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INVESTIGATION OF HEAVY METALS DISTRIBUTION IN DIFFERENT TILOPIA FISH TISSUES FROM PECHIPARAI WATER RESERVIOR, KANYAKUMARI DISTRICT AND ASSESSMENT OF BIOACCUMULATION PATTERNING OF LEAD (PB) IN TILOPIA FISH

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Abstract

Environmental pollution is the unintentional alteration of the physical, chemical, and biological properties of the soil, water, and air that causes harm to living things. A heavy metal is defined as an element with an extremely high atomic weight and a density that is five times larger than that of water. Environmental chemists have concentrated their efforts most heavily on heavy metals because of their high level of toxicity, making them among the pollutants that are most harmful to the environment. Heavy metals are frequently present in trace amounts in natural streams, but many of them are toxic even at very low concentrations.The bioaccumulation of heavy metals endangers human health. Heavy metals such as mercury, lead, cadmium, cobalt, nickel, and others may prevent the growth of blood cells. The liver, kidneys, circulatory system, and transmission of nerve impulses can all suffer from heavy metal accumulation. Many malignancies may occur as a result of exposure to certain heavy metals. Calcium may be replaced by lead in the body, which can result in birth abnormalities and brain damage. Mercury is harmful to humans, especially when it takes the form of methylmercury. Heavy metals have a substantial impact on the generation of reactive oxygen species (ROS), which in aquatic animals eventually lead to tissue damage and the oxidation of biomolecules. To combat oxidative stress, aquatic creatures have antioxidant mechanisms. According to the seasonal evaluation of heavy metals (Cu, Cd, Pb and Zn) in different tissues (Head, Gills, Trunk and Intestine) of tilopia fishes collected from pechiparai water resorvior, Kanyakumari district showed the significance of heavy metals distribution at p-value > 0.05 level. Further, the out data of Pb estimation exhibited

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the prominent accumulation in intestine (16.1984 ppm Pb) among the other tissues and control groups. Hence it explained the philological probability of accumulation of lethal heavy metals in fish tissues significantly.

Keywords: Pechiparai water reservoir, Tilopia, Heavy metals (Lead, Copper, Cadmium and Zinc), Atomic adsorption spectrophotometry and Bioaccumulation.

Introduction

Environmental pollution is the unwanted change in physical, chemical and biological characteristics of air, water and soil, leading to harm to living organisms (Wong M.H., 2012). Definition of a heavy metal is the element which is having a high atomic weight and high density five times greater than that of water (Banfalvi G., 2011). Due to their high degree of toxicity, environmental chemists have focused their attention most intensely on heavy metals, which are among the contaminants that pose the greatest harm to the environment. Natural waterways often include minimal levels of heavy metals, but many of them are dangerous even at extremely low doses. (Herawati N., 2000). Metals that are very poisonous even in trace amounts include arsenic, lead, cadmium, nickel, mercury, chromium, cobalt, zinc, and selenium. A growing worry in environmental pollution is the quantity of heavy metals in our resources, especially in light of the numerous industrial activities that have led to the discharge of metal-containing effluents into fresh water without proper treatment (Salomons W., 1995). Heavy metals are released from natural sources through volcanic eruptions, sea-salt sprays, forest fires, rock weathering, biogenic sources and wind-borne soil particles, and can cause serious health problems to humans and other mammals (Herawati N., 2000). Heavy metals are released from anthropogenic processes such as industrialization, agriculture, wastewater treatment, mining and metallurgical processes, and runoffs (He Z.L,, 2005). The health of people is under peril from heavy metal bioaccumulation. Mercury, lead, cadmium, cobalt, nickel, and other heavy metals may interfere with the development of blood cells. Heavy metal buildup can cause problems with the liver, kidneys, circulatory system, and transmission of nerve impulses. Certain heavy metals may potentially contribute to the development of different cancers. Lead can replace calcium in the body, which can lead to brain damage and birth defects. Mercury, especially in the form of methylmercury, is dangerous for humans (Botkin, *et al*., 2002). In order to preserve human health and wellbeing, water is crucial. In many parts of the world when the supply of potable water is inconsistent or nonexistent, surface water is frequently used as an alternate source of drinking water. The most pervasive and plentiful material in nature is water. There are 1400 million billion litres of water in total, but the majority of it cannot be utilised for drinking since it is 97% sea water and just 3% fresh water, of which 2% is trapped in glaciers and polar ice caps, and the remaining 1% is not portable. In aquatic systems, heavy metals are regarded as the most harmful contaminants.They play a significant role in the development of reactive oxygen species (ROS), which eventually cause tissue damage and the oxidation of biomolecules in aquatic animals.Aquatic organisms possess antioxidant systems to cope with the oxidative stress(Ali, Hazrat& Khan, Ezzat. (2018).

Materials and Methodology

Study Area

The Pechiparai Dam, one of four dams of the Kodayar irrigation project, is located in the Kanyakumari District of Tamil Nadu. It was built between 1896 and 1906 for the Travancore Government during the rule of SrimoolamThirunaal Maharaja. The Pechipparai dam, the largest impoundment in the Kanyakumari district (Latitude 8o26'59.48" N, Longitude 77o18'26.84" E), has abundant native freshwater fish species in its streams (**Figure: 1**). The Pechiparai reservoir's morphometric and hydrodynamic characteristics include the length of the dam (1821 feet), the mean depth (32.5 feet), the catchment area (20719.9 hectares), the maximum water storage capacity (14200 million cubic feet), and the minimum water storage capacity (4350 million cubic feet).

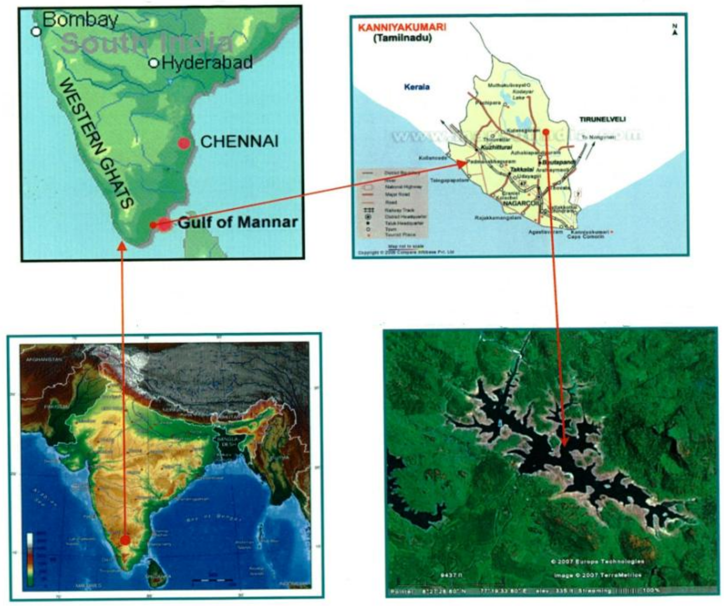

Figure: 1. Geographic Location of Pechiparai Water Reservior

Evaluation of Heavy metals and Biological parameters of Nile tilapia (*Oreochromisniloticus*)

The selected Nile tilapia (*Oreochromisniloticus*) were collected from Pechiparai dam and transferred to laboratory conditions for further heavy metal analysis. The collected fish samples were dissected to rip out the internal organs such as the trunk, gills, gut, and head. The dissected organs were washed with autoclaved distilled water and de-moisturized by oven drying at 105 °C for 24 hours. After drying, the samples were collected and weighted for analysis of the heavy metal accumulations (Cu, Cd, Pb, and Zn). The preparation of fish part samples were followed by (Perkin Elmer., 1996) and mixed with 5mL of HNO_3 (65%) and 5mL of H_2SO_4 in polypropylene vials. After 10 minutes of mixing, 1 mL of H_2O_2 was added, and samples were placed in a furnance for 1 hour at 1000 °C. After digestion, the residues were diluted to 25mL with HNO_3 (0.3%). The diluted content was filtered through grade 1 Whatman filter paper. And the filtrate was analysed for heavy metal accumulations. Target heavy metals such as Cu, Cd, Pb, and Zn were analysed using Atomic Absorption Spectrophotometry at a wavelength of 324.8nm for copper, 228.8nm for cadmium, 283.3nm for lead, and 213.9nm for zinc with the above mentioned parameters. The produced peaks were correlated with the standard curve and calculated the target metal concentration in ppm (parts per million).

Fish Collection and Acclimatization

The collected fishes were acclimatised for 3 days in light: the dark cycle was maintained at 12 h light: 12 h darkness, using fluorescent lights (334-376 Lux) in 150 L stocking tanks using dechlorinated tap water with an adequate filtration system (USEPA, 1999) and grouped into two main groups (Group) and further divided into 4 subgroups in each main group (Control, 0.23 gm/L Pb, 0.46 gm/L Pb and 0.69 gm/L Pb). The acclimatisation tubes were kept at the pechiparai environment's pH (6.8 to 7.2) and temperature (26-28°C). During acclimatization, the physical parameters such as pH, temperature, fish activities, and feed habit were monitored regularly.

Lead Bioaccumulation ExperimentalSetup

The experimental design was slightly modified using the methodology of Shams Tabrez*et al*., (2021). The grouped fish were segregated into individual plastic tubs with respective labels and were let stand for overnight. The next day, the selected heavy metal (Lead Pb) was introduced into the experimental tubs at an increasing concentration of 0.23, 0.46, and 0.69 g/L. Group. The experiment lasted 5 days, and the fish were fed 50 g of aquatic fish feed (Taiyo, Aini fish feed) in the mornings of the experimental days. During the experimental period, the water pH and temperature were monitored regularly.

Estimation of Lead (Pb) in experimental Tilopia fish samples

The selected Tilapia (*Oreochromisniloticus*) was collected from the experimental tubs labeled as group (Control and 0.69 g/L). The collected fish samples were dissected to rip out the internal organs such as Trunk, Gills and Gut. The dissected organs were washed with autoclaved distilled water and de-moisturized using Oven dry at 105 ºC for 24 hours. After dried, the samples were collected and weighted for analysis the lead accumulations. The dried fish samples were acid treated and prepared the fish part samples using the protocol described by Perkin Elmer., (1996). The diluted content was filtered through grade 1 whatman filter paper. And the filtrate was analyzed for heavy metal accumulations. Target heavy metals Lead (Pb) was analysed using Atomic Absorption Spectrophotometry at a wavelength of 283.3nm with the above mentioned parameters along with standard curve and calculated the target metal concentration in ppm (parts per million).

Results

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Estimation of Heavy Metals traces in Tilopia Fishes

The study tilopia fishes (*Oreochromisniloticus*) were periodically collected from pechiparai water reservoir on Pre-Monsoon, Monsoon and Post-Monsoon. The collected fishes were dissected and prepared for the estimation of heavy metals (Cu, Cd, Pb and Zn) using AAS. The processed samples were introduced into the sample holder of AAS instrument and measured the concentration of heavy metals at 324.8 (Cu), 228.8 (Cd), 283.3 (Pb) and 213.9 (Zn) nm respectively. **Table: 1 and Figure: 2**. Explained the average ranges of heavy metals measured in relevant fish samples and showed the maximum Cu in trunk (0.00739 ± 0.01ppm), Cd (0.022167 ± 0.00 ppm) in intestine, Pb (0.408867 ± 0.37ppm) was estimated in head while Zn abundant in head (0.787767 ± 1.35 ppm). One-way ANOVA in **Table: 2**. was showed the distribution of heavy metals in fish parts were significant at p-value > 0.05 level.

Table: 1. Average Distribution of Heavy Metals in Fish parts over Different Monsoon Seasons

Fish Parts	**Head**	**Gills**	**Trunk**	**Intestine**
	Concentration of Heavy Metals in ppm			
Copper (Cu)	0.0064 ± 0.00	0.006 ± 0.00	0.00739 ± 0.01	0.005133 ± 0.00
Cadmium (Cd)	0.015033 ± 0.00	0.0161 ± 0.01	0.015167 ± 0.00	0.022167 ± 0.00
Lead (Pb)	0.408867 ± 0.37	0.1967 ± 0.02	0.160833 ± 0.01	0.1442 ± 0.09
Zinc (Zn)	0.787767 ± 1.35	0.608267 ± 1.04	0.560867 ± 0.94	0.703767 ± 1.20

Table: 2. Summary Data of Heavy Metals Distribution by One-Way ANOVA

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	0.043492	3	0.014497	0.127915	0.940859	4.066181
Within Groups	0.906691	8	0.113336			
Total	0.950183	11				

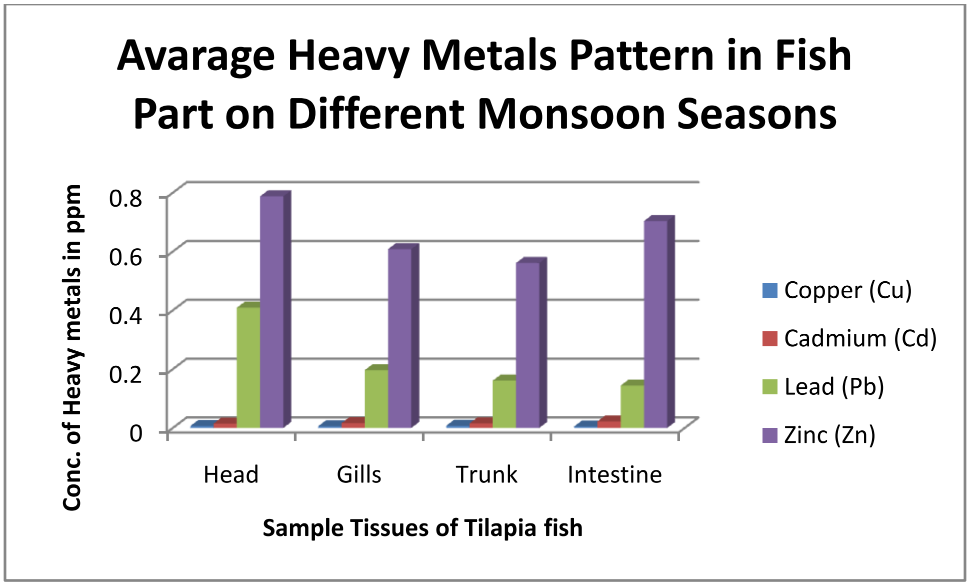

Figure: 2. Average Distribution of Heavy Metals in Fish parts over Different Monsoon Seasons

Estimation of Lead (Pb) in experimental Tilopia fish samples

The experimented fishes were further dissected to collect the blood and separate the internal organs like the trunk, gills, and gut. The dissected organs were washed thoroughly with sterile distilled water three times and subjected to digestion of the sample for the estimation of lead (Pb). The processed fish organs such as trunks, gills, and gut were later studied for the concentration of bioaccumulation of lead acetate into the study tissues using atomic absorption spectrophotometry at 283.3nm wavelength. In a 0.69 g/L Pb tub, the out data **Table: 3 and Figure: 3** of lead estimation revealed a significantly higher bioaccumulation trace of lead on gut (16.1984 ppm). While Gills (0.7452 ppm) and Trunk (0.6238 ppm) showed fair accrual of Pb compared with control group.

Table 3: Estimation of Lead (Pb) in Induced Fish (Tilopia) Tissues

Estimation of Lead (Pb) in Group				
S. No	**Sample**	Trunk	Gills	Gut
		Concentration in ppm		
1.	Control	0.6809	0.3740	0.5810
2.	0.69 g/L	0.6238	0.7452	16.1984

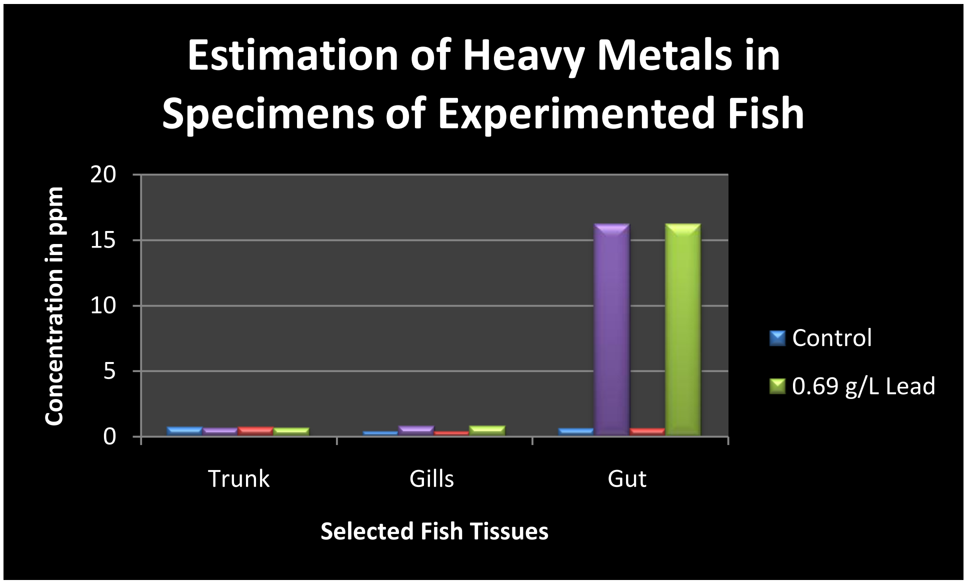

Figure: 3. Estimation of Lead (Pb) in Induced Fish (Tilopia) Tissues

Discussion

Khan, Anwarzeb, *et al*., (2015) have exposed the heavy metal pollution is a major hazard to human life, with fish organs having the highest levels of lead, cadmium, copper, and muscle. *P. fluvidraco* had higher accumulations than *C. carpio*. According to Bawuro*et al*., (2018) fish species and organs have different concentrations of heavy metals, with flesh having the lowest concentration and gills having a greater quantity of Cd. Metal interspecific variation was explored in relation to age, geographic distribution, and species-specific characteristics. Pb concentrations are above legal limits in Clarias and Tilapia, making them unsafe for human consumption and posing a threat to public health.Joystu D *et al*., (2017) found poisonous heavy metals in the monsoonal runoff from Kolkata, which may have an impact on seasonal variance.KH. M. El-Moselhy*et al*., (2014) described the concentrations of heavy metals in fourteen benthic and pelagic fish species collected from three important landing places in the Egyptian Red Sea were examined in the liver, gills, and muscles. Muscles had the lowest concentrations of all metals, while the liver had the highest ratios of Pb and Mn. Metal concentrations were in the same range as or lower than those found in related species.The levels of the heavy metal in the water were below the international acceptable threshold, according to studies done by Abdel-Baki*et al*., (2011).

Conclusion

According to the assessment of heavy metals distribution in tilopia fish parts during different monsoon seasons (Pre-monsoon, Monsoon and Post-monsoon), higher metal was found in Cu in trunk (0.00739 ± 0.01ppm), Cd (0.022167 ± 0.00 ppm) in intestine, Pb (0.408867 ± 0.37ppm) was estimated in head while Zn abundant in head (0.787767 ± 1.35 ppm) also showed the distribution of heavy metals in fish parts were significant at p-value > 0.05 level. After bioaccumulation experiment, lead (Pb) was estimated significantly higher bioaccumulation trace of lead on gut (16.1984 ppm). While Gills (0.7452 ppm) and Trunk (0.6238 ppm) showed fair accrual of Pb compared with control group.

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