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RESEARCH ARTICLE

Heavy metal accumulation in Channa striata from Kolleru Lake and human health risk assessment

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Abstract

Heavy metals are an important group of chemical contaminants and food is the major vehicle for entry into the system. Fish and fishery products are constitute a major source of heavy metals in food.This observations deals with the human health risk assessment of metal accumulation through the consumption of fresh water fish *Channa striata* form Kolleru Lake the concentration of zinc (Zn), copper (Cu), nickel(Ni) lead (Pb),cadmium (Cd) and mercury (Hg) were investigated in muscle and liver of fish in this area. The study explains the metal concentration in the fish and leads to health risk assessment in the human beings.

INTRODUCTION

Metals are non-biodegradable and are considered as major environmental pollutants causing cytotoxic, metagenic and carcinogenic effects in animals (More et al., 2003).Under certain environmental conditions, heavy metals can accumulate to toxic concentrations and cause ecological damage(Guven,1999). So, heavy metals acquired through the food chain as a result of anthropogenic activities and pollution are potential chemical hazards that can threaten consumers. Metals such as zinc, copper and manganese are essential metal since they play important role in biological systems. Whereas lead and mercury are toxic even in small amount. Aquatic organisms have the ability to accumulate heavy metals from various sources including sediments, soil erosion and run off air deposition of pollutants and discharges of waste water (Goodwin et al., 2003).Therefore, accumulation of heavy metals in aquatic organisms can pose a long lasting effect on biogeochemical cycling in the ecosphere. According to world health organization (WHO, 1991), metals occurs less than 1% of the earth's crust, with trace amount generally found in the environment and when these concentrations exceed a stipulated limit, they may toxic to the surrounding environment. The last three decades were witness to several reports on the toxicity of heavy metals in human beings, due to the contamination in the fish and fishery organisms (Mohamad, 2014; Krishna et al., 2014).

Kolleru Lake, one of the largest fresh water lake in India and a Ramsar site is situated between the two major river basins of the Krishna and Godavari, Andhra Pradesh. It covers parts of West Godavari and Krishna districts of Andhra Pradesh and it opens into the Bay of Bengal through Upputeru which is 72 km long. The catchment of the lake extended up to 6121 km^2 of which 4763 km^2comprised of upland 1358km^2 are deltaic. Release of the industrial and aquaculture effluence have been reported to the influence of aquatic organisms. Particularly residence of the lake is greatly affected. *Channa striata* has high nutritive value, recuperative medical qualities and huge demand in this area. Therefore, the present study would be provide a base line data related to the heavy metal pollution in the Kolleru Lake and could be designing strategies aimed at the management of the control of the metal pollution and associated with health risk.

MATERIALS AND METHODS

Fish samples (*Channa striata*) are collected from fish landing centre, at Kolleru and transported to the laboratory in ice boxes and stored at -10°C until subjected for future analysis. The fishes were dissected and care was taken to avoid external contaminated to the samples. Rust free stainless steel kit was sterilized to dissect the fishes. None edible parts (Fins, scales, intestine) removed and parts like muscle and liver was chopped in to small pieces before air drying and then dried on an oven at 60°C until constant weight was obtained. The dried samples were powdered with pestle and mortar. The resulting fine powder was stored until chemical analysis. The samples (triplicate) were analyzed to each metal (Zn, Pb, Ni, Cu, Hg, and Cd) and was detected in ash samples of fish muscle recoded in mg/kg according to APHA (1998) using an Atomic Absorption Spectrophotometer (GBC Avanthe model, Australia). Statistical analyses were performed using SPSS 12.0 software for windows. Mean and standard deviation (±) of heavy metal concentrations in mg/kg dry weight of fish muscle and liver were calculated.

Health Risk Assessment: Health risk assessment was calculated only for fish muscle. The liver was eliminated according to common house hold practices in this area.

Estimated daily intake (EDI):

$$EDI = \frac{E_F \times E_D \times F_{IR} \times C_f \times C_m}{W_{AB} \times T_A} \times 10^{-3}$$

E_F = The exposure frequency 365 days/year.

E_D = The exposure duration, equivalent to average years).life time (65

F_{IR} = The fresh food ingestion rate (g/person/day) which is considered to be India 55 g/person/day (Mitra et al., 2012).

C_f = The conversion factor (= 0.208) (The content of fresh weight (fw) to dry weight (dw) considering 79% of moisture content).

C_m = The heavy metal concentration in food stuffs (mg/kg dw).

W_{AB} = Average body weight (bw) (average body weight to be 60kg).

T_A = Is the average exposure of time for non carcinogens (It is equal to ($E_F \times E_D$) as used by in many previous studies (Wang et al., 2005).

Target hazard quotient:

$$THQ = \frac{EDI}{RfD}$$

RfD: Oral reference dose (mg/kg bw/day).

"THQ" below 1 means the exposed population is unlikely to experience obviously adverse effects, whereas "THQ" above means that there is a chance of non-carcinogenic effects, with an increasing probability as the value increases.

RESULTS AND DISCUSSIONS

The average concentration of heavy metals (Zn, Pb, Ni, Cu, Hg and Cd) determined in fish muscle and liver are given (Table.1). The highest concentration of the metal in liver and muscle tissue of was recorded in Zn, followed by Cu, Ni, Pb, Hg and Cd. Higher concentration metals was recorded in the liver compare with muscle tissues. Zn is essential element and is an important component of the human body. Zinc is an essential nutrient for all living things. For this reason, algae growing in streams and lakes can absorb a large part of the zinc dissolved in water. Zn showed protective effect against the Cd and Pd toxicity. In the present study shows that the average concentration of fish muscle goes to 30.5 mg/kg and fish liver goes to 32.9 mg/kg of zinc and it contain within the permissible limits of WHO (2010) standards. Lead is a heavy metal that occurs in nature mainly lead sulphide. This metal is extremely insoluble and is readily absorbed by organic matter, especially under reducing conditions, Buckley and Hargrave (1989) reported that the lead sources of environmental contamination are from mining, smelting and reprocessing operation and as a combustion product of lead additives in gasoline. Lead has also been used in a variety of paints and is a common constituent in municipal and industrial wastes. Lead was causes mental retardation among children and also hyper tension in pregnant women (Beevens et al., 1976). Lead poising causes by symptoms of intestinal cramps, anemic condition and fatigue (Umar et al., 2001). Lead is highly toxic to aquatic organisms, especially fish (Rompala et al., 1984). The biological effects of sub lethal concentrations of lead included delayed embryonic development, suppressed reproduction and inhibition of growth, increased mucous formation, neurological problems, enzyme inhalation and kidney dysfunction (Leland and Kawabara, 1985). In the present study the level of average lead in muscle and liver goes to 6.2 and 7.1 mg/kg respectively. According to WHO (1985), the maximum accepted limit was 2 mg/kg for food fish. The present study indicated that the concentration of lead levels was higher than permissible limits.

Nickel plays important role in the biological systems. In the present study nickel was observed at an average of 8.4 mg/kg in case of fish muscle, and 10.5 mg/kg (body weight) in the liver. Our present study shows that the average concentration was higher than WHO (1985) and FAO (1989) standards. Copper is an essential metal of number of enzymes, and also higher levels of copper leads to toxic effects on aquatic biota. Excessive intake of this metal results in its accumulating in the liver. Sources of contamination in natural sediments are often related to mining wastes, industrial metal manufacturing and processing, corrosion products or as a result of excessive use of antifouling paints in marine areas. Copper is also often association with sewage sludge, where it is most likely complexes with a variety of organic compounds. In the present study the results shows that the average concentration of copper in fish muscle goes to 9.3 mg/kg (body weight) in case of muscle where as liver goes to 13.5 mg/kg, which is higher than the permissible limits set by WHO (1985).

Mercury (Hg) is generally consider as one of the major pollutants of aquatic environment. When the deposited in the biota, mercury under goes to biotransformation, inform of organic mercury (Methyl mercury).It is highly dangerous as it readily bio accumulates in the aquatic organisms. Methyl-Hg the most toxic form of mercury is a known neurotoxin. Consumption of Hg contaminated fish on regular basis therefore has been recognized to cause of severe health problems. Mercury concentration of above permissible levels in fish muscle can be associated with emaciation, decreasing in coordination, losing appetite and mortality in fish (Eisler, 1987). Mercury pollution in aquatic ecosystems has received great attention since the discovery of mercury as the cause of Minamata disease in Japan in the 1950’s. Mercury poisoning in the adult brain is characterized by damage of discrete visual cortex areas and neuronal loss in the cerebellum granule layer (Vettori et al., 2003). Further, mercury poisoning during the early stages of nervous system development may cause catastrophic consequences for infants who exhibit widespread neural impairment (Harada, 1995). In the present study mercury average concentration was 1.5 mg/kg in muscle tissue and 1.9 mg/kg in the liver which was higher than permissible levels of WHO (1985). Cadmium is toxic element which shows their carcinogenic effect on aquatic biota and humans. It is widely distributed at low levels in the environment and is not an essential element for humans, animals and plants. In the present study Cd shows 1.3 mg/kg in case of muscle and liver 1.5 mg/kg. According WHO(1989), the pregnant women and breast feeding woman are likely to be at much greater risk due to the vulnerability of embryos and infants exceeding due to the permissible limits of Cd.

Heavy metals are one of the more serious pollutants in our natural environment due to their toxicity. The efficiency of metal up take from polluted water may different ecological need, metabolism and contaminated level, food and sediment as well as other environmental factors such as temperature, salinity and interacting agent (Rauf et al., 2009). When the organisms are exposed to high level metal in an aquatic environment, they can absorb the available metals directly from the environment via the gills or contaminated water and food, thus accumulated them in their tissues and enter the food chain and extend to so many other problems to humans (Ahmad and Othman, 2010).

Fish is one of the most important food sources and thus, intake of trace elements form capture fish, especially toxic elements if one of great concern for human health. To evaluate the health risk to people in Kolleru area, the “Target Hazard Quotient” (THQ) of heavy metal was estimated on the concentrations of metal in fish muscle and daily fish consumption. Chapman et al, (1996) reported that the predominant pathways for heavy metal uptake, target organs, and organisms sensitivity are highly variable and are dependent of factors such as metal concentrations, age, site, physiological status, habitat preferences, feeding behavior and growth rates of fish. The increasing demand of food safety has accelerated researching regarding the risk associated with consumption contaminated by heavy metal (Mansour et al., 2009). In the present study our results clearly showed that the all observed metals are higher than that of results reported by Li et al. (2014), Mohamad & Osman (2014), and Krishna et al., (2014).

The estimated Target Hazard Quotient of the observed heavy metals through consumption of fish was given in table 2. The average “THQ” values for individual heavy metal are above 1, except mercury and cadmium. Ambedkar and Maniyan (2011) concluded that the heavy metal concentration were above the maximum levels recommended by regulatory agencies and depending on daily intake by consumers, might represent a risk for human health. Li et al., (2014) reported that highest total “THQ” value poses relatively higher potential health risks of human beings, particularly for the people residing in the areas with serious metal pollution.

Finally, we conclude that long term continuous monitoring is essential of metal pollution in Kolleru Lake. The “THQ” values of the all the studied metals in fish samples were above 1 except Cd. It is suggesting that the concentration of the metals in fish muscle from this area pose to health hazards to the consumers.

Table 1. Average heavy metals concentration (mg/kg dry weight) in liver and muscle of *Channa striata* collected from Kolleru Lake, Andhra Pradesh, India.

S. No.	**Heavy Metals**	*Channa striata* (No. Specimens-20)	
		Muscle (Means ± SD)	**Liver** (Means ± SD)
1.	**Zinc (Zn)**	30.5±2.5	32.9±2.9
2.	**Lead (Pb)**	6.2±1.4	7.1±1.6
3.	**Nickel (Ni)**	8.4±1.2	10.5±1.9
4.	**Cupper (Cu)**	9.3±1.5	13.5±1.8
5.	**Mercury (Hg)**	1.5±0.19	1.9±0.19
6.	**Cadmium (Cd)**	1.3±0.25	1.5±0.28

Abbreviations: S. No. : Serial Number; SD: Standard deviation

Table 2. THQ values of muscle in *Channa striata* collected from Kolleru Lake, Andhra Pradesh, India.

S. No.	**Heavy Metals**	*Channa striata* (No. Specimens-20)
		Muscle THQ ± SD
1.	Zinc (Zn)	6.31±1.21
2.	Lead (Pb)	1.28±0.75
3.	Nickel (Ni)	1.73±0.84
4.	Cupper (Cu)	1.92±0.95
5.	Mercury (Hg)	0.3±0.12
6.	Cadmium (Cd)	0.269±0.13

Abbreviations: S. No: Serial Number; THQ: Target Hazard Quotient; SD: Standard deviation

REFERENCES

Ahmad AK, Othman Sh M (2010). Heavy metal concentrations in sediments and fishes from Lake Chini, Pahang. Malay. J. Biol. Sci., 10: 93-100.

Ambedkar G, Muniyan M (2011). Accumulation of metals in the five commercially important freshwater fishes in Vellar River, Tamil Nadu, India. Archi. Appl. Sci. Res., 3(3): 261-264.

APHA (1998). Standard Methods for the Examination of Water and Wastewater (20th ed). New York, American Public Health Association, Washington DC, USA.

Beevens DG, Erskine E, Robertson M, Beattle AD, Campbell BC, Goldberg A (1976). Blood lead to hypertension. Lancet, 2: 1-3.

Buckley DE, Hargrave BT (1989). Geochemical characteristics of surface sediments. In- Nicholls, HB (Ed). Intvestigation of Marine environmental Quality in Halifax harbour (pp. 1963: 9-36), Can. Tech. Rep. Fish. Aqua. Sci.

Chapman PM, Allen HE, Godteredsen KZ and Graggen MN (1996). Evolution of bioaccumulation factors in regulating metals. Envir. Sci.Tech., 30: 448.

Eisler R (1987). Mercury hazards to fish, wild fish, and invertebrate: a synoptic review. US Fish and wild life service Report, 85 (1.10) Washington, DC, USA.

FAO (1989). National Research council Recommended Dietary allowances 10th Edn. National Academy Press. Washington DC. USA.

Goodwin T.H, Young A.R, Holmes M.G.R, Old G.H, Hewitt N, Leeks G.J. L , Packman J.C and Smith B.P.G (2003). The temporal and spatial variability of sediment transport and yields within the Bradford Beck catchment, West Yorkshire. Sci .Total Environ. 314-316: 475- 494.

Guven K,Ozbay C,Unlu E,Satar A.(1999). Acute lethal Toxicity and aAccumulation of Copper in Gammarus pulex (L.) (Amphipoda).Turk J Biol; 23:513-21

Harada M (1995). Minamata disease: Methyl mercury poisoning in Japan caused by environmental pollution. Crit. Rev. Toxicol., 25(1): 1.24.

Krishna P.V, Jyothirmayi V, and Madhusudhana rao K (2014). Human health risk assessment of heavy metal accumulation through fish consumption,from Machilipatnam coast,Andhra Pradesh,India.Int.Res.J.Public Environ.Health.,1(5):121-125.

Leland HV, Kuwabara JS (1985). Trace Metals, In: Rand G.M., and Petrocelli S.R. (eds.), Fundamentals of Aquatic Toxicology (pp.374-415) Hemisphere, New York, USA.

Li Z, Zhang D, Wei Y, Luo L, Dai T (2014). Risk assessment of trace elements is cultured from freshwater fishes from Jiangxi Provence, China. Environ. Monit. Assess., 186: 2185-2194.

Mansour SA, Belal MH, Abou-Arab AAK, Gad MF (2009). Monitoring of pesticides and heavy metals in cucumber fruits produced from different farming systems. Chemosphere, 75(5): 601–609.

Mohamad EA, Osman AR (2014). Heavy metals concentration in water, muscle and gills of *Oreochromis niloticus* collected from the sewage treated water and the White Nile. Inter. J. Aquacul., 4(6): 36-42.

More T.G, Rajput R.A and Bandela N.N (2003). Impact of heavy metals on DNA content in the whole body of freshwater bivalve, *Lamelleiden marginalis.* Environ.Sci.Pollut.Res., 22:605-616

Rauf A, Javed M, Ubaidullah M (2009). Heavy metal levels in three major carps (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) from the River Ravi, Pakistan. Pakist. Vet. J., 29(1): 24-26.

Rompala JM, Rutosky FW, Putnam DJ (1984). Concentrations of environmental contaminants from selected waters in Pennsylvania. United States Fish and Wildlife Service Republic, State College, Pennsylvania, US.

Umar A, Umar R, Ahmad MS (2001). Hydrogeological and hydrochemical frame works of regional aquter system in Kali-Ganga sub-basin. India. Envir. Geol., 40 (4-5): 602-611.

Vettori MV, Alinovi R, Belletti S, Goldoni M, Franchini I, Multi A (2003). In vitro model for the evaluation of the neurotoxicity of methyl Mercury. Current state of knowledge. Med. Lav. 94-183.

WHO (1985). Guidelines for drinking water quality. Recommendation WHO. Geneva\1985; 1: 130.

WHO (1989). Heavy metals-environmental aspects of environment and health criteria. No.85. Geneva, Switzerland.

WHO (1991). Inorganic Mercury-Environmental Health Criteria. Geneva World Health Organization, 118: 1591.

WHO (2010). Summery and conclusion joint FAO/WHO expert committee of food additives. (JECFA/73/SC) 73^{rd} meeting Geneva