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Bioaccumulation of Heavy Metals in Tissues of Some Fishes in Bansagar Dam on Son River in Deolond, Shahdol Division in Central India

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ABSTRACT:

The concentrations of heavy metals (Cu, Zn, Fe, Pb and Hg) were measured in the Muscles, liver, gills, kidney and gonad of fish species collected from Bansagar dam, Deolond in central India. The levels of heavy metals varied significantly among fish species and organs. Muscles possessed the lowest concentration of metals. The essential metals as Cu were accumulated mainly in liver and gonad, Zn accumulated mainly in Gills and Liver, Fe were accumulated in all organs with little bit fluctuation in concentration while Pb accumulated in gill, liver and gonad and Hg exhibited their highest concentrations in gonads. The concentration of metals in the present fish organs within the permissible limits given by WHO and FAO but in case of Hg and Pb these are higher than the limits. This study reveals that fishes found in this dam are not suitable for human consumption it may cause severe health threats.

KEY-WORDS: Heavy metals, Bansagar dam, Fishes, health threats.

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INTRODUCTION

The pollution of the aquatic environment with heavy metals has become a worldwide problem in recent years, because they are indestructible and most of them have toxic effect on organisms [19]In the recent years, world consumption of fish has increased simultaneously with the growing concern of their nutritional and therapeutic benefits. In addition to its important source of protein, fish typically have rich contents of essential minerals, vitamins and unsaturated fatty acids[20].The American Heart Association recommended eating fish at least twice per week in order to reach the daily intake of omega-3 fatty acids. However, fish are relatively situated at the top of the aquatic food chain; therefore they normally can accumulate heavy metals from food, water and sediments[10].

In the last few decades, the concentrations of the heavy metals in fish have been extensively studied in different parts of the world [13].Most of these studies concentrated mainly on the heavy metals in the edible parts that is fish muscles however other studies reported the distribution of metals in different organs like the liver, kidney, hearts, gonads, bone, digestive tract, gills and brain. The content of toxic heavy metals in fish can counteract their beneficial effects and may cause many adverse effects on human health this may include serious threats like renal failure, liver damage, cardiovascular diseases and even death[17] .

Heavy metals are implicated in neurological disorders especially in the foetus and in children, which can lead to behavioural changes and impaired performance in intelligent quotient (IQ) test [16].The quality of the ecosystem has been degrading due to agriculture and human activities. Fish is an important component of the human diet in many villages and cities in shahdol division of central India and Bansagar Dam is the very enormous source of fish culture and transportation of fishes to different region of shahdol division and other places too, for this reason, the results obtained from the study would provide information on background levels of metals in the fish species of the river Sone, contributing to the effective monitoring of both environmental quality and the health of organisms inhabiting the river ecosystem.

It is therefore very important for study to be conducted on the concentration of heavy metals in the tissues of fishes of river Sone in Bansagar dam at Deolond in central India and check whether or not the concentration levels are within the permissible limits for human consumption in comparison to safety reference standards for the consumption of fish. Because in this area many people are dependent on fish as a food, especially fisher mans and it may cause severe health hazards.

MATERIALS AND METHODS

Fish Sampling

12 water samples and 24 commercial fish samples were used for study in three seasons of the year summer, winter and rainy, during two years (from 2015-16 to 2016-17) from every site. The collected species were *Labeo rohita, Labeo calbasu, Notopterus notopterus and Channa punctatus*. These fish species represent different biotopes and are economically important. Collected fish were immediately preserved in an ice box and transferred to the laboratory where they were classified, weighed, measured by total length and kept frozen at −20 °C until further analysis. The fish and water samples collected from the different sites and analyzed at laboratory. Atomic Absorption Spectrophotometer (AAS) was used for the determination of the heavy metals in the tissue and water samples.

Determination of Metal Concentrations

Preparation of subsamples and analysis were made for metal analysis, frozen fish were partially thawed and each fish was dissected using stainless steel instruments. Muscles, Liver, Gills, Kidney and Gonad were taken out and dehydrated it, in oven, composite samples of 2–5 g were used for subsequent analysis.

The samples were digested with ultra pure nitric acid at 100°C until the solution become clear. The solution was made up to known volume with deionized distilled water and analyzed for Cu, Zn, Pb, Fe and Hg using the Atomic Absorption Spectrophotometer (AAS model ELICO, SL-168) the obtained results were expressed as mg/kg.

Observations

Concentrations of heavy metals (Cu, Zn, Pb, Fe and Hg) in the muscles, liver, gill, kidney and gonad of fish collected from the different sites of Bansagar Dam.

As shown in Table-01, the contamination levels of these five metals were high in tissues. Specially, the concentration of Hg and Pb exceeding, FAO and WHO target values. Consumption of water as well as fish may create health problems related with Hg and Pb contamination may occur in human beings.

The accumulation of metals in a single species showed significant inter-specific variations in all metals. However it can be noticed that, different organs exhibited different patterns in metals accumulation. In other words, no single type of fish showed the highest metals in all organs. Therefore, concentrations of metals between species were analyzed in single organ; all results showed significant variations between species. Furthermore, some fish from the same species collected from different sites also significantly accumulated different concentrations of metals. Variations of metals distribution in the studied fish can be summarized as the following:

Table-I:- Table showing mean (±SD) concentrations of heavy metals (mg/kg) in some organs of fish species collected from Bansagar Dam.

FISH SPECIES	ORGANS	Cu	Zn	Fe	Hg	Pb
Labeo rohita	**Muscles**	0.000±0.000	0.921±0.001	1.754±0.011	1.836±0.021	0.852±0.012
	Liver	3.513±0.001	1.465±0.002	2.112±2.001	0.408±2.011	2.969±0.065
	Gills	1.084±0.001	1.505±0.001	2.023±1.002	1.642±0.001	3.241±0.002
	Kidney	3.250±0.000	1.326±0.002	1.541±0.003	1.210±0.012	2.542±0.015
	Gonad	2.350±0.002	1.420±0.013	2.324±0.013	0.921±0.031	3.074±0.011
Labeo calbasu	**Muscles**	0.000±0.000	0.769±0.003	1.927±0.032	1.248±0.021	2.102±0.027
	Liver	2.920±0.002	0.986±0.101	2.077±0.002	1.889±0.001	2.992±0.045
	Gills	0.000±0.000	0.910±0.002	2.424±0.011	0.921±0.011	1.245±0.033
	Kidney	0.000±0.000	0.420±0.011	2.775±2.002	0.226±0.002	2.421±0.012
	Gonad	3.173±0.002	0.479±0.014	2.776±0.011	1.320±0.006	3.221±0.008
Notopterus notopterus	**Muscles**	2.566±0.003	1.136±0.003	2.200±0.005	0.091±0.001	2.924±0.042
	Liver	3.288±0.000	1.625±0.032	2.411±0.012	1.532±0.041	2.920±0.020
	Gills	1.229±0.002	1.666±1.011	1.358±1.006	0.881±0.062	3.074±0.078
	Kidney	1.020±0.000	1.201±1.000	2.101±0.008	0.982±0.015	2.241±0.059
	Gonad	2.001±0.001	1.521±0.013	1.520±0.009	1.642±0.031	3.991±0.033
Clupisoma garua	**Muscles**	1.624±0.000	1.424±0.022	1.586±0.005	0.523±0.072	2.958±0.084
	Liver	2.410±0.002	1.650±0.031	1.603±1.021	0.661±0.001	3.243±0.007
	Gills	1.360±0.001	1.623±0.003	2.052±1.020	0.101±0.023	3.054±0.001
	Kidney	1.423±0.003	1.522±1.002	2.001±0.002	0.441±0.003	2.043±0.002
	Gonad	2.101±0.002	1.422±0.012	1.531±1.008	1.210±0.045	3.221±0.011

Table-II:-Table showing maximum permissible limit (MPL) of heavy metals in fish tissues (mg/kg) according to international standards.

	Cu	Zn	Fe	Pb	Hg
FAO/WHO limit	30	30	43	01	0.6
FAO(1983)	30	30	---	0.5	---
WHO 1989	30	100	100	02	---

Copper (Cu)

The copper concentration in the tissues of *Labeo rohita* is 0.00, 3.513±0.001, 1.084±0.001, 3.250±0.000, and 2.350±0.002 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Labeo calbasu* are 0.00, 2.920±0.002, 0.00, 0.00, and 3.173±0.002 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Notopterus notopterus* 2.566±0.003, 3.288±0.000, 1.229±0.002, 1.020±0.000, 2.001±0.001 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Clupisoma garua* are 1.624±0.000, 2.410±0.002, 1.360±0.001, 1.423±0.003, 2.101±0.002 in Muscles, Liver, Gills, Kidney, and Gonad respectively.

Zinc (Zn)

The Zinc concentration in the tissues of *Labeo rohita* is 0.921±0.001, 1.465±0.002, 1.505±0.001, 1.326±0.002, and 1.420±0.013 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Labeo calbasu* are 0.769±0.003, 0.986±0.101, 0.910±0.002, 0.420±0.011, and 0.479±0.014 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Notopterus notopterus* 1.136±0.003, 1.625±0.032, 1.666±1.011, 1.201±1.000, 1.521±0.013 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Clupisoma garua* are 1.424±0.022, 1.650±0.031, 1.623±0.003, 1.522±1.002, 1.422±0.012 in Muscles, Liver, Gills, Kidney, and Gonad respectively.

Iron (Fe)

The Iron concentration in the tissues of *Labeo rohita* is 1.754±0.011, 2.112±2.001, 2.023±1.002, 1.541±0.003, and 2.324±0.013 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Labeo calbasu* are 1.927±0.032, 2.077±0.002, 2.424±0.011, 2.775±2.002 and 2.776±0.011 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Notopterus notopterus* are 2.200±0.005, 2.411±0.012, 1.358±1.006, 2.101±0.008, and 1.520±0.009 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Clupisoma garua* are 1.586±0.005, 1.603±1.021, 2.052±1.020, 2.001±0.002, and 1.531±1.008 in Muscles, Liver, Gills, Kidney, and Gonad respectively.

Mercury (Hg)

The Mercury concentration in the tissues of *Labeo rohita* is 1.836±0.021, 0.408±2.011, 1.642±0.001, 1.210±0.012 and 0.921±0.031 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Labeo calbasu* are 1.248±0.021, 1.889±0.001, 0.921±0.011, 0.226±0.002, and 1.320±0.006 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Notopterus notopterus* are 0.091±0.001, 1.532±0.041, 0.881±0.062, 0.982±0.015, and 1.642±0.031 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Clupisoma garua* are 0.523±0.072, 0.661±0.001, 0.101±0.023, 0.441±0.003, and 1.210±0.045 in Muscles, Liver, Gills, Kidney, and Gonad respectively.

Lead (Pb)

The Lead concentration in the tissues of *Labeo rohita* is 0.852±0.012, 2.969±0.065, 3.241±0.002, 2.542±0.015 and 3.074±0.011 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Labeo calbasu* are 2.102±0.027, 2.992±0.045, 1.245±0.033, 2.421±0.012, and 3.221±0.008 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Notopterus notopterus* are 2.924±0.042, 2.920±0.020, 3.074±0.078, 2.241±0.059, and 3.991±0.033 in Muscles, Liver, Gills, Kidney, and Gonad respectively. In *Clupisoma garua* are 2.958±0.084, 3.243±0.007, 3.054±0.001, 2.043±0.002, and 3.221±0.011 in Muscles, Liver, Gills, Kidney, and Gonad respectively.

DISCUSSIONS

Present study showed the lowest concentration of metals in muscle. The essential metals as Cu were accumulated mainly in liver and gonad, Zn accumulated mainly in Gills and Liver, Fe were accumulated in all organs with little bit fluctuation in concentration while Pb accumulated in gill, liver and gonad and Hg exhibited their highest concentrations in gonads.

The accumulation of metals in liver is probably linked to its role in metabolism [24]. high levels of Cu and Zn in hepatic tissues are usually related to a natural binding proteins such as metallothioneins[11] which act as an essential metal store as Zn and Cu to fulfil enzymatic and other metabolic demands [23] while Fe tends to accumulate in hepatic tissues due to the physiological role of the liver in blood cells and haemoglobin synthesis [11].On the other hand, the liver also showed high levels of non-essential metals such as Pb to displace the normally metallothioneins associated metals in hepatic tissues [2] .previous studies also show similar trends to accumulate high level of essential and non-essential metals in liver cells in fishes [24,07,03,12,06].

Presence of these metals in gills shows that gills are main route of metal ion exchange from water [21] as they have large surface area and facilitate rapid diffusion of toxic metals [05].Therefore it is suggested that metals accumulated in gills are mainly concentrated from water specially Pb and Zn, previous studies also show the similar things as [14,04,01,21,07] .

It is well known that muscles are not active site for metal biotransformation and accumulation [08] but in polluted aquatic habitats the concentration of metals in fish muscles may exceed the permissible limits for human consumption and imply severe health threats.

CONCLUSIONS

The concentration of metals in the present fish organs within the permissible limits given by WHO and FAO but in case of Hg and Pb these are higher than the limits. So health risk analysis of heavy metals in the edible part (muscle) of the fish indicated safe levels for human consumption and concentrations in the muscles are generally accepted by the international legislation limits however in some areas of this region people consume whole fish with all organs specially small size fishes and the ovary is consumed by many people's so study reveals that fishes found in this dam are not suitable for human consumption it may cause severe health threats.

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