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The Effects of Heavy Metals on the Fish Biodiversity in West Bengal

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Abstract: Heavy metals are naturally exist in very little amount in aquatic system. But now a days this amount are higher than previous time due to many activities. The main cause of the heavy metals amount increase is industrial waste product mixed with water system. Fish and others aquatic organisms absorb the pollutants directly from water and indirectly from food chains. This heavy metal can effect on geological, hydrological and also it effects fish population and growth. Secondarily it effects human through fish. Heavy metals are entered into fish bodies by gills, body surface and digestive track. The present study assessed heavy metals effect on fish biodiversity in west Bengal, India. This study also highlight actual level of heavy metals in industrial and non-industrial area in west Bengal.

Keywords: Heavy Metals, Contamination, Disease, Source.

1. **Introduction-** We know that air, light and water are natural resources. But water is one of the most valuable resource. Pollution is the main problem in the world wide and most important pollutants are the heavy metals in aquatic system. Heavy metals are dangerous for aquatic organisms and it can be transmitted in the food chain leading to disease in human. The source of heavy metal in aquatic system is industrial discharge contains. Discharge contains carry a huge amounts of toxic metals, which can affect the surrounding soils and water system. The toxic metals consist of different metals such as- cadmium (cd), zinc (Zn), chromium (cr) and lead (Pb). Heavy metal contamination may have serve effects on the ecological balance of environment and a diversity of aquatic organisms. This type of heavy metals effect on fish as an anemia, eosinophilia, branchial and renal lesions, fins damaged, behavioral changes. Air guzzling etc. the state of west Bengal covered with a coastal area. Coastal area of west Bengal can be considered as the geographic space of interaction between terrestrial and marine ecosystems. But coastal zone receive a large amount of heavy metals from agriculture and industrial area. So, this study aimed to determine the actual level of heavy metal in water system and some fish's tissues.

2. Materials and Methods

2.1 Description of the study area- this study covered industrial, non-industrial and agricultural area in west Bengal. West Bengal is a state of India, where different types of industrial area such as- thermal power station, Durgapur steel plant, fertilizer and cement industry present and also agriculture area- Burdwan, Murshidabad, Hooghly and Nadia districtsare present.

Hooghlyis the westernmost estuary of Gangetic delta that cover almost coastal area of west Bengal. Hooghly is an industrial hub where different types of industrial management such as paper, textiles, chemicals, plastics, leather, jute, pesticides etc. a huge amount of toxic and chemical substance released from this industrial area and mixed into the aquatic system.

Damodar River passes through the districts of burdwan. Now a days burdwan districts divided into two new districts. One is purbaburdwan and other is paschimburdwan. Purbaburdwan is covered with agriculture section and paschimburdwan is covered with industrial section such as- thermal plant, coal mine, coal washery, steel plant, Asansol industrial complex, Durgapur industrial complex.

2.2 Sample collection and analysis- Water samples were collected at regular intervals from different area. All samples were taken in wide mouth plastic bottles. For heavy metal analysis, the sample were fixed with 0.5ml of concentrated nitric acid in the field to prevent heavy metals precipitation and were digested with 3:1 mixture of concentrated HNO_3 and $HCLO_4$. Digested water filtered with whatman-

42 filter paper and analyzed for Lead (Pb), Cadmium (Cd), Chromium (Cr), Iron (Fe), Copper (Cu), and Nickel (Ni).

For species sample analysis in this study we collectthree different fish in different area. We highlight mainly three areas for this sample analysis- river Ganga, Damodar River, Murshidabad districts. Three fishes are- ***Channastriatus, Labeobata, and Barilus bola***. The fishes were collected to the laboratory in an ice box and kept in a deep freezer. Then the fishes washed with normal water and finally with distilled water. Then liver, intestine, gill, scale, dorsal and ventral, caudal muscle and whole body isolated from each experimental species to analyze heavy metal concentration.

Now samples were weighed and heated to make ash into a muffle furnace at 100,200,300,400 degree Celsius for one hour and at 500 degree Celsius for six to seven hours. The samples were cooled at room temperature and acidified by one: one HNO_3 and distilled water. Then heated again it 500^0c for one hour. After cooling the sample one: one HCL: distilled water added and heated in a hot plate until boiling. Then the samples were cooled and measured to 50 ml and filtered with a 100 s&s round filter. Then the samples were stored in a refrigerator at 4^0 Celsius. Heavy metal concentrations were measured using air acetylene flame with combination, as well as single element hollow cathode lamps into an atomic absorption spectrophotometer.

Fishes	**Organs**	**Lead (Pb) mg/kg**	**Chromium (Cr)mg/kg**	**Nickel (Ni) mg/kg**	**Cadmium (Cd) mg/kg**
Channastriata	**Liver**	325.6	253	187.3	73.6
Labeobata		378.7	14.9	33.4	12.2
Barilius bola		600.2	12.5	ND	10.3
Channastriata	**Intestine**	233.2	145.6	85.3	37.1
Labeobata		55.4	22.3	84.6	20.1
Barilius bola		862.4	25.9	102.1	6.7
Channastriata	**Gill**	315.7	76.3	42.6	ND
Labeobata		313.7	16.9	38.2	ND
Barilius bola		249.5	22.3	113.9	3.3
Channastriata	**Scale**	172.3	76.9	133.5	6.1
Labeobata		236	67.5	30	6.2
Barilius bola		189.5	ND	ND	ND
Channastriata	**Muscle (Dorsal)**	75.6	29.9	25	0.1
Labeobata		134.5	9.5	ND	1.7
Barilius bola		19.8	11.9	55.7	ND
Channastriata	**Muscle (Ventral)**	91.3	36.2	84.5	4.5
Labeobata		108.6	14.7	ND	ND
Barilius bola		18.7	37.8	0.3	4.2
Channastriata	**Muscle (Caudal)**	75.7	56	30	ND
Labeobata		133.8	22.2	ND	0.9
Barilius bola		163.7	51.8	33.2	3.2

Table 1-Heavy Metal concentration (mg/kg) in different organs of***Channastriata, Labeobata, Barilius bola of West Bengal.***

Lead (Pb) - Highest amount of lead present in ***Barilius bola*** intestine and lowest amount of lead present in *Barilus bola* ventral muscle. The amount of lead in three species liver is *Channastriata*325.6 mg/kg, *Labeobata 378*.7 mg/kg and *Barilius bola is 600.2 mg/kg* and 862.4 mg/kg lead present in barilius bola intestine. (Table 1 shows the all data of lead concentration in different tissue in different fishes).

2.2.1 Chromium (Cr) - The highest amount of chromium present in *Channastriata* liver, the amount is 253 mg/kg and lowest amount of chromium present in *Labeobata dorsal muscle, amount is 9.5* mg/kg. The amount of chromium in *channastriata*intestine is 145.6 mg/kg.Table 1 shows the all collected data of chromium concentration in different body parts in three fishes.

2.2.2 Nickel (Ni) - The maximum concentration of Ni was in *Channastriata* liver and minimum concentration of Ni was in *Barilius bola* ventral muscle. The maximum concentration is 187.3 mg/kg and minimum concentration is 0.3 mg/kg. The concentration of Ni in *Labeobata*intestine is 84.6 mg/kg. Table 1 shows the all collected data of Nickel concentration in different body parts in three fishes.

2.2.3 **Cadmium (Cd) -** The maximum concentration of cadmium was in *channastriata* 73.6 mg/kg and the minimum concentration of cadmium was in *channastriata* dorsal muscle 0.1 mg/kg. Table 1 shows all collected data of cadmium concentration in different body parts in three fishes- *Channastriata, Labeobata, and Barillius bola.*

The analysis of the heavy metal concentration highlight that the lead is high value present in other metal. The mean value of four heavy metal in liver is 158.47 mg/kg. Mean of heavy metal in intestine is 140.05 mg/kg and also mean of heavy metal in gill, scale, muscle is 99.365 mg/kg, 76.49 mg/kgand 37.08 mg/kg.

Organs	Lead (Pb)	Chromium (Cr)	Nickel (Ni)	Cadmium(Cd)	Mean of heavy metals
Liver	434.83	93.46	73.56	32.03	158.47
Intestine	383.66	64.6	90.66	21.3	140.05
Gill	292.96	38.5	64.9	1.1	99.365
Scale	199.26	48.13	54.5	4.1	76.49
Muscle	91.3	30	25.41	1.62	37.08

Table 2- Mean concentration of heavy metals (mg/kg) in different organs of fishes in west Bengal.

3. Result and Discussion- the effects of heavy metals can affect the individual growth rates, physiological function, and reproduction in fish. Heavy metals enter in the fish bodies through three ways. First is gills- gills are considered as the significant site for direct uptake of metals from the water and also heavy metals enters digestive track and body surface. Human intake protein substance from aquaculture and heavy metals also affect human life. Different diseases are created by the heavy metal in human life. Such as- skin diseases, liver and kidney damage, cancer, alteration in gametic material.

List of Heavy Metals	WHO (World Health Organization)	USEPA (United States Environment Protection Agency)	ISI (Indian Standard Institution)	CPCB (Central Pollution Control Board)	ICMR (Indian Council of Medical Research)
Iron (mg/l)	0.1	-	0.3	1.0	1.0
Cupper (mg/l)	1.0	1.3	0.05	1.5	1.5
Mercury (mg/l)	0.001	0.002	0.001	No Relaxation	0.001
Cadmium (mg/l)	0.005	0.005	0.01	No Relaxation	0.01
Arsenic	0.05	0.05	0.05	No Relaxation	0.05
Lead	0.05	-	0.10	No Relaxation	0.05
Zinc	5.0	-	5.0	15.0	0.10
Chromium	0.1	-	0.05	No Relaxation	-

Table-3 Permissible Limits of Heavy Metals in Water

Area details	Cd	Cr	Cu	Co	Fe	Ni	Pb	Zn
Berhampore	1-2	10-18	3-7	-	365-1744	41-84	8-21	65-95
Damodar River	ND-0.0013	-	0.00065-0.01249	-	-	-	0.0005-0.00651	0.00213-0.02632
Dakshineswar	ND-3	16-22	4-8	-	792-1413	35-44	5-97	42-83
Diamond Harbour	-	-	5-90	-	30-560	-	12-62	150-710
Gangasagar	-	-	2-90	-	40-320	-	11-38	30-520
Kolkata	-	-	1-49	-	90-420	-	17-76	20-280
Palta	ND-3	13-21	4-7	-	884-2345	35-53	5-15	68-111
Rishra - Konnagar	0.043-0.088	0.281-0.391	0.155-0.322	-	-	-	0.041-0.058	0.545-0.691
Uluberia	ND-3	13-24	3-6	-	353-1584	34-83	3-52	58-84

Table-4 Concentration of Different Heavy Metals in Different Area in West Bengal ($\mu g\ L^{-1}$)

3.1 Effects of chromium on fish- chromium effects on fish is highly dangerous for both human and aquatic system. Chromium in take in fish body from surrounding water or by ingestion of food in environment. Chromium effect on fish body like a poisonous effect. Anemia, eosinophilia and branchial and renal lesions problem can observe due to effect of chromium. Chromium also damages the gill of fish, when fish swimming near point of chromium disposal.

3.2 Effects of chromium on humans by fish intake-chromium is harmful for human life. Chromium is a leather products can causes skin rash like allergic reaction. Other health problems caused by chromium are faded immune system, skin diseases, ulcer, respiratory track problem, alteration in genetic material, lung cancer, liver and kidney damage and also death.

3.3 Effects of cadmium on fish-Cadmium is the non-essential and most toxic metal which is widely distributed in the aquatic environment. The source of heavy metals are municipal waste and burning of fossil fuels and it also enter into the fresh water by industrial and household waste. Due to

cadmium reproduction rate of aquatic organisms may be affected and fins disease, respiratory disease can observed.

3.4 Effects of cadmium in humans by intake of fish-cadmium are stored in the lipid component of the fish so this heavy metals are well protected when entering the human body. Due to the effect of cadmium different disease like kidney problem, diarrhea, stomach problems, fractures in bone, damage to DNA, cancer, nervous system failure, reproduction and fertility failure and damage of immune System Observed.

3.5 Effects of led in humans by intake of fish-lead toxicity has become very important due to its great concern for human health. 'Pb' damage the liver, kidneys, brain, nerves and other organs. Due to Pb reproductive disorders osteoporosis observe and also heart diseases, high blood pressure and anemia can observed. If toxic levels of lead increase then memory problems, behavioral disorders, mental retardation, resulting in lowered IQ and learning deficits can observed.

3.6 Effects of led on fish-lead enters in water system through industrial and sewage waste system. Due to Pb generative damage in aquatic fish and also blood and nervous problem can observe.

3.7 Effects of copper on fish-the use of copper to kill algae, fungi and Mollusca's demonstrates that is highly toxic for aquatic organisms. Copper is one of the most toxic metals to aquatic organisms and ecosystems. Fish are exposed to copper via their gills and the water and sediments in which they live as well as through the food chain. The effects of copper on aquatic organisms can be directly or indirectly lethal. Gill become frayed and lose their ability to regulate transport of salts such as sodium and potassium chloride into and out of fish. These salts are important for the normal functioning of the cardio vascular and nervous system. When the salt balance is disrupted between the body of a copper exposed fish and the surrounding water the death of the fish can result. Copper also effects on fish olfaction. Fish collect their food, migration and avoid predators, these type of function occur by olfaction.

Commercially importance fish species from west Bengal are very danger due to effects of heavy metal. They are- *Barilus bola, Puntiussarana, Catlacatla, Cirrhinusmrigala, C reba, Labeorohita, Labeocalbasu, Labeoboga, Labeoboggul, Labeodyocheilus, Wallagoatu, Mystusseenghala, Labeobata* in danger condition and their production level are low.

3.8 Effects of Zn on fish body-zinc toxicity may cause skeletal anomalies in fishes. Zinc also reduces DNA dependent RNA polymerase activity and also direct damage to the gill of fish. Zinc also effect on inhibition, reproductive failure.

3.9 Effects of Zn in Human by Intake of Fish-if human take Zn effected fish then human can attack nausea, vomiting, cramps and diarrhea. If long-term intake then increased levels of LDL and decreased levels of HDL (High Deficiency Lipoprotein) can observed.

4.Conclusion-Heavy metals like cadmium, nickel, zinc, chromium, lead were present in different organs like gill, intestine, dorsal and ventral muscle. Human also affected by eating fish and can cause a few health problem. Due to rapid industrialization a negative impact of heavy metals fish production do not grow rapidly. Lots of fish disease can show in this case. To eliminate and avoided the aquatic life loss there is need to use the advanced technologies generating less heavy metals pollution to environment. Recycling product or wasted product do not throw in aquatic system.

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