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Bioaccumulation of heavy metals in selected tissues of the major carp*Catlacatla* (Hamilton) in the Nelatur lake "adjacent to Sri DamodaramSanjeevaiah (SDS-APGENCO) thermal power plant" of SPSR Nellore District, AP, India

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Key words: *Catla catla,* Heavy metals, Bio accumulation, Contamination

Abstract

The flyash released from the TPP's contain heavy metals and pollute the surface and ground water sources and effect the food chain of the ecosystem. These heavy metals are the most hazardous pollutants due to speed of their dissemination in biosphere and their accumulative concentration (Pandey *et al.*, (2010). The increasing amounts of heavy metals enter in aquatic environment can result in high accumulation levels of these contaminants in fish and their consumers, which pose a serious risk to ecosystem and human health (Lapido *et al.*, 2012). The bioaccumulation of four heavy metals (As, Hg, Pb & Mn) were evaluated in the selected tissues of the major edible carp *Catlacatla* from the Nelatur lake adjacent to the SDS-TPP. The results vividly indicate that the bioaccumulation of the Arsenic level is high followed by Mercury, Lead and Manganese (As>Hg>Pb>Mn). Among the tissues the Liver recorded higher levels followed by Gill, Muscle and Small intestine (Liver > Gills> Muscle> Small intestine). The present findings are useful as early warning for environmental monitoring strategies and constant raise of these heavy metals in the future will have adverse effects on consumers.

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Introduction

The contamination of natural aquatic resources with heavy metals released from industrial effluents and also anthropogenic activities has become a matter of concern over the past decades (Waqar *et al.*, 2013). The rapid development of industry and agriculture has resulted in increased heavy metal pollution which is a significant environmental hazard for invertebrates, fish and humans (Uluturhan & Kucksezgin, 2007). Among the contaminants the heavy metals have received considerable attention due to their toxicity and bioaccumulation in biota of aquatic ecosystem (Nadmitov *et al.*, 2015). They permeate the aquatic environment by various means, penetrate in the circle of metabolism, become toxic and disturb physiological functions of organism (Klavins *et al.*, 2009). Fish being the top consumer in the aquatic food chain accumulate large amount of heavy metal in their body. These chemicals once observed are transported by the blood to either a storage point (bone, liver) or further transported to other organs (kidney, gill, fat) (Dural *et al.*, 2007). Therefore, the World Health Organization (WHO) as well as Food and Agriculture Organization (FAO) insist on monitoring the levels of heavy metals while regulating the constituents of food products.

The SPSR Nellore district in Andhra Pradesh State of South India is known as 'granary of India' due to major paddy cultivation. Huge coastal line and abundant water resource predominantly leading the district in aquaculture and agriculture. But in the last decade, rapid development of industry especially the thermal power plants (TPPs) has resulted in increased heavy metal pollution which is a significant environmental hazards for flora and fauna. Evaluating the ecological risk from heavy metal has become a hot topic. Sri DamodaramSanjeevaiah (SDS-APGENCO, TPP) is situated in Nelatur coastal village of MuthukurMandal, SPSR Nellore District, AP, India and geographically located at 14.31° N and 80.10° E (Fig 1). This thermal plant is adjacent to Nelatur Lake. This lake is very prominent in the village and one of the most precious water treasures for flora and fauna. So far, no investigation has been made to assess the levels of heavy metals in natural biota of this lake. Since, the contamination of natural aquatic resources with heavy metals released from SDS Thermal power plant has become a serious concern, the present work is aimed to study the levels of four heavy metals (As, Hg, Pb & Mn) in the selected tissues of the major carp *Catlacatla* from the Nelatur Lake which is edible and commercially important fish.

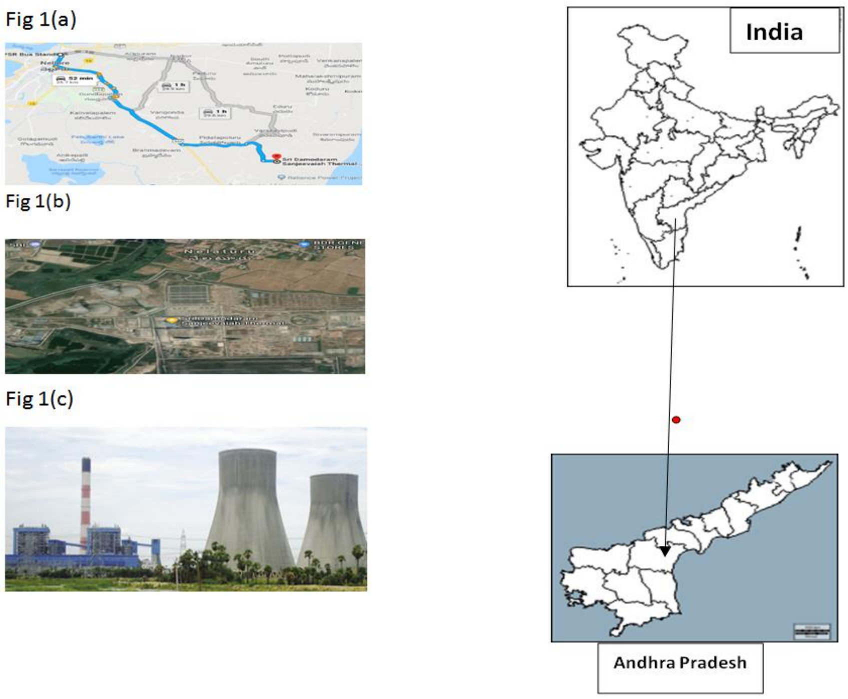

Fig . 1. Map of India showing the location of SDS thermal power plant.

Materials and methods

Fish collection

Fresh water fish, *Catlacatla* ranging from 20 to 25 cm in length and weighing between 500 to 550 grams were collected by fisherman from Nelaturlake which is adjacent to Sri DamodaramSanjeevaiah (SDS-APGENCO) thermal power plant. Fish were transported to the laboratory in polythene bags with appropriate and handling. As soon as fish transported to laboratory the tissues to be studied: muscle, gill, liver and small intestine were isolated by using dissecting instruments, placed in the labelled plastic boxes/ polythene bags with ice to stop decomposition and immediately placed at -20°C until prepared for analysis.

Sample treatment

The fish samples previously stored in deep freezer were allowed to at room temperature about 27°C . The liver, gill, muscle, and small intestine were dried in a hot air oven for 24 hours at a temperature of 110-115°C. After drying the fish samples were taken separately into tiny pieces using a pre-cleaned porceline mortar and pistle and placed in a separate labelledpetridishes and stored in desiccator until digestion. The digested liver, gill, muscle and small intestine tissues were taken into an atomic absorption spectrophotometer, Shimadzu model AA- 7000 by using an air acetylene flame (APHA.1998).

The determination of the above heavy metals in the above selected tissues was carried out for one year (2017) at monthly intervals and the results were presented in tables (1-4) and Fig.s (2-5).

Results and discussions

The study has revealed the various concentrations of four heavy metals in the tissues: like muscle, gill, liver and small intestine of freshwater major carp *CatlaCatla* collected from the Nelaturlake, adjacent to the (SDS-APGENCO).

Arsenic

The maximum and minimum concentration of arsenic in the tissues varied between 1.53 to 0.70. The liver concentration ranged from 1.53 to 1.42, and in the muscle tissue varied between 0.86 and 0.73. The gill tissue recorded 0.95 to 0.86 concentration followed by the small intestine tissue ranging from 0.76 to 0.70. Among the tissues, liver has recorded maximum levels throughout the study period followed by gill, muscle and small intestine tissues. All the tissues have recorded maximum levels in the month of July and minimum levels in the month of October. (Table. 1 and Fig. 2)

Mercury

Throughout the study period, mercury level in the tissues ranged from 1.27 to 0.61. The maximum and minimum concentration of mercury in liver varied between 1.27 to 1.16. The concentration of mercury in gill varied between 1.08 to 0.98. The mercury concentration in muscle varied between 0.87 to 0.81.

The maximum and minimum concentration of mercury in small intestine varied between 0.67 to 0.61. During the study period, maximum levels is observed in the month of July and minimum levels is observed in the month of September. (Table. 2 and Fig. 3).

Lead

In all the tissues the lead levels varied between 0.98 and 0.40. The maximum and minimum concentration of lead in liver varied between 0.98 and 0.88. Gill tissue recorded the concentrations from 0.76 to 0.69. The maximum and minimum concentration of lead in muscle ranged from 0.58 to 0.51. Lead in small intestine varied between 0.48 and 0.40. In all the tissues maximum levels is observed in the month of June and minimum levels is observed in the month of September. (Table. 3 and Fig. 4)

Manganese

The maximum and minimum concentration of manganese in all the tissues varied between 0.07 and 0.01. The liver tissue recorded higher levels followed by gill, muscle and small intestine tissues. In the all the tissue, maximum levels are observed in the month of July and minimum levels in the month of September throughout the study period. (Table. 4 and Fig. 5).

Table 1. Heavy metal Arsenic (As) bioaccumulation in the major carp, *Catlacatla*(µg/Kg).

SN	Tissues	January	February	March	April	May	June	July	August	September	October	November	December
1	Muscle	0.75 (0.01)	0.74 (0.01)	0.75 (0.01)	0.77 (0.01)	0.78 (0.02)	0.79 (0.01)	0.85 (0.02)	0.83 (0.01)	0.82 (0.01)	0.73 (0.01)	0.82 (0.02)	0.83 (0.02)
2	Gill	0.88 (0.01)	0.88 (0.01)	0.89 (0.01)	0.90 (0.02)	0.91 (0.02)	0.92 (0.02)	0.95 (0.02)	0.94 (0.02)	0.92 (0.02)	0.86 (0.01)	0.92 (0.02)	0.92 (0.02)
3	Liver	1.44 (0.03)	1.44 (0.03)	1.46 (0.03)	1.47 (0.01)	1.48 (0.03)	1.47 (0.03)	1.53 (0.04)	1.50 (0.04)	1.51 (0.43)	1.42 (0.03)	1.52 (0.04)	1.52 (0.04)
4	Small Intestine	0.72 (0.01)	0.72 (0.01)	0.72 (0.01)	0.73 (0.01)	0.74 (0.01)	0.74 (0.02)	0.76 (0.01)	0.74 (0.02)	0.74 (0.02)	0.70 (0.01)	0.71 (0.02)	0.72 (0.01)

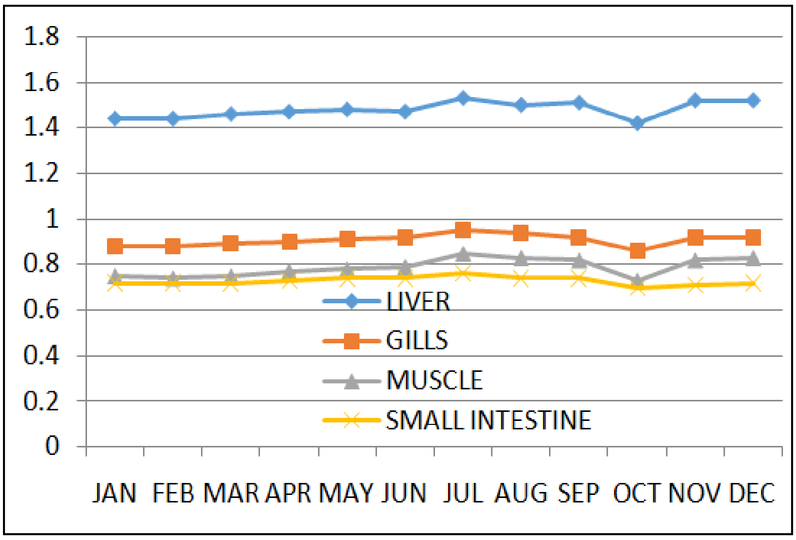

Fig. 2. Arsenic bioaccumulation in *Catlacatla*.

Table 2. Heavy metal Mercury (Hg) bioaccumulation in the major carp, *Catlacatla* (µg/Kg).

SN	Tissues	January	February	March	April	May	June	July	August	September	October	November	December
1	Muscle	0.82 (0.02)	0.82 (0.02)	0.83 (0.02)	0.83 (0.01)	0.83 (0.01)	0.84 (0.02)	0.87 (0.02)	0.84 (0.01)	0.81 (0.01)	0.85 (0.01)	0.86 (0.01)	0.86 (0.01)
2	Gill	0.99 (0.05)	1.00 (0.02)	1.02 (0.01)	1.04 (0.02)	1.05 (0.02)	1.05 (0.02)	1.08 (0.02)	1.05 (0.01)	0.98 (0.01)	1.06 (0.02)	1.07 (0.01)	1.07 (0.02)
3	Liver	1.18 (0.02)	1.19 (0.02)	1.22 (0.03)	1.24 (0.02)	1.22 (0.03)	1.24 (0.03)	1.27 (0.03)	1.24 (0.03)	1.16 (0.03)	1.25 (0.03)	1.26 (0.03)	1.26 (0.03)
4	Small Intestine	0.62 (0.01)	0.63 (0.01)	0.62 (0.03)	0.63 (0.01)	0.64 (0.01)	0.65 (0.01)	0.67 (0.01)	0.64 (0.01)	0.61 (0.01)	0.65 (0.01)	0.66 (0.01)	0.66 (0.01)

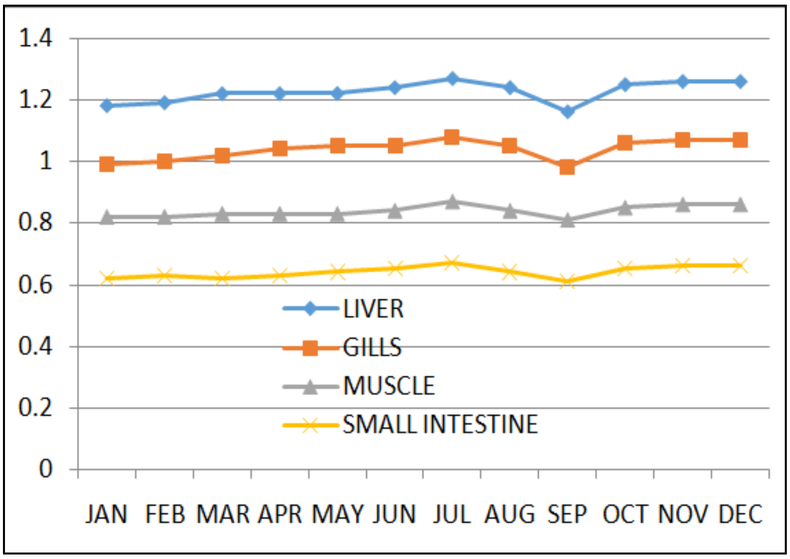

Fig. 3. Mercury bioaccumulation in *Catlacatla*.

Table 3. Heavy metal Lead (Pb) bioaccumulation in the major carp,*Catlacatla* (µg/Kg).

SN	Tissues	January	February	March	April	May	June	July	August	September	October	November	December
1	Muscle	0.55 (0.01)	0.54 (0.02)	0.53 (0.02)	0.55 (0.01)	0.55 (0.02)	0.58 (0.02)	0.55 (0.03)	0.56 (0.02)	0.56 (0.03)	0.51 (0.01)	0.56 (0.02)	0.57 (0.02)
2	Gill	0.71 (0.02)	0.70 (0.02)	0.71 (0.02)	0.72 (0.02)	0.72 (0.02)	0.76 (0.03)	0.72 (0.01)	0.75 (0.03)	0.69 (0.01)	0.72 (0.02)	0.73 (0.02)	0.72 (0.02)
3	Liver	0.89 (0.02)	0.89 (0.02)	0.92 (0.03)	0.93 (0.03)	0.94 (0.03)	0.98 (0.03)	0.94 (0.03)	0.94 (0.03)	0.88 (0.02)	0.95 (0.03)	0.96 (0.03)	0.96 (0.03)
4	Small Intestine	0.43 (0.01)	0.41 (0.01)	0.41 (0.02)	0.46 (0.01)	0.44 (0.01)	0.48 (0.02)	0.43 (0.01)	0.46 (0.02)	0.46 (0.02)	0.40 (0.01)	0.43 (0.01)	0.44 (0.02)

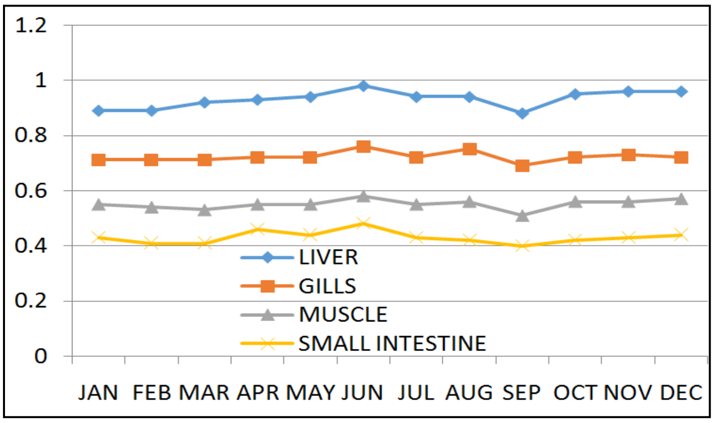

Fig. 4. Lead bioaccumulation in *Catlacatla*.

Table 4. Heavy metal Manganese (Mn) bioaccumulation in the major carp, *Catlacatla* (µg/Kg).

SN	Tissues	January	February	March	April	May	June	July	August	September	October	November	December
1	Muscle	0.02 (0.01)	0.02 (0.01)	0.02 (0.01)	0.02 (0.01)	0.03 (0.01)	0.03 (0.01)	0.04 (0.02)	0.02 (0.01)	0.01 (0.01)	0.02 (0.01)	0.02 (0.01)	0.03 (0.01)
2	Gill	0.02 (0.01)	0.03 (0.01)	0.02 (0.01)	0.02 (0.01)	0.03 (0.01)	0.03 (0.01)	0.05 (0.02)	0.03 (0.01)	0.01 (0.01)	0.03 (0.01)	0.03 (0.01)	0.02 (0.01)
3	Liver	0.02 (0.01)	0.02 (0.01)	0.03 (0.01)	0.03 (0.01)	0.04 (0.02)	0.04 (0.02)	0.07 (0.03)	0.04 (0.02)	0.01 (0.01)	0.04 (0.02)	0.04 (0.02)	0.04 (0.02)
4	Small Intestine	0.02 (0.01)	0.02 (0.01)	0.03 (0.01)	0.03 (0.01)	0.02 (0.01)	0.02 (0.01)	0.04 (0.02)	0.02 (0.01)	0.01 (0.01)	0.02 (0.01)	0.02 (0.01)	0.03 (0.01)

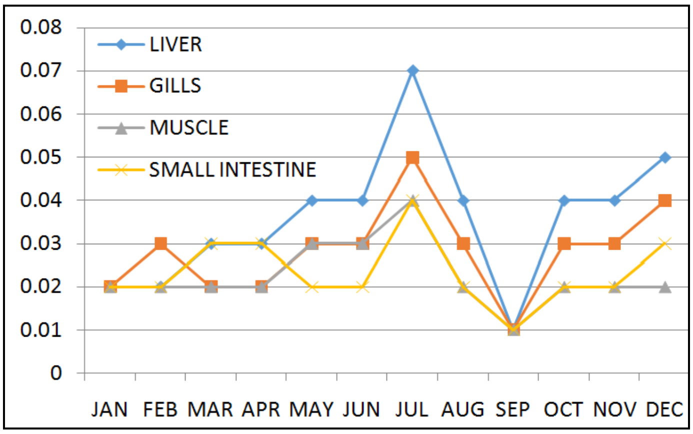

Fig. 5. Manganese bioaccumulation in *Catlacatla*.

Discussion

Water pollution has become a serious problem due to discharge of untreated industrial effluents, containing huge quantities of heavy metals. Having contaminated water, Heavy metals can have a negative impact on aquatic ecosystem especially on the food web (Barletta *et al*, 2012). Fish are on the top of the aquatic food chain and are continuously exposed to chemicals and heavy metals in contaminated waters (Gupta *et al*., 2017).

Heavy metals accumulated in organisms are consumed by fish are permeate the fish directly through skin and gill. The concentration of heavy metals in biological compartments, such as fish muscle is a complex combination of biological and ecological variables. In fish these elements can cause disturbances in growth and reproduction as well as histopathological alterations in the skin, gills, liver, spleen and kidney (Vivek *et al.*, 2007).

For these reasons, evaluation of heavy metals in commercially important fish is important from a toxicological perspective, verifying whether there is a significant health risk arising from fish consumption. Therefore, the levels of contaminants in fish are of particular interest because of the potential effects of these polluting substances on the fish themselves and on the organisms that consumes them, including humans (Burger and Coghfeld 2005, Kar *et al.*, 2008, Noli *et al.*, 2016).

Bioaccumulation of heavy metals in the selected tissues of the major carp *Catlacatla* is a reliable tool for the assessment of environmental pollution (Authman *et al.*, 2013). The present study provides crucial information on the distribution of heavy metals in the tissues of the major carp which is of great economic importance. Although the levels of bioaccumulation of heavy metals in the tissues of carp do not exceed the safe levels for human consumption, the constant presence of heavy metals in concentration near those consider safe for human consumption is a reason for warning population who regularly consume fish from the Nelaturlake adjacent to SDS Thermal Power Plant.

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