

**IJCR**

Vol 05 issue 18

Section: Healthcare

Category: Review

Received on: 09/08/13

Revised on: 23/08/13

Accepted on: 16/09/13

A REVIEW ON THE DETECTION OF HEAVY METALS IN WATER BODIES, FISH ORGANS, SEDIMENT RIVER BEDS

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ABSTRACT

The consumption of highly contaminated water and eatables may prove lethal to the human being and may bring genetic disorders. Toxic heavy metals are continuously released to the aquatic bodies in Allahabad as a rapid industrialization. Metals are the problem of magnitude and of ecological significance due to their high toxicity and ability to accumulate in living organisms. Many toxicologists have worked on the analysis and detection of heavy metals in the water bodies, soil, sediments, plankton, fish organs, etc. The main aim of this paper is to provide an in-depth review for the heavy metal concentration in water, fish, sediments, eatables, such as vegetables grown on River beds, etc and to give recommendations to prevent the health hazards against consumption.

Keywords: Heavy Metal, Sediments, Industrialization, Hazards.

INTRODUCTION

Due to evolution of technology, the rise of industries at or along the bank of water bodies is one of the main causes of pollution which may cause the health hazards for the population consuming the contaminated water and other related eatables. Many publications are available all around the world consisting the heavy metal detection and have been discussed in the paper. Due to the number of references collected from the variety of sources, some lacks or omissions are possible. Authors have tried to cover maximum number of information, some of them are briefly discussed below:-

Widianarko *et al* (2000) studied the relationship among sediment, water and fish for their metal concentrations in urban streams of Semarang, Indonesia and found a significant declining trend of lead concentrations with increasing organism

size, whereas for two other metals, Zn and Cu, the concentrations did not depend on the body weight. However, metal concentration in the sediment was the most important factor governing the toxicity of metal in fish body. The fish living in highly polluted sites have also developed a physiological adaption by accumulating a large quantity of metals.

Tole *et al* (2003) carried out a study to establish the concentrations of Pb, Cd, As and Se in Lake Victoria waters, sediments and fish in order to assess the current threats to human health from heavy metal pollution, and also compare the current status with previous studies conducted in the Lake, so that current trends in heavy metal pollution in the Lake waters, sediments, and fish can serve as a pointer to future status.

Nnaji *et al* (2007) used flame Atomic Absorption Spectrometer (AAS). The *Oreochromis Niloticus*

and *Synodontis Schall* were caught with cast net from twenty sampling points. The fish samples were dissected to separate the fish head/viscera from other parts after weighing. The samples were digested with concentrated acid solution and the digests were analysed. Mean metal contents in the fish head/viscera of *O. Niloticus* in the upstream and downstream area were calculated. After comparison of these values with FAO limits in fish tissue the study suggested that it is unsafe to consume the fish head/viscera of both fish species from River Galma.

Abdallah (2008) studied the concentrations of Cd, Pb, Cu, Cr and Zn in muscles of some commercially fish species collected from two coastal areas of the Egyptian coast of the Mediterranean Sea west of Alexandria (El-Mex Bay and Eastern Harbour). For all trace element examined, in all fishes zinc was the highest followed by Cr, Cu, Pb and Cd. The levels of Cr surpassed the maximum permissible concentration in most fish tissues, followed by Pb and Cd in some species. Cu and Zn concentrations were found to be below the maximum permissible levels proposed by Food and Agriculture Organization.

In Saudi Arabia V, Cd, Zn, As, Ni, Pb and Hg levels in most common available fish species in Saudi markets were determined by Al-Bader (2008). Results showed that the concentrations of metals were below the maximum allowed limit by the Saudi and international legislations for fish human consumption permissible limit.

Mourtaja (2008) determined concentrations of Zn, Cr, Cd, Pb and Cu in three marine fishes namely, Grey mullet, Barracuda and Sigan species. The average concentrations of these heavy metals in muscles of Grey mullet were for Zn: 4.675; Cr: 0.120; Cd: 0.096; Pb: 2.606 and Cu: 0.3743 (g/g dry wt.). In Barracuda the average concentrations were 6.030, 0.151, 0.092, 2.618 and 0.247 (g/g dry wt.), respectively. In Sigan fish the averages were 6.258, 0.141, 0.123, 2.389 and 0.570 (g/g dry wt.), respectively.

Obasohan and Eguavoen (2008) investigated accumulation levels of Cu, Mn, Zn, Cd, Ni and Pb in a freshwater fish (*Erpetoichthys Calabaricus*) from Ogba River, Nigeria, during dry and rainy seasons. Findings showed that the accumulation levels in fish exceeded the levels of the metals in water and indicated bioaccumulation in fish and no significant differences of metal levels between the dry and rainy season. Findings also showed that both dry and rainy season mean levels of Cu, Mn and Ni in fish exceeded WHO recommended limits in food, suggested that the fishes of the River are not suitable for human consumption. They recommended that a close monitoring of metal pollution of Ogba River is strongly advocated, in view of the possible risks to health of consumers of fish from the River.

Prasath *et al* (2008) used Atomic Absorption Spectrophotometer for the detection of accumulation of heavy metals (Zn, Cu, Fe, Mn, Co, Pb, Cd and Ni) in water, sediments and fish (*Mugil Cephalus*) at Poompuhar coast (southeast coast of India) before and after Tsunami. Accumulation of heavy metals was observed in the order of Sediments > Fish > Water. In water, the order was found to be Mn > Fe > Zn > Cu > Ni > Cd > Co > Pb; Mn recorded a maximum of $506.9 \mu\text{L}^{-1}$ and Pb recorded a minimum of $0.006 \mu\text{L}^{-1}$. In sediments, the order was Mn > Fe > Cu > Zn > Pb \approx Co \approx Cd \approx Ni; Mn recorded a maximum of $851.1 \mu\text{g.g}^{-1}$ and a minimum of below detectable levels were found in Pb, Co, Cd and Ni. In fish, the order was found to be Fe > Zn > Mn > Cu > Ni > Co \approx Pb \approx Cd; Fe recorded a maximum of $529.13 \mu\text{g.g}^{-1}$ and a minimum of below detectable levels were found in Pb and Cd.

Saeed and Shaker (2008) presented a report about concentrations of Fe, Zn, Cu, Mn, Cd and Pb in *O. Niloticus* (*Tilapia*) fish tissues, water and sediments in northern Delta Lakes. They found that the edible part of *O. Niloticus* from Lake Edku and Manzala contained the highest levels of Cd while fish from Manzala Lake contained the highest level of Pb. They reported that Nile tilapia

caught from these two Lakes may pose health hazards for consumers.

Vinodhini *et al.* (2008) determined the bioaccumulation of heavy metals in various organs of the fresh water fish exposed to heavy metal contaminated water system using Atomic Absorption Spectrophotometer. The experimental fish was exposed to Cr, Ni, Cd and Pb at sub lethal concentrations for periods of 32 days. The results were given as $\mu\text{g/g}$ dry wt. The accumulation of heavy metal gradually increases in liver during the heavy metal exposure period. All the results were statistically significant at $p < 0.001$. The order of heavy metal accumulation in the gills and liver was $\text{Cd} > \text{Pb} > \text{Ni} > \text{Cr}$ and $\text{Pb} > \text{Cd} > \text{Ni} > \text{Cr}$. Similarly, in case of kidney and flesh tissues, the order was $\text{Pb} > \text{Cd} > \text{Cr} > \text{Ni}$ and $\text{Pb} > \text{Cr} > \text{Cd} > \text{Ni}$. In all heavy metals, the bioaccumulation of lead and cadmium proportion was significantly increased in the tissues of *Cyprinus carpio* (Common carp).

Rauf *et al* (2009) carried out a study to determine heavy metal (cadmium and chromium) concentrations in gills, kidneys, liver, skin, muscles and scales of three fish species (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*). The sample collection was carried out from three places viz. Lahore Siphon (Up-stream), Shahdera Bridge and Baloki Headworks (Down stream) in the River Ravi, Pakistan. The results showed that Heavy metal concentrations varied significantly depending upon the type of fish tissues and locations. The concentrations of Cd and Cr differed significantly ($p < 0.001$) among five fish organs and three sites and non-significantly between the three fish species. Fish liver appeared to have significantly higher tendency for the accumulation of cadmium and chromium (4.26 ± 1.57 and $6.23 \pm 1.14 \mu\text{g g}^{-1}$), while gills had minimum concentrations (1.10 ± 0.53 and $1.46 \pm 0.52 \mu\text{g g}^{-1}$) of these metals. Generally, *Catla Catla* showed higher levels of metal concentrations than *Labeo Rohita* and *Cirrhina Mrigala*. Metal contamination was highest at Baloki Headworks,

probably due to inclusion of more effluents from industrial and sewage water.

Lakshmanan *et al* (2009) carried out a study on the detection of accumulated heavy metals in the fishes of Parangipettai coastal waters. The fishes are important from the commercial point of view and analyzed for the Zn, Pb, Cr, Co and Cd concentrations in the muscles. The statistical results suggested that there is no significant species-specific difference. The highest concentration of Cr and Zn whereas lowest concentration of $\text{Pb} < \text{Cd} < \text{Co}$ in the five species of fish tissues were detected. The concentration of elements in muscles is reported as 0.415 ± 0.27 - 1.168 ± 1.49 , 0.103 ± 0.14 - 0.807 ± 0.13 , 0.114 ± 0.14 and 0.006 ± 0.00 - 0.014 ± 0.00 ppm for Cr, Zn, Pb, Cd and Co respectively. Cd, Co and Pb were found highly concentrated in muscles of The *Anchoviella commersonii* fish comparative to other fish studied. However, the *Upeneus vittatus* contained the highest concentrations of Zn and lowest concentration of most of the metals. The authors suggested that there is no hazard to human being on consuming these fishes as the metal concentrations found in there study were similar to the metal levels of the fishes collected from pitchavaram mangroves and mudasalodai landing centre.

In India, Raja *et al* (2009), determined the concentrations of Cr, Cd, Cu, Fe, Mg, Mn, Ni, Co, Zn and Al in four commercially available marine edible fish species from Parangipettai coast. They reported that metal levels in edible parts of the investigated fish was in the permissible safety levels for human uses according to FAO, 1983; EC, 2001; Food and Drug Administration, 2001 standards.

In Nigeria, Alinnor and Obiji (2010) performed a study to examine trace metal (Pb, Fe, Cd, Mn, Hg, Cu and Zn) composition in fish samples from Nworie River and in frozen fish samples purchased from Ekeonunwa. Nworie River contaminated the biota in the aquatic system with these elements which its toxicants will be

transferred to man by consumption of fish obtained from the River. Also they found that frozen fish samples purchased from Ekeonunwa market were contaminated with heavy metals.

Mandour *et al* (2011) used atomic absorption spectrophotometer for the analysis of Fifty-four drinking groundwater samples collected in April 2010 from some districts of the Dakahlyia governorate, Egypt. The water samples were analyzed for Fe, Mn, Pb, Ni, Cr, Zn, Cu, Co and Cd concentrations. Two were found suitable for drinking; from the water sample from Aga district showed slightly higher levels of Cd and Ni (Ikhtab and Feshbena) than other areas; the concentrations were higher than the permissible limits of Egyptian Ministry of Health and WHO.

Sabra *et al* (2011) carried out the sequential extraction study on the sample of sediment of Deule canal. The sediments were subjected to a physico-chemical characterization comprising particle size classification and heavy metals sequential extraction studies. Study reported the total metallic concentrations of several metals such as Cd, Zn, Pb or Cu exceeded from the limit permitted by French standards. Particles that are less than 53 μm in size contains as an average, 92% of the total weight of each metal. These particles represent about 85% of the suspended matter dry weight. This sequential extraction study reveals that most of the studied metals are strongly linked to the sediments because of their association with the sulphides and with the organic matter.

Kaur *et al* (2012) used ICP-MS for the monitoring of seasonal variation (Year 2011) of the heavy metals concentration of water of Yamuna River flowing through Delhi. The analysis was carried out for the heavy metals Pb, Fe, Zn, Mn, Cd, Co, Cu, Cr and Ni. For this purpose, sampling was done from ten selected study sites (most likely to be affected by industrial & anthropogenic activities) during two seasons i.e. summer (May) and winter (January). Result shows broad variation in the heavy metal levels varying from high

concentration during summer and low concentrations during winter season. The concentration of Pb, Cd, Cr, Cu, Zn and Co was detected under the permissible limits of ICMR, CPCB, WHO and EPA. Eminent concentrations of Fe, Ni & Mn were reported at Boat club, Yamuna Bazaar, Nigambodh Ghat, Delhi old Bridge, ITO, Nizamuddin Bridge and Mayur Vihar. Also, Pb, Cd, Cu and Co have shown significant variation ($p < 0.05$) in their concentration between summer and winter seasons, with less accumulation during winter and high during summers. Authors discussed that high heavy metal concentration during summer may be attributed to increased water temperature during summer that may result in increased metal toxicity.

Shabanda *et al* (2012) used atomic absorption spectrophotometer for the detection of Cd, Cr, Pb, Mn and Al in water, sediments, gills and flesh of both *Synodontisorex* and *Bagrus filamentosus* from River Jega in Kebbi State, Nigeria. The pattern of distribution of the heavy metals showed a preponderance of Cr and Mn over other metals in the organs of the two fish species as well as in the water and sediment samples. Al was not detected in the organs of fish species, water and sediment. The concentration of Mn was found highest in the sediment and lowest in water. The unexpectedly high concentration value obtained for Cr and Mn calls for medical alertness since it exceeded the WHO recommended acceptable limits for consumption. Cd and Pb distribution in all the samples was lower than the WHO and USEPA recommended acceptable limits for consumption.

DISCUSSION

The toxicologist has continually detected the heavy metal concentration in various water bodies, plants, vegetables, etc. Human health is directly affected by the consumption of polluted water, fish, fruits, vegetables, and plants etc which are the main sources of food for human. Earlier studies have shown exceeded heavy metal limit which shows that fish and drinking water is not

suitable for consumption whereas somewhere it is below the permissible limit.

CONCLUSION

There is a need to maintain control on disposal of industrial waste in water bodies and to bio-monitor the trace elements in the water and other eatables. The practice of trace element detection should be continued to avoid possible consumption of contaminated eatables. It is recommended that awareness should be spread among the people regarding the hazards on consumption of polluted water and related eatables. It is also essential that farmers should be educated to reduce such contamination and should be encouraged to use the controlled amount of pesticides, to avoid the leaching of waste water and cultivating in a field far away from industrial area as well as areas prone to contamination.

ACKNOWLEDGMENT

The Corresponding author is highly obliged to University Grant Commission for providing fellowship for research and development work in Forensic Science.

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