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Original Research Paper

Zoology

# Heavy metals in sailfish *Istiophorus platypterus* from Visakhapatnam fishing harbour, East Coast of India

**John Kiran P*** *Corresponding Author

**Annapurna Y**

**Sree Ramulu K.**

**ABSTRACT** The current study has been carried out to determine the accumulation of heavy metals (iron, copper, zinc, cadmium and lead) in the fish sample *Istiophorus platypterus* collected from the Visakhapatnam fishing harbour, east coast of India. The heavy metals in the fish sample were predicted using Flame Atomic Absorption Spectrophotometer. Heavy metal concentration varied significantly depending upon the environmental factors. The distribution of heavy metals were in the order of magnitude was Iron > Zinc > copper > lead > cadmium. In general, determined metal concentrations were within the range or below the levels in similar species from comprehensive studies. The concentration of metals in the present study were within the limits of the international legislation and are safe for human consumption.

**KEYWORDS** : Heavy metals, pollutants, Bioaccumulation, *Istiophorus platypterus.*

## Introduction

Pollution of the aquatic environment and its effects on the living resources, particularly the fishery resources, has unspecified substantial interest as well as significance in the recent times. Pollution from metals is a imperative problem affecting the estuaries and inshore regions **[1]**. Marine pollution is a universal environmental problem. Different human activities on land, water and air contribute to the contamination of seawater, sediments and organisms with potentially toxic substances. After emancipated into the sea, contaminants can stay in the water in dissolved form or they can be removed from the water column through sedimentation to the bottom sediments **[2]**. Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bio-accumulate in aquatic **[3]**.

Metals from anthropogenic and natural sources are there in aquatic ecosystems **[4]**, so it is possible that organisms absorb them *via* the body surface, food, and respiratory tissue such as gills or mouth after absorption, metals are transported through the blood and accumulated in various tissues or organs **[5, 6]**. As a result, metals may be relocated through the food web resulting in increased concentrations among trophic levels; in other words, biomagnification might occur **[7]**. Eventually, a risk to the health of marine life would be **[8].**

The predatory sailfish, *Istiophorus platypterus*, situated at the top of the marine food web, is predominantly exposed to moderately high concentrations of **[9, 10]**. Metal exposition can be influenced by the migratory pattern of *I. platypterus* that enhances contact with the waters of various places because of periodic latitudinal massive movements, parallel to the coast with trans-boundary crossing ranging from 12 to 20 days in each place **[11, 12]**. *I. platypterus* is considered as a mono stock population in the Eastern Pacific Ocean **[13, 14]** which have finest temperatures that favor the reproduction and feeding of this fish **[15]**. This predator has a elevated metabolic rate and tends to intake a huge variety of crustaceans, fish, and cephalopods **[16, 17]**. Therefore, the uptake metals can be directly prejudiced by the adjoining water and consumed organisms **[18]**.

Particularly aquatic systems are extra sensitive to heavy metal pollutants and the gradual augment in the levels of such metals in aquatic environment, mainly due to anthropogenic sources, became a problem of principal concern **[19]**. This is due to their perseverance as they are not usually eliminated either by biodegradation or by chemical means, in contrast to most organic pollutants. Moreover, the decay of organic material in aquatic systems together with detritus formed by natural weathering processes and unrestrained mining activities provides a rich source of nutrients in both the bottom sediments and overlying water body **[20, 21]**.

Heavy metals such as iron, copper and zinc are essential metals since they play an important role in biological systems. Whereas cadmium and lead are non-essential metals, as they are toxic, even in trace amounts **[22]**. For the normal metabolism of the fish, the essential metals must be taken up from water, food or sediment **[23]**. These indispensable metals can also produce toxic effects when the metal intake is excessively elevated **[24]**. Hence, it is important to ascertain the levels of heavy metals in these organisms to evaluate whether the concentration is within the permissible level and will not cause any hazard to the consumers **[25]**.The objective of this study was to determine the contamination levels and bioaccumulation of these heavy metals *viz*., iron, copper, zinc, cadmium and lead given *Istiophorus platypterus* from the Visakhapatnam fishing harbor, east coast of India.

## Material and methods

*Istiophorus platypterus* (sailfish) muscle samples were taken from fish landing centers in Visakhapatnam harbor from April 2016 to March 2017 at a frequency of twice per week. Approximately 20 grams of muscle tissue below the dorsal fin was taken by dissecting from the flank area and straddling the lateral line of the fish. The muscle sample was weighed on an electronic balance in pre-weighed petri dishes. This known weight of muscle sample was dried in hot air oven at 80$^{\circ}$c for overnight. Three grams of fully dried muscle sample is weighed on an electronic balance and is transferred into a round bottom flask. 7ml of concentrated Nitric acid ($HNO_3$) and 3 ml of Hydrogen peroxide ($H_2O_2$) (Merck, Darmstradt, Germany) is added in the ratio of 7:3 (v/v) to the sample. Sample digestion was done by using microwave digester (Ethos plus High Performance Microwave Labstation, Milestone, USA). The microwave parameters were 800 W power for 45 min (15 min temperature increasing, 15 min temperature holding and 15 min ventilation). The digested sample was made upto 100ml with double distilled water and analysed by using Atomic Absorption Spectrophotometer (GBC 932AA, GBC Scientific Instruments, Australia) following the AOAC method **[26]**.

Statistical analyses were done in triplicate and the means were compared using Analysis of Variance (ANOVA). ANOVA was carried out for monthly wise and seasonal wise data comparison. This statistical analysis and box charts were done by using Originpro 8. The level of significance was fixed at 5%.

## Results

Of the five metals studied in the current work, copper, zinc, iron are essential elements while cadmium and lead were non-essential elements for most of the living organisms (Trieff, 1980).The distribution of heavy metals were in the order of magnitude was Iron > Zinc > copper > lead > cadmium (graph 1). In monthly wise (table 1), iron content found more in the month of September (19.54±0.05) followed by February (18.67±0.04) and October (17.78±0.11), the least iron concentration was observed in the month of July (8.52±0.05). In seasonal wise, the overall mean metal concentration of iron was found more in post-monsoon (15.06±1.38) season followed by monsoon (14.35±2.58) season and pre-monsoon (13.80±0.91) season (table 2). A significant difference ($p<0.05$) was noticed between the months and no significance ($p>0.05$) was found in between the seasons.

Copper concentration was observed high in the month of February (2.85±0.04) followed by October (2.73±0.14) and July (2.55±0.04) and this metal content accumulated very low in the month of August (0.82±0.05) in monthly wise observation (table 1). Seasonally, the mean metal concentration of copper accumulated more in post-monsoon (1.97±0.37) season and less concentration found in pre-monsoon (1.43±0.27) season (table 2) respectively. A significant values ($p<0.05$) were found in between the months and seasons. The metal zinc concentration accumulated more in the month of February (10.26±0.04) followed by October (8.68±0.06) and January (8.67±0.07) and this metal zinc observed less in the month of September (4.40±0.04) in a monthly wise observation (table 1). In seasonal wise manner, this metal zinc found more concentration in post-monsoon (8.42±0.75) season followed by pre-monsoon (6.80±0.61) season and monsoon (5.71±1.01) season (table 2). The overall mean accumulation of zinc was 6.98 ppm. No significance ($p>0.05$) was observed in between the seasons and a significant values ($p<0.05$) were found in between the months.

In seasonal wise observation, Cadmium concentration found more in pre-monsoon (0.20±0.02) season followed by monsoon (0.14±0.05) season and post-monsoon (0.11±0.02) season (table 2). In monthly wise observation, cadmium was accumulated more in the month of September (0.30±0.03) followed by March (0.25±0.02) and June (0.21±0.01) which has shown in table 1 respectively. A significant difference ($p<0.05$) was found in between the months and no significance ($p>0.05$) was observed in between the seasons. The heavy metal lead concentration found more in the month of February (1.65±0.03) followed by June (1.61±0.13) and November (1.43±0.04) which had shown in table 1. Seasonal wise mean metal concentration of lead accumulated more in post-monsoon (1.32±0.16) season followed by monsoon (1.14±0.13) season and pre-monsoon (1.00±0.29) season (table 2) respectively. A significant values ($p<0.05$) were observed between the months and seasons.

**Graph 1. overall mean metal accumulation in *Istiophorus platypterus***

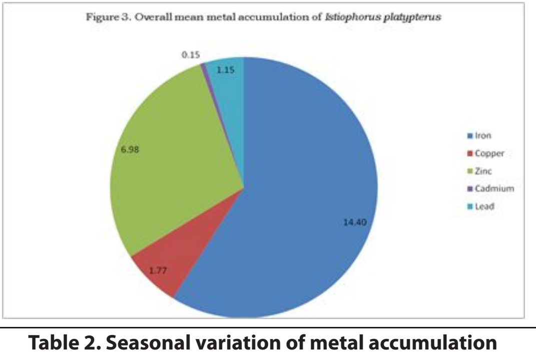


**Table 2. Seasonal variation of metal accumulation**

| | Pre-monsoon | Monsoon | Post-monsoon |
|---|---|---|---|
| Iron | 13.80±0.91 | 14.35±2.58 | 15.06±1.38 |
| Copper | 1.43±0.27 | 1.90±0.45 | 1.97±0.37 |
| Zinc | 6.80±0.61 | 5.71±1.01 | 8.42±0.75 |
| Cadmium | 0.20±0.02 | 0.14±0.05 | 0.11±0.02 |
| Lead | 1.00±0.29 | 1.14±0.13 | 1.32±0.16 |

**Table 1. Monthly observation of metal accumulation in *Istiophorus platypterus***

| | Fe | Cu | Zn | Cd | Pb |
|---|---|---|---|---|---|
| Mar | 14.45±0.13 | 1.50±0.11 | 7.37±0.06 | 0.25±0.02 | 0.85±0.02 |
| Apr | 11.50±0.07 | 0.85±0.04 | 5.33±0.11 | 0.20±0.02 | 0.26±0.05 |
| May | 15.86±0.04 | 1.19±0.09 | 8.18±0.11 | 0.12±0.02 | 1.26±0.05 |
| Jun | 13.37±0.06 | 2.16±0.05 | 6.33±0.11 | 0.21±0.01 | 1.61±0.13 |
| Jul | 8.52±0.05 | 2.55±0.04 | 4.40±0.14 | 0.06±0.01 | 0.89±0.04 |
| Aug | 11.57±0.07 | 0.82±0.05 | 5.34±0.06 | 0.14±0.01 | 1.41±0.10 |
| Sep | 19.54±0.05 | 1.49±0.07 | 4.40±0.04 | 0.30±0.03 | 1.32±0.11 |
| Oct | 17.78±0.11 | 2.73±0.14 | 8.68±0.06 | 0.04±0.01 | 0.92±0.03 |
| Nov | 13.44±0.06 | 1.27±0.05 | 6.61±0.07 | 0.08±0.01 | 1.43±0.04 |
| Dec | 15.70±0.07 | 2.32±0.08 | 8.15±0.06 | 0.11±0.04 | 0.85±0.06 |
| Jan | 12.43±0.07 | 1.42±0.10 | 8.67±0.07 | 0.17±0.04 | 1.36±0.05 |
| Feb | 18.67±0.04 | 2.85±0.04 | 10.26±0.0 | 0.06±0.01 | 1.65±0.03 |

## Discussion

In the present study it has been observed that the lowest concentration of metals in muscle of I.P. The essential metals iron, copper and zinc were accumulated in more quantity while cadmium and lead were accumulated in minimal levels in *Istiophorus platypterus*. Indispensable metals are usually regulated by metabolic processes in the body, so in many cases they do not correlate with length or weight **[27, 28]**. The concentrations of heavy metals found in the edible part of *I. platypterus*, were compared with national and international standards. It was found that about 28 % of the *I. platypterus* samples demonstrated concentrations of cadmium higher than the Mexican permissible limit **[29, 30, 31, 32]**, and more than 40 % were higher than the European Union limits **[33]**. In the case of lead and copper, none of the muscle samples reached the limits recognized **[34]**.

Iron is considered as indispensable metal because of its biochemical and physiological role in blood cells and hemoglobin synthesis and cofactor of many enzymes **[35, 36]**. However, more amount of iron above the physiological level in living organisms may show in iron overload **[37]**. However in other studies the highest accumulation was observed in *O. niloticus, L. niloticus* **[38]** *O. mossambicus* **[39]**. Accumulation levels reported in this study substantiated to the findings in *O. niloticus* and *L. niloticus* **[40]**. The copper concentrations in marine food also tend to be eminent, in comparison to other aquatic species, because they contain haemocyanin, a copper-containing protein that functions as an oxygen-transport **[41]**. As copper is a vital part of many enzymes and necessary for the synthesis of haemoglobin, most marine organisms have evolved mechanisms to regulate concentrations of this metal in their tissues. High concentration of copper was in the month of February (2.85±0.04 µg/g). The level of copper in I.P was within the permissible limits. The copper contents in the samples were much less than the FAO-permitted level of 30 µg/g **[42]**. Excessive intake of copper may lead to liver cirrhosis, dermatitis and neurological disorders **[43]**. Seafoods are good source of dietary copper, which is an essential element available to humans **[44]**. However, copper is very toxic when consumed excessively, and the presence of copper in seafood was limited **[42]** for fish and fishery products to 30 mg/kg. In the present study, the mean values of copper were in between 0.82±0.05 and 2.85±0.04 which was relatively similar with **[45]**.

Fish can accumulate zinc from both the surrounding water and from their diet **[46]**. Although zinc is an essential element, at high concentrations, it can be toxic to fish, cause mortality, growth retardation and reproductive impairment **[47]**. Zinc is capable of interacting with other elements and producing antagonistic, additive or synergistic effects **[48, 49]**. Fish can accumulate zinc from the surrounding water and diet. Although zinc is an essential element at high concentration it is toxic to fish, causes mortality, retardation in growth and reproductive impairment occurs **[50]**. Cadmium is accumulated primarily in major organ tissues of fish rather than in muscles and flesh **[51]**. This was the case in the present study as cadmium in flesh shows the least level. Cadmium is a nonessential metal that is potentially toxic to most fish and wildlife, particularly marine fish organisms. Cadmium injures kidneys and cause symptoms of chronic toxicity, including impairment of kidney function, poor reproductive capacity, hypertension, tumours and hepatic dysfunction **[52]**. Although Cd is a toxic element that would deposit in human body and is danger to human health **[53]**. In the present study, the highest value of cadmium was documented from 0.04±0.01 and 0.30±0.03 µg/g and the total mean concentration of cadmium accumulated in Istiophorus platypterus was 0.15 µg/g, it was below the permissible limit. These values detected did not exceed the NCBP concentration of 2.1µg/g threshold considered harmful to fish and predators **[54, 55]**.

Lead is one of the most ubiquitous metals with no known biological function in humans and it is detectable in all phases of the inert environment and biological systems **[56]**. In addition, lead has been reported to cause neurotoxicity in humans **[57]**, nephrotoxicity, hepatotoxicity and many others adverse health effects **[58]**.The present study provides evidence of lead biomagnification as has been reported previously in the Gulf of California region in other trophic nets **[59]**.Guidelines were established by different countries to serve as a reference of the levels of certain elements (Cu, Zn, Fe, Cd and Pb) in fishery products for trading purposes and for protecting human health.

## Conclusion

The concentrations of heavy metals in the fish samples were quite normal. However, more concentrations of some heavy metals determined in the fish edible part inhabiting that the catchment were related to a high influx of metals, as a result of pollution from the dredged mined out, thereby increased bioavailability to the fish. Health risk analysis of heavy metals in the edible parts of the fish indicated safe levels for human consumption and concentrations in the muscles are generally accepted by the international legislation limits. Accumulation of cadmium and lead in edible part of *Istiophorus platypterus* may be considered as an significant warning signal for fish health and human consumption. Although levels of heavy metals were not elevated, a probable threat may emerge in the future based on the industrial waste waters and domestic activities in this area.

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