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Analysis of accumulation of heavy metals (Copper, Zinc, Iron, Cadmium and Lead) in *Polynemus tetradactylus*, environment pollution from east Godavari district-Andhra Pradesh, India.

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ABSTRACT

Accumulation of heavy metals in *Polynemus tetradactylus* is an indication of pollution in aquatic ecosystem due to anthropogenic activities. The order of metal magnification was Fe>Zn>Cu>Cd>Pb, whereas the total mean metal concentration of heavy metals *viz*., copper, zinc, iron, cadmium and lead were recorded as 9.96±0.10; 42.50±0.58; 76.24±1.04; 0.31±0.05 and 0.14±0.05 ppm and all the values were found in permissible levels except cadmium as per European standards. No significance ($p > 0.05$) was observed in between the species. The levels of Cu, Zn, Fe, Cd and Pb may cause health issues to the rural communities that depend on fish meal as fish supplement in view of its rich protein content.

Keywords: Accumulation of Heavy metals; *Polynemus tetradactylus*; Environment pollution

INTRODUCTION

Pallamkurru is the place on the banks of river Godavari, which flows eastward through the state of Andhra Pradesh and joins the Bay of Bengal. The river forms an estuary which is a source of livelihood for the rural fisherman folk in that area. This major source in recent times has been prone to pollution due to various anthropogenic activities, thus affecting the health of fishes.

Fish is an important source of food for humans and is a key component in many natural food webs. Fish is one of the sources of biologically valuable protein, fats and fat-soluble vitamins (Belitz and Grosch, 1987). The high-quality protein of fish is good for health than meat and poultry. Fish consists of 15-24% proteins; 1-3% carbohydrates; 0.1-22% lipids; 0.8-2% inorganic substances and 66-84% water (Suzuki, 1981). These are important for human health, growth and intelligence.

Seafood is significant in human nutrition because of its unique nutritive value due to the presence of proteins, fats, vitamins and minerals (Rao *et al*., 2016).

Toxicity of zinc, copper and cadmium (Molahoseini, 2014; Khan *et al.,* 2013) in the aquatic environment increases the risk of entering in to the living systems directly or indirectly, causing serious health issues (Guan *et al.,* 2014; Chen *et al.,* 2016). Long term zinc, copper and cadmium exposure leads to health problems such as physiological problems in blood production and liver malfunction.

Fish easily absorbs pollutants from water and then deposit them in the tissue through bio-concentration, bioaccumulation and food chain (Chen and Chen, 2001). In this regard, heavy metals have long been recognized as an important pollutants due to their toxicity and ability to accumulate in marine organisms. Some of the listed toxic metals are arsenic, beryllium, cadmium, chromium, cobalt, tin, zinc, copper, iron, lead, manganese, aluminium, mercury, nickel and selenium (Ornstein *et al.,* 1997). Humans as consumers of seafood may be affected by consuming them. The effects include chronic and acute diseases (Al-Yousuf*et al.,* 2000). Due to the fact that even trace amounts of some heavy metals can exhibit high toxicity to marine biota and humans, there is an increasing interest in studying these metals in the marine environments (Sadiq, 1992). Among these heavy metals *viz.,* copper, zinc, iron, cadmium and lead metals represent the greatest potential concern to the environment and human health (Rushinadha*et al.,* 2016).

This study is an effort for determining the occurrence of heavy metals in *Polynemustetradactylus*. In view of the potential risk to human beings through the food chain in Pallamukurru, dissemination of these findings will be helpful to the main stakeholders or agencies that monitor environmental pollution.

MATERIAL AND METHODS

Samples were collected from the local markets of Pallamukurru from March 2015 to February 2016. 80-100 grams of edible part was taken by dissecting from the flank area spanning the lateral line of the fish. Samples stored in ice were bought to the laboratory. The samples were washed in running water and the excess water was removed with blotting paper. The wet weight of each individual sample along with petri dish was recorded carefully and the samples were placed in hot air oven for drying at 80 C for overnight. Nitric acid and hydrogen peroxide, is added in the ration of 7:3 ratio conical flask to prevent precipitation of metals and to avoid microbial activity and 3 ml of hydrogen peroxide to stabilize the concentration the samples is kept in microwave digester for digester for digestion at 150°C for 45 min.

The digested samples were transfer into 100 ml flask and distilled water was added upto the mark. These samples were analysed under F-AAS (Flame Atomic Absorption Spectrophotometer) (GBC 932AA, GBC Scientific Instruments, Australia) following AOAC method (AOAC, 2000). Statistical analysis has been done by one way ANOVA. The data set was tested for homogeneity of variance and for normal distributes. For all statistical tests, probability of $p<0.05$ was considered significant.

RESULTS

The data accomplished during this study were discussed in the following sections. Heavy metals like copper, zinc, iron, cadmium and lead were detected from *Polynemustetradactylus* in a month wise manner, collected from the local market Pallamukurru, east coast of India. In season wise accumulation, the highest values were recorded in monsoon (10.70±0.11) followed by post-monsoon (10.15±0.11) and pre-monsoon (9.03±0.09) seasons (Table 2), while the overall copper metal concentration was found as 9.96±0.10 (Table 1). The order of metal magnification in season wise was monsoon>post-monsoon>pre-monsoon seasons.

Zinc is one of the most abundant and movable of the heavy metals and is transported in natural waters in both dissolved form and as suspended fragments. The total mean values of zinc concentration observed was 42.50±0.58 (Table 1), whereas the season wise accumulation, more amount of zinc was found in pre-monsoon (41.76±0.72) followed by post-monsoon (44.58±0.60) and monsoon (41.15±0.42) seasons (Table 2), the regression values of this zinc metal concentration were $r^2 = 0.96$ and significance values were observed within the seasons ($p = 0.13$).

Table 1: Total mean metal accumulation in *Polynemustetradactylus*

Copper	Zinc	Iron	Cadmium	Lead
9.96±0.10	42.50±0.58	76.24±1.04	0.31±0.05	0.14±0.05

Table 2: Seasonal variation of metal accumulation in *Polynemustetradactylus*

	Copper	Zinc	Iron	Cadmium	Lead
Pre-monsoon	9.03±0.09	41.76±0.72	76.76±1.08	0.30±0.06	0.10±0.04
Monsoon	10.70±0.11	41.15±0.42	75.50±1.03	0.31±0.04	0.18±0.07
Post-monsoon	10.15±0.11	44.58±0.60	76.46±1.01	0.31±0.06	0.15±0.06

The season wise accumulation of iron was recorded highest in pre-monsoon (76.76±1.08)followed by post-monsoon (76.46±1.01)and monsoon (75.50±1.03) seasons which are shown in table 2 significant values were observed within the seasons but not in between the seasons ($p = 0.10$); regression values were as $r^2 = 0.97$; and the order of magnification of metal accumulation in season wise is pre-monsoon>post-monsoon>monsoon seasons, where as the overall mean metal concentration of iron content was 76.24±1.04 (Table 1).

The highest values of cadmium concentration was found in post-monsoon (0.31±0.06) followed by monsoon (0.31±0.04) and pre-monsoon (0.30±0.06) seasons which was represented in table 2 and the order of metal magnification was post-monsoon> monsoon>pre-monsoon seasons, while the total average concentration of cadmium was 0.31±0.05 (Table 1). No significant values were observed within the seasons ($p>0.05$) and regression values of cadmium content in between the seasons was $r^2 = 0.87$ respectively.

In this study, the total mean value of lead content was 0.14±0.05 which is shown in table 1. In season wise accumulation, the magnification order of metal accumulation was monsoon>post-monsoon>pre-monsoon seasons (Table 2) and the highest values of lead concentration was found in monsoon (0.18±0.07) followed by post-monsoon (0.15±0.06) and pre-monsoon (0.10±0.04) seasons, the regression values in between the seasons was $r^2 = 0.84$ and no significant ($p>0.05$) values were observed in between the seasons and significance ($p<0.05$) was found within the seasons.

DISCUSSION

Seasonal variations observed in the metal concentrations could be attributed to the differences in local pollution, bioavailability of metals (variations among physiochemical factors) and fish metabolism (growth cycle, reproduction and feeding) (Aucoin*et al.,* 1999; Eastwood *et al.,* 2002; Mendil, 2005). In addition to these other indirect activities such as energy demand activities, atmospheric deposition and runoff in putting, could lead to metal contamination, are variable among seasons. The alteration in feeding habits could be the reason of observed different.

Humanity today is facing high level of pollution with different pollutants among which the heavy metals are dangerous and hazardous. Pollutants and heavy metals are found in the aquatic environment in many forms, they can be found as organic and inorganic complexes or suspended molecules or dissolved ions and these forms differ with respect to their bioavailability toxicities (Tokalioglu*et al.,* 2000). Heavy metals are naturally found in the environment but in very low concentrations (Ososkov*et al.,* 1997

The high levels of Cu, Zn and Fe can be attributed to their biological role in normal metabolism and the growth of plankton and fish, which cause them to have an active uptake and storage (Dhinakaran*et al.,* 2014). The highest concentrations of Cu, Zn, Fe, Cd, and Pb were found in tissues of fish from the selected site in which the water contained high levels of the measured metals (Al-Najare, 2009)

The National Research Council has listed the estimated safe and adequate daily intake of Cu for adults as 1.5–3.0 mg (Huang, 2003). The mean copper concentration accumulated in this study was in between 7.31 ± 0.04 and 12.84 ± 0.16 ppm has exceeded than (Dhanakumar*et al.,* 2015) but not exceeding the permissible level recommended by FAO (1983) for human consumption.

Zinc accumulation in coastal fish tissues measured in the present study was within the same range as that reported for the same species in other European studies (Cicek*et al.,* 2009; Al-SayeghPetkovsek *etal.,* 2012). These results are supported by Canli and Atli (2003), Mendil and Uluozlu (2007) and Uysal*et al.,*(2008), whose observations demonstrated that heavy metal accumulation in various tissues of fish species living in the same habitat, differed significantly according to species.

In the present study, seasonal variation of iron metal accumulation was shown in table 1. Generally, post-monsoon is associated with increase of metals, which become enriched in the accumulative phases of the sedimentary material (Alagarsamy, 2006).

Cadmium was detected in each sample (0.11 ± 0.01 to 0.51 ± 0.03 μg/ g wet sample in fish) and the levels were considered low. It has been well established that the occurrence of Cd in marine aquatic environment is only in trace concentrations (ATSDR, 2003b). The threshold concentration of cadmium in fish muscles design for human consumption set by the European Commission is 0.1mg/gw.w,

The current study showed the overall mean metal value was 0.14±0.05. According to Lithuanian Standards of Hygiene, the Maximum Tolerable Limit of lead in fish meat is 0.4mg/kg which is less than the value adopted by the European Commission for lead in marine fish muscle (EC, 2000) while FAO set a limit of 0.5mg/kg (FAO, 1983). Mustafa *et al* (2002) have found that the levels of Pb in marine fish ranged from 0.33 to 0.86 mg/kg in *Triglagurnardus* and *Dracunculusvulgaris* respectively.

Many parameters and factors have effects on heavy metals concentrations in aquatic ecosystems such as water temperature dissolved oxygen, salinity, pH, sex and age, phase of life (Salman &Nasar, 2014). In addition, muscle generally exhibited low metal levels, which may be attributed to the fact that muscle is not an active tissue with respect to metal accumulation (Amundsen *et al.,* 1997; Sunlu*et al.,* 2001; Sunlu, 2004; Visnjic-Jeftic*et al.,* 2010). Nevertheless, metal analysis in muscle remains important given that the flesh is destined for human consumption. It thus appears that for good bio-monitoring of environmental pollution, the above study is useful.

CONCLUSION

The present work represents heavy metals contamination in *Polynemustetradactylus* collected from Pallamukurru for the first time. It provides baseline data regarding heavy metals concentration in the selected fish species. This data can be a guideline for future researchers and environmental managers to identify future anthropogenic impacts at the study area with respect to the studied metals and better assess the need for remediation by monitoring for changes from the existing levels.

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