Mercury (Hg) in gills, muscles and liver of *Catla catla* from various collection sites of different catchment areas of Shivnath River between Rajandgaon and Drug districts of Chhattisgarh, India. These collection sites are: Mohara (Latitude:20.839; Longitude:81.265); Mohad (Lat:21.189; Long:81.300); Sankara (Lat.:21.283; Long.:82.672); Pulgaon (Lat.:21.195; Long.:81.300); Dhamdha (Lat.:21.101; Long.: 81.187). The samples were collected from upper, lower and middle bed of the river.

For study four duration have been selected First collection from January to March- to know the variation in bioaccumulation of heavy metal (Hg) in spring condition i.e. increasing temperature trend. Second collection from April to June- to know the bioaccumulation trend in extreme temperature, high kinetic value and poor water quality condition. Third collection from July to September- to know bioaccumulation trend in monsoon condition with plenty of water and that too in running condition. Fourth collection from October to December- to know bioaccumulation trend in low temperature, sufficient water and comparatively low kinetic value.

For the selected fish fauna (*Catla catla*) from each experimental set, all tissues (Muscle, Gill and Liver) were quickly dissected out and stored in 5% formalin for further process. All samples were then dissoluted by taking 0.2gms of dried content of liver and digested in a mixture of (HNO_3 10ml and H_2O_2 5ml in 2:1 ratio) and were heated on electric hot plate 80ºC with 10ml of 2M HNO_3 for digestion. The sample was filtered with whatman 42 and was stored at 4ºC for atomic absorption analysis. Atomic absorption measurement of all digested samples was carried out with calculation. Analyte concentration was expressed as % of metal calculated from the formula –

$X = m\ 100/M$

Where: X–Standard for weight of the metal in sample. m-Microgram of the metal per milliliter of test solution (obtained from reading). M–The mass in micrograms per milliliter of the sample in test solution.

All the data collected from each experimental set was subjected for statistical validation considering central tendencies, dispersion, skewness and test of significance (ANOVA).

Results and discussion

The Mercury accumulation in muscle, gill and liver was estimated from *Catla catla* in different season of the year from five collection points (Mohara, Mohad, Sankara, Pulgaon and Dhamdha) of Shivnath River, India.

The Mercury accumulation in muscles of *Catla catla* was found maximum in the month of October-December from all five collection centers. The maximum concentration was reported from Pulgaon collection centre (1.2±0.06mg/kg b.w.) followed by Dhamdha (1.12±0.07mg/kg b.w.) and Mohad (1.04±0.07 mg/kg b.w.). But the minimum concentration was reported in the month of April-June from all the collection centres except Mohara and Mohad, where minimum accumulation was reported in the month of January-March. The lowest bioaccumulation was reported from Mohara (0.24±0.02mg/kg b.w.) followed by Mohad (0.26±0.03mg/kg b.w.) and Sankara (0.36±0.02mg/kg b.w.) (Figure-1).

The Mercury bioaccumulation in gill of *Catla catla* from all five collection centres were also estimated and maximum bioaccumulation was found in the month of January-March from all centers except Mohara and Sankara where it was reported in the month of October-December. The maximum concentration was reported from Dhamdha (1.48±0.03mg/kg b.w.) followed by Pulgaon (1.04±0.07mg/kg b.w.) and Mohad (0.8±0.06mg/kg b.w.). But the minimum bioaccumulation was reported in the month of July-September from all collection centers except Pulgaon in the month of April-June. The lowest bioaccumulation was reported from Mohara (0.28±0.03mg/kg b.w.) followed by Pulgaon (0.3±0.04kg b.w.) and Mohad (0.32±0.05mg/kg b.w.) (Figure-2).

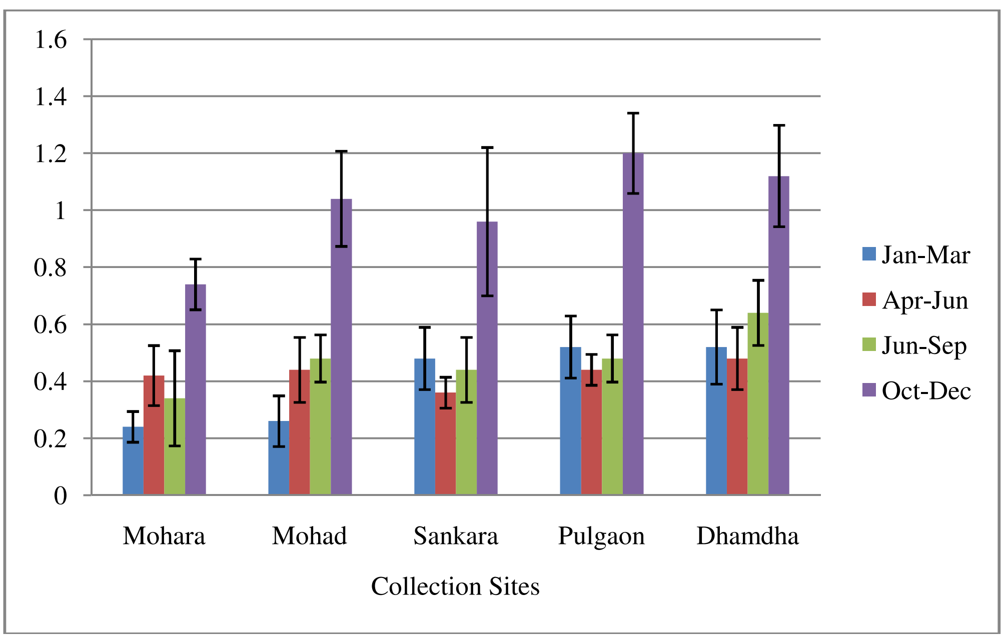

Figure-1: Mercury Bioaccumulation in Muscle of *Catla catla* from all collection sites.

The Mercury bioaccumulation in liver was also estimated in *Catla catla* in all season from all collection centres. In liver maximum bioaccumulation was reported from January-March from all centers except Mohara and Sankara where it was reported in the month of October-December. The highest concentration was reported from Sankara (0.96±0.11mg/kg b.w.) followed by Pulgaon (0.88±0.04mg/kg b.w.) and Dhamdha (0.64±0.19mg/kg b.w.). But the minimum concentration of mercury in liver was found variable throughout the year in all four seasons and from all five collection centre. The lowest bioaccumulation was reported from Mohad (0.04±0.02mg/kg b.w.) followed by Mohara and Pulgaon (0.08±0.03mg/kg b.w.) (Figure-3).

Comparatively it was found that muscle is more susceptible for bioaccumulation of Mercury than any other parts because maximum average accumulation in the muscle was found (1.01±0.06mg/kg b.w.) and liver was found least susceptible because average accumulation was found (0.18±0.01mg/kg b.w.). Dhamdha collection centre was found more susceptible for bioaccumulation of Mercury by *Catla catla* (1.08±0.09 mg/kg b.w.) followed by Pulgaon (1.04±0.05mg/kg b.w.) and Sankara (0.88±0.08mg/kg b.w.). The mercury bioaccumulation in *Catla catla* was reported maximum in the month of winter (Oct-Mar) and from muscle (average bioaccumulation 1.01±0.16mg/kg b.w.) followed by gill (0.94±0.11mg/kg b.w.) and liver (0.65±0.19mg/kg b.w.). The highest bioaccumulation was reported from Dhamdha (F=<33.75 at 5% P), followed by Pulgaon (F=<62.22 at 5% P), Mohad (F=<40.16 at 5% P), Sankara (F=<15.33 at 5% P) and Mohara (F=<18.34 at 5% P) (Table-1). The Hg bioaccumulation in *Catla catla* was reported significant from all collection centers but remarkably in winter from October-March unlike other heavy metal bioaccumulation in summer.

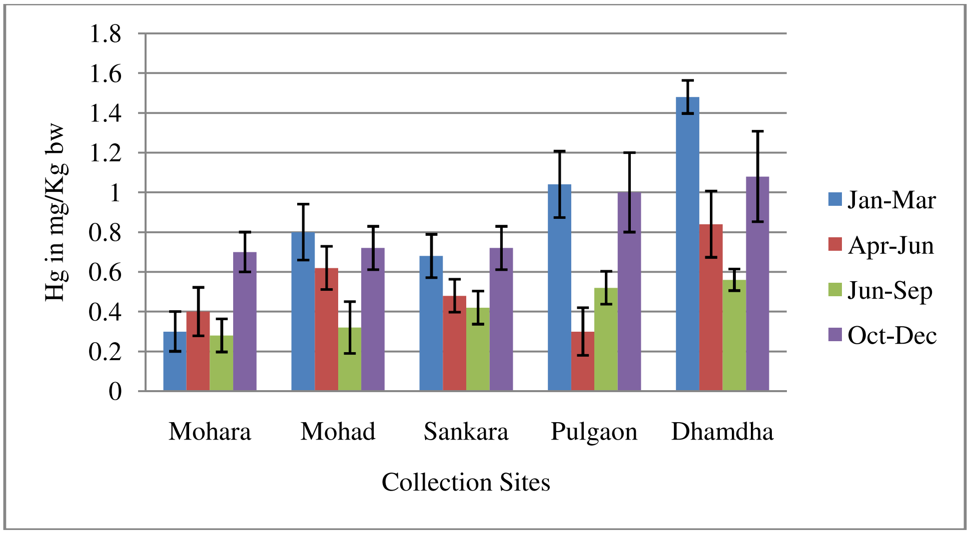

Figure-2: Mercury Bioaccumulation in Gill of *Catla catla* from all collection sites.

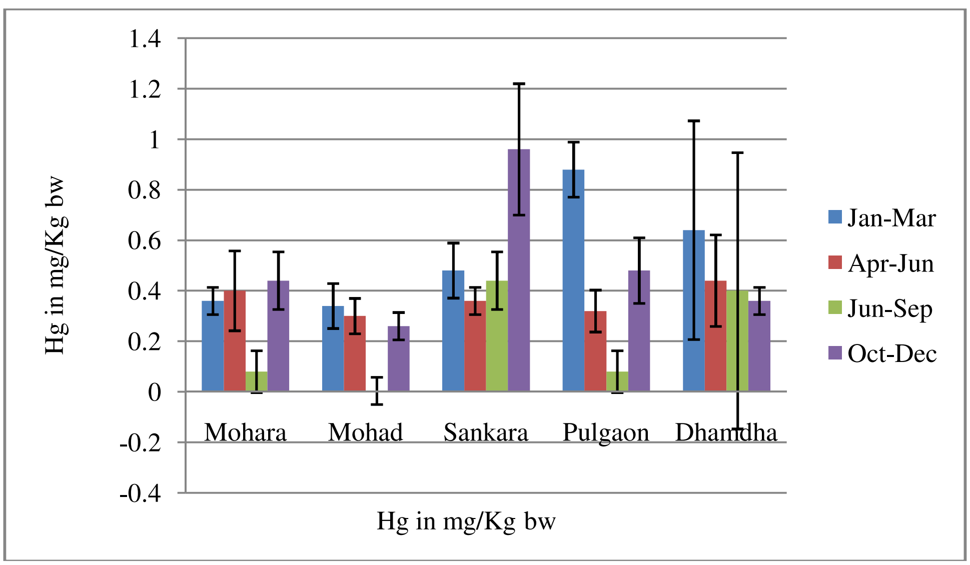

Figure-3: Mercury Bioaccumulation in liver of *Catla catla* from all collection sites.

Table-1: Bioaccumulation of Hg in different parts of *Catla catla*

Collection centre	Body Parts		
	Muscle	Gill	Liver
Mohara	0.74±0.08 (Oct-Dec)	0.7±0.1 (Oct-Dec)	0.44±0.11 (Oct-Dec)
Mohad	1.04±0.16 (Oct-Dec)	0.8±0.14 (Jan-Mar)	0.34±0.08 (Jan-Mar)
Sankara	0.96±0.26 (Oct-Dec)	0.72±0.10 (Oct-Dec)	0.96±0.26 (Oct-Dec)
Pulgaon	1.20±0.14 (Oct-Dec)	1.04±0.16 (Jan-Mar)	0.88±0.10 (Jan-Mar)
Dhamdha	1.12±0.17 (Oct-Dec)	1.48±0.08 (Jan-Mar)	0.64±0.43 (Jan-Mar)
Mean ± SD	1.01±0.16	0.94±0.11	0.65±0.19

Yigit et al.[5] have estimated concentration of Hg in the fish samples of Lake Egidrdir, Turkey from different collection centers during the spring of 2001. They found mercury (Hg) concentration 0.0032mg/l from water, 0.16µg/g in sediments, 1.362µg/l from planktons, 0.017µg/g in fish muscles and 0.018 µg/g from fish gills which was statistically significant higher value than the permissible limit. Kaoud et al.[6] have examined the effect of mercury (Hg) on mortality, resistance and bioaccumulation in the tropical giant freshwater *Macrobrachium rosenbergii* and reported bioaccumulation of mercury (Hg) in gill, hepatopancreas and muscle to be variable but accumulation in muscle was found marginally increased. *Macrobrachium rosenbergii* showed histopathological alterations in gills, hepatopancreas and muscle after exposure of mercury. Our finding is almost affirmative to the findings of various authors but novelty of our finding is its maximum bioaccumulation in the month of winter than the summer.

For mercury exposure to human fish ingestion is one of the major sources[7]. In water both mercury and methyl mercury are found in small concentration but it is readily absorbable in early stage of food chain by algae in the form of methyl mercury and through algae it moves to advance stage of food chain. Fish also absorb methyl mercury firstly but excrete of its insoluble state[8]. It is estimated that a 70kg human body accumulate up to 13mg mercury or a highly recessive molecule which binds with sulphydryl group and gives toxicity[9]. It also binds with hydroxy carboxyl group and phosphoryl group for toxicity but in least quantity. The skin nail and hair are most susceptible in human body for accumulation o mercury[10].

Sager et al.[11] proved that mercury causes damage to DNA. Hammond[12] advanced the idea that mercury impairs mitosis and disrupts neural migration. It is neuro toxic during prenatal and postnatal period. In fetus it causes mental retardation, cerebral palsy, seizures and ultimately death[13]. Kidney is highly susceptible to mercury salt, develops acute tubular necrosis and immunologic glomerulonephritis[14,15].

Banking on above literatures it seems that finding of our experiment is highly significant. A large number of populations are dependent upon Shivnath River for fish and prawn as a member of food chain and unknowingly they are receiving mercury (Hg) especially in winter. So present finding is helpful for population of catchment area from their health point of view.

Conclusion

Mercury is known toxicant heavy metal for human and fish is one of the important components of food chain. In present study it was observed that Shivnath River is one of the sources for bioaccumulation of Mercury through fish food chain which causes toxicity to human population of catchment area. It is also reported that in winter bioaccumulation of Hg in fish is higher than other seasons. So our finding is suggestive to human population of catchment area related to fish and season concerned.

References

1. Izrael Yu A. (1983). Acid rains in Russian. Gidrometeoizdat, Leningrad, 243.
2. Sarnowski P. and Jezierska B. (2007). A new coefficient for evaluation of condition of fish. *Electronic Journal of Ichthyology*, 2, 69-76.
3. Abida B., Harikrishna S. and Irfanulla K. (2009). Analysis of heavy metals in water, sediments and fish samples of Madivala lakes of Bangalore, Karnataka. *International Journal of Chem Tech Research*, 1(2), 245-249.
4. Hilal A.A. and Ismail N.S. (2008). Heavy metals in eleven common species of fish from the Gulf of Aqaba, Red Sea. *Jordan journal of Biological sciences*, 1(1), 13-18.
5. Yigit S. and Altindag A. (2006). Concentration of heavy metals in the food web of Lake Egirdir, Turkey. *Journal of environmental Biology*, 27(3), 475-478.
6. Kaoud H.A. and Eldahshan A.R. (2010). Bioaccumulation of cadmium in fresh water prawn *Macrobrachium rosenbergii*. *Nature and Science*, 8(4), 157-168.
7. United States Environmental Protection Agency (1997). Mercury study report to congress (PDF) 3. Washington D.C.
8. Cosoros G., Cahn P.H. and Siler W. (1973). Mercury concentration in fish, plankton and water from three Western Atlantic Estuaries. *Journal of Fish Biology*, 5(6), 641-647.
9. Peir S.M. (1975). The role of heavy metals in human health. *Texas Rep Biol Med.*, 33(1), 85-106.

10. Tan M. and Perkin J.E. (2000). Route of decomposition of thiomerosal (thimerosal). *Int. J.Pharm.*, 208(1-2), 23-34.

11. Sager P.R., Aschner M. and Roder P.M. (1984). Persistent differential alterations in developing cerebellar cortex of male and female mice after methylmercury exposure. *Dev Brain Res.*, 12, 1-11.

12. Hammond P.B. and Aronson A.L. (1964). Lead poisoning in cattle and horses in the vicinity of a smelter. *Ann. N.Y. Acad. Sci.*, 111, 595-611.

13. Methylmercury W.H.O. (1990). Environmental health criteria 101. Geneva: World Health Organization, 1-144.

14. Hultman P., Lindh U. and Horsted-Bindsev P. (1998). Activation of immune system and systemic immune-complex deposits in brown Norway rats with dental amalgam restorations. *J Dent Res.*, 77, 1415-1425.

15. Tominack R., Weber J., Blume C., Madhok M., Murphy T., Thompson M. and Scalzo A. (2002). Elemental mercury as an attractive nuisance: multiple exposures from a pilfered school supply with severe consequences. *Pediatric emergency care*, 18(2), 97-100.