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# Studies On Heavy Metals Contamination In Water, Sediment And Food Fish Channa Striata From Lake Kolleru, Andhra Pradesh

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## ABSTRACT

This study aimed principally to asses the contamination of heavy metals like Zn, Cu, Ni, Cd, and Pb are analysis in water, sediment and food fish Channa striata from the lake Kolleru. The study of contamination levels will be use full for environmental remediation and ecosystem restoration at contaminated sites and its provides a scientific data and protective measures for the lake.

The study aimed principally to access such contamination by examining the results of heavy metals Zn, Cu, Ni, Cd, and Pb analysis in water Sediment and food fish Channa. This study would allow identification of different accumulation metals as well as provides as assessment of the Magnitude of the metal contamination in the swamp environment.

## INTRODUCTION

Lakes are important source of fresh water and it represents additional storage capacity of hydrological systems. Artificial and natural changes in either quality or quantity of water may alter not only the stream flow regime but also the water balance of the region, affecting ecological balance in the region. Fresh water is an important need to the human being and is considered as the "elixir of life". It is consuming in the largest quantity throughout the world for drinking, irrigation, hydropower generation and aquaculture.

India is blessed with unparalleled resources of rivers, reservoirs, estuaries, lakes, ponds and flood wetlands. Natural waters are extremely varies in chemical composition and the factors controlling the composition include physical, chemical and biological processes. Fresh water has been more important to the humankind and other living organism of the environment for sustenance of life and maintaining the balance of the nature; hence "Rivers, lakes, ponds and reservoirs are the major components for the water resources". Fresh water represents a very small part of the total water on the earth.

Fishes are the valuable source of high grade protein and other organic products. They occupy significant position in socio economic fabrication of South Asian countries by providing nutritious food for population and also as an employment opportunity. Freshwater fishes provide valuable source of food supply to the inhabitants of countries located in tropical regions.

More than 10.86 million people are depended on these different water systems in India and their fisheries. From past decade, the weather in India has become less predictable due to climate change, so these situations make it important to store river water in the form of reservoirs.

Reservoirs ‘the man-made lakes’ are constructed with the aim of generation of electricity and water storage for purpose of irrigation. Along with that, these water bodies have tremendous potential for fisheries that in turn has several economic and social advantages.

The present study highlights the potential of reservoirs in India with reference to fish community and biodiversity perspectives for conservation as well as stock enhancement and management challenges and advocates for planning innovative strategies for sustaining river and reservoir fish biodiversity.

Murrels belongs to the family channidae can be recognized by the shape of head, which resembles that of snake hence termed as snake head. Murrels contribute important fresh water fishery in various parts of India and in great market demand because of their pleasant tasty flesh and presence of less number of bones/spines.

Contamination of heavy metals in the environment is a major global concern, because of toxicity and threat to the human life and ecosystem. The levels of metals in all environments, including air, water and soil are increasing in some cases to toxic levels, with contributions from wide variety of industrial and domestic sources. Metal contaminated environments pose serious threat to health and ecosystems.
Roane and Pepper (2000) have classified metals into three categories on the basis of their biological functions and effects: -

1. The essential metals with known biological functions [viz., Na, K, Mg, Ca, V, Mn, Fe, Co, Ni, Cu, Zn, Mo, and W]
2. The toxic metals [viz., Ag, Cd, Sn, An, Hg, Ti, Pb, Al] and metalloids [viz., Ge, As, Sb, and Se]

## MATERIALS AND METHODS

Samples of the present study were collected over a period of two years from the Kolleru lake including 3 Stations: Station 1 (Western Zone), Station 2 (Eastern Zone), Station 3 (Upputeru Drain). The data of fish length and weight are recorded. The gut contents were dissected and preserved 5% formalin. The content of each stomach was examined using binocular microscope. A weight of the stomach of the individual fish was recorded, based on the weight of the stomach and body weight of the fish. Gastro Somatic Index of individual fish was calculated using the following formula.

The data of fish length, weight were recorded. The gut content was dissected and preserved 5% formalin. The content of each stomach was examined using binocular microscope. A weight of the stomach of the individual fish was recorded, based on the fish body weight of the fish. Gastro Somatic index of individual fish was calculated using the following formula.

$$\text{Gastro Somatic index (GSI)} = \frac{\text{Weight of the Stomach}}{\text{Weight of the fish}} X\,100$$

Gut contents were analyzed both qualitatively and quantitatively (Hynes, 1950). The volume of food in each gut of fish was measured by Pillay, (1952) and various food items are identified.
The food content found in the stomach was divided into five groups.

1. Gorged : Stomach was heavy food
2. Full : Stomach was full with food
3. ½ Full : Stomach was ½ full and slightly distended
4. ¼ Full : Stomach was ¼ food
5. Empty : Stomach without food

Point's method: The degree of apparent fullness of the stomach was determined and points was assigned. Gorged (1.25), Full (1.00), ½ Full (0.50), ¼ Full (0.25), Empty (0.00).

## HEAVY METAL ANALYSIS

**Water:** For estimation of heavy metal in water, 500ml of water sample was filtered and was subjected to nitric acid digestion. For digestion, 5ml of 6 N HNO3 was added to 50 ml of the sample followed by heating to slow bill till the digestion was completed Which was indicated by a light colored clear solution. The digested sample was used for metal estimation using atomic Absorption spectrophotometer as per APHA (1992).

**Fish:** The edible part of muscle tissues and non-edible part and liver of the fishes were separated and washed with tap water followed by double distilled water, weighed and then oven dried to constant weight at 101ºC for 3 hours. The dried fish samples was crushed and powered in an agate mortar, and then stored in sample bottles at 30ºC further analysis. The dried muscle and liver tissue samples of a 2.5 ± 0.25 mg each fish was digested using microwave digestive system. After digestion, the residues ware filtered to 25 ml with 2.5% of HN03. Approximately 1 ml of concentrated HNO3 was added to the water samples to prevent microbial utilization of heavy metals. Suspended particulate matter in a water sample was separated by filtering through 0.45mm what man GF/c filter. The digested water, sediment and fish samples were assessed the Atomic Absorption Spectrometry (AAS).

### 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):

$$EDI = \frac{EF \times ED \times FIR \times Cf \times Cm}{WAB \times TA} \times 10^{-3}$$

EF = The exposure frequency 365 days/year.

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

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

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

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

WAB = Average body weight (bw) (average body weight to be 60kg).

TA = Is the average exposure of time for non carcinogens (It is equal to (EF×ED) 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

## Correlation among metal content in the water, sediment, muscle and liver of fish From June 2023 to May 2024

STATION - I

**Correlations**

| | | WATER | | | | | SEDIMENT | | | | | MUSLE | | | | | LIVER | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead |
| WATER | Zinc | 1 | | | | | | | | | | | | | | | | | | | |
| | Copper | .938** | 1 | | | | | | | | | | | | | | | | | | |
| | Nickel | .942** | .971** | 1 | | | | | | | | | | | | | | | | | |
| | Cadmium | .826** | .910** | .882** | 1 | | | | | | | | | | | | | | | | |
| | Lead | .950** | .914** | .946** | .876** | 1 | | | | | | | | | | | | | | | |
| SEDIMENT | Zinc | .963** | .956** | .950** | .870** | .943** | 1 | | | | | | | | | | | | | | |
| | Copper | .951** | .953** | .911** | .840** | .852** | .943** | 1 | | | | | | | | | | | | | |
| | Nickel | .949** | .910** | .955** | .794** | .930** | .959** | .896** | 1 | | | | | | | | | | | | |
| | Cadmium | .729** | .620* | .536 | .402 | .527 | .634* | .734** | .589* | 1 | | | | | | | | | | | |
| | Lead | .923** | .785** | .815** | .681* | .832** | .884** | .855** | .909** | .744** | 1 | | | | | | | | | | |
| MUSLE | Zinc | .928** | .907** | .912** | .752** | .834** | .944** | .930** | .946** | .710** | .921** | 1 | | | | | | | | | |
| | Copper | .893** | .837** | .851** | .636* | .796** | .885** | .844** | .903** | .774** | .919** | .964** | 1 | | | | | | | | |
| | Nickel | .955** | .910** | .957** | .799** | .939** | .969** | .895** | .994** | .583* | .916** | .953** | .911** | 1 | | | | | | | |
| | Cadmium | .835** | .924** | .956** | .798** | .871** | .895** | .812** | .900** | .406 | .685* | .861** | .813** | .904** | 1 | | | | | | |
| | Lead | .927** | .839** | .873** | .688* | .819** | .838** | .883** | .875** | .727** | .912** | .906** | .897** | .884** | .752** | 1 | | | | | |
| LIVER | Zinc | .914** | .930** | .975** | .860** | .933** | .948** | .865** | .956** | .481 | .846** | .923** | .876** | .968** | .948** | .859** | 1 | | | | |
| | Copper | .934** | .845** | .864** | .711** | .879** | .940** | .859** | .933** | .700* | .954** | .950** | .954** | .953** | .803** | .872** | .901** | 1 | | | |
| | Nickel | .957** | .951** | .977** | .856** | .932** | .973** | .925** | .962** | .601* | .889** | .961** | .911** | .977** | .922** | .904** | .982** | .931** | 1 | | |
| | Cadmium | .800** | .669* | .705* | .430 | .665* | .778** | .743** | .792** | .757** | .883** | .877** | .929** | .818** | .656* | .839** | .746** | .895** | .809** | 1 | |
| | Lead | .949** | .972** | .990** | .876** | .935** | .959** | .920** | .957** | .594* | .848** | .945** | .896** | .962** | .945** | .891** | .976** | .900** | .987** | .743** | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

## Correlation among metal content in the water, sediment, muscle and liver of fish From June 2023 to May 2024

STATION – II

**Correlations**

| | | water | | | | | sediment | | | | | muscle | | | | | liver | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead |
| Water | Zinc | 1 | | | | | | | | | | | | | | | | | | | |
| | Copper | .930** | 1 | | | | | | | | | | | | | | | | | | |
| | Nickel | .960** | .979** | 1 | | | | | | | | | | | | | | | | | |
| | Cadmium | .869** | .932** | .901** | 1 | | | | | | | | | | | | | | | | |
| | Lead | .932** | .871** | .881** | .819** | 1 | | | | | | | | | | | | | | | |
| sediment | Zinc | .957** | .891** | .942** | .806** | .879** | 1 | | | | | | | | | | | | | | |
| | Copper | .944** | .879** | .910** | .831** | .834** | .961** | 1 | | | | | | | | | | | | | |
| | Nickel | .943** | .916** | .958** | .857** | .915** | .930** | .883** | 1 | | | | | | | | | | | | |
| | Cadmium | .844** | .710** | .778** | .675* | .846** | .898** | .846** | .857** | 1 | | | | | | | | | | | |
| | Lead | .834** | .715** | .770** | .669* | .841** | .850** | .789** | .857** | .971** | 1 | | | | | | | | | | |
| muscle | Zinc | .917** | .865** | .918** | .721** | .840** | .961** | .914** | .928** | .886** | .871** | 1 | | | | | | | | | |
| | Copper | .934** | .806** | .887** | .753** | .829** | .952** | .924** | .920** | .872** | .829** | .927** | 1 | | | | | | | | |
| | Nickel | .940** | .919** | .964** | .816** | .881** | .912** | .853** | .972** | .786** | .812** | .921** | .898** | 1 | | | | | | | |
| | Cadmium | .723** | .678* | .772** | .533 | .579* | .773** | .756** | .809** | .640* | .602* | .840** | .818** | .798** | 1 | | | | | | |
| | Lead | .955** | .893** | .953** | .779** | .856** | .969** | .935** | .943** | .846** | .833** | .957** | .935** | .960** | .836** | 1 | | | | | |
| liver | Zinc | .773** | .705* | .769** | .542 | .820** | .840** | .704* | .836** | .821** | .824** | .874** | .803** | .852** | .644* | .830** | 1 | | | | |
| | Copper | .924** | .862** | .931** | .747** | .844** | .971** | .917** | .952** | .901** | .874** | .989** | .950** | .935** | .867** | .970** | .864** | 1 | | | |
| | Nickel | .921** | .903** | .954** | .794** | .846** | .941** | .880** | .976** | .850** | .854** | .968** | .918** | .964** | .864** | .959** | .845** | .981** | 1 | | |
| | Cadmium | .612* | .457 | .542 | .282 | .649* | .705* | .585* | .674* | .739** | .729** | .756** | .720** | .658* | .631* | .692* | .880** | .742** | .708* | 1 | |
| | Lead | .970** | .975** | .988** | .898** | .872** | .937** | .920** | .931** | .750** | .749** | .897** | .881** | .951** | .740** | .954** | .736** | .905** | .928** | .535 | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**Correlation among metal content in the water, sediment, muscle and liver of fish From June 2023 to May 2024**

STATION-III

| Correlations | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WATER | | | | | SEDIMENT | | | | | MUSCLE | | | | | LIVER | | | | |
| | | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead | Zinc | Copper | Nickel | Cadmium | Lead |
| WATER | Zinc | 1 | | | | | | | | | | | | | | | | | | | |
| | Copper | .946** | 1 | | | | | | | | | | | | | | | | | | |
| | Nickel | .917** | .918** | 1 | | | | | | | | | | | | | | | | | |
| | Cadmium | .909** | .963** | .901** | 1 | | | | | | | | | | | | | | | | |
| | Lead | .946** | .953** | .943** | .942** | 1 | | | | | | | | | | | | | | | |
| SEDIMENT | Zinc | .897** | .937** | .914** | .974** | .929** | 1 | | | | | | | | | | | | | | |
| | Copper | .895** | .880** | .865** | .870** | .831** | .914** | 1 | | | | | | | | | | | | | |
| | Nickel | .939** | .913** | .946** | .940** | .931** | .939** | .909** | 1 | | | | | | | | | | | | |
| | Cadmium | .710** | .629* | .701* | .657* | .707* | .744** | .824** | .750** | 1 | | | | | | | | | | | |
| | Lead | .841** | .760** | .853** | .808** | .840** | .836** | .857** | .928** | .896** | 1 | | | | | | | | | | |
| MUSCLE | Zinc | .920** | .948** | .922** | .937** | .919** | .968** | .963** | .943** | .761** | .841** | 1 | | | | | | | | | |
| | Copper | .854** | .837** | .895** | .834** | .805** | .884** | .941** | .936** | .786** | .891** | .932** | 1 | | | | | | | | |
| | Nickel | .926** | .947** | .943** | .938** | .908** | .940** | .941** | .964** | .726** | .856** | .970** | .949** | 1 | | | | | | | |
| | Cadmium | .786** | .751** | .846** | .710** | .735** | .750** | .762** | .836** | .598* | .736** | .803** | .892** | .874** | 1 | | | | | | |
| | Lead | .913** | .851** | .938** | .839** | .895** | .873** | .871** | .960** | .743** | .901** | .914** | .938** | .926** | .907** | 1 | | | | | |
| LIVER | Zinc | .743** | .810** | .788** | .780** | .717** | .837** | .907** | .820** | .675* | .723** | .921** | .929** | .903** | .815** | .823** | 1 | | | | |
| | Copper | .951** | .910** | .948** | .915** | .917** | .941** | .958** | .972** | .806** | .915** | .961** | .943** | .970** | .840** | .947** | .845** | 1 | | | |
| | Nickel | .913** | .860** | .951** | .853** | .892** | .888** | .902** | .961** | .790** | .914** | .925** | .952** | .954** | .922** | .984** | .843** | .972** | 1 | | |
| | Cadmium | .668* | .598* | .735** | .552 | .616* | .583* | .642* | .756** | .547 | .708** | .674* | .823** | .753** | .933** | .864** | .726** | .717** | .848** | 1 | |
| | Lead | .865** | .893** | .889** | .921** | .859** | .963** | .964** | .935** | .782** | .847** | .977** | .946** | .956** | .796** | .889** | .924** | .944** | .911** | .680* | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

## Risk assessment

The Target Hazard Quotient (THQ) estimated for the individual heavy metals through consumption of fish. The results showed that fishes are accumulated the highest concentration of Zinc, demonstrating that this species could be valuable as bio-indicator in environmental survey.

**THQ values of Fish *Channa striata* from 2023-2024**

| S. No. | Heavy Metals | Station-I | Station-II | Station-III |
|---|---|---|---|---|
| 1 | Zinc (Zn) | 5.27±0.6 | 4.9± 0.4 | 5.3 ±0.5 |
| 2 | Copper (Cu) | 2.4± 0.05 | 2.47± 0.07 | 2.5± 0.08 |
| 3 | Nickel(Ni) | 1.1± 0.0 | 1.12± 0.048 | 1.1± 0.045 |
| 4 | Cadmium (Cd) | 0.3± 0.03 | 0.3± 0.07 | 0.31± 0.05 |
| 5 | Lead (Pb) | 1.07± 0.028 | 1.09± 0.024 | 1.1± 0.026 |

## CONCLUSION

Heavy metals and other toxic compounds from industrial effluents are noted for their high potency for high level disorders. Deposition of such harmful industrial products, wastes and contaminants into the lakes possess serious problems to the environment.

The seasonal variation of heavy metals in water and selected food fishes of Channa straiata in the three stations in the lake Kolleru was investigated in the present study. The concentration of heavy metal in the organisms in relation to those in sediment and tropic level was also studied to assess the ecological risk.

Seasonal variations play an important role in accelerating the distribution dissolved metals in lake Kolleru. Metals like Zn, Cu, Ni, Cd and Pb received by the lake water, varied seasonally with minimum distribution occurring in the monsoon months and maximum in summer months. This minimum most likely reflects on the reduced input of these metals from non-point sources together with effluents from industrial flow and maximum concentration due to the VTPS and other anthropogenic activities. The concentration of metals, Zn was higher followed by Cu, Ni, Pb and Cd. The metal concentration in Kolleru lake at VTPs region might be due to the presence of industrial effluents from different sources (Already mentioned in Previous slide).

Based on the results obtained regarding levels of metals in fish Channa striata, variations in metals like Zn, Cu, Ni, Cd and Pb in the muscle and liver. Among the tissues liver goes highest record compare with muscle. The concentration of metal in the specific tissues can give possible evidence of environmental pollution by specific metals at given site of study area.

The levels of various metals in fish tissues goes Zn is highest concentration in both muscle and liver. Followed by Cu, Ni, Pb and Cd. Cadmium is the lowest concentration recorded in both muscle and liver in the case of Channa striata. Cadmium levels have been found to be minimum in fish tissue, but it is toxic even at very low concentration.

Fish is the most important food sources and intake of heavy metal from, capture fishery, especially toxic elements, are great concern for human health THQ values for the present study higher than 1 in case of Zn where as Cu, Ni, Pb and Cd are below 1.

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