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Monitoring of heavy metals (Cu, Zn, Fe, Pb and Cd) accumulation in muscle and liver of *Plesionika martia*, east coast of India

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Abstract
The current study was carried out to determine the levels of heavy metals like copper (Cu), zinc (Zn), iron (Fe), lead (Pb) and cadmium (Cd) in the muscle and liver parts of shrimp (*Plesionika martia*) species. Atomic absorption spectrometry (AAS) was used to assess and evaluate the levels of these metals from the two parts in seasonal wise accumulation. The results of this study shown that the total mean values of metal accumulation in muscle part was, copper (5.43 ppm), zinc (12.99 ppm), iron (2.92 ppm), lead (0.21 ppm) and cadmium (0.66 ppm) whereas in liver part, copper (123.82 ppm), zinc (31.20 ppm), iron (21.22 ppm), lead (1.97 ppm) and cadmium (1.03 ppm). The overall mean metal concentration of muscle was Zn>Cu>Fe>Cd>Pb, whereas the magnification of mean metal concentration in liver part were accumulated as Cu>Zn>Fe>Pb>Cd respectively. This study highlights those toxic metals are found to be below the recommended tolerable levels in shrimp of WHO (World Health Organization) and seafood safety standards which may not constitute a health hazards for consumers.

Keywords: Heavy metals, seafood, bioaccumulation, *Plesionika martia*

Introduction

Seafood, especially shrimps provide a major source of essential nutrients such as proteins, vitamins, fats and minerals which help in the maintenance of life to man (Rao *et al*., 2016) [24]. It is always in news as it is proclaimed to be most nutritious and healthy food as well as being linked to increasing number of food borne outbreaks across the globe (Rushinadha *et al*., 2016) [26]. As the demand for shrimp is continuously increasing, making the required protein available to the existing population is a challenge (Ramesh *et al*., 2017) [23]. Shrimps are widely consumed in many parts of the world by humans due to high protein content, low saturated fat and sufficient omega fatty acids known to support good health (Geetha *et al*., 2016) [9]. Body composition is a good indicator of the physiological condition of a shrimp but it is relatively time consuming to measure (Rani *et al*., 2016) [24].

Aquatic organisms have ability to accumulate heavy metals from various sources including sediments, soil erosion and runoff, air depositions of dust and aerosol, and discharge of waste water (Goodwin *et al* 2003) [11]. Many factors including season, physicochemical properties of water, habitat, age and physiological conditions of shrimps acts a major role in accumulation of metals (Rao *et al*., 2016) [25]. Gills are directly in contact with water; therefore the concentration of metals in gills reflects metal concentration in water where the shrimp lives (Rushinadha and Sreedhar, 2017) [27].

Pollution and its effects on the living resources, especially the fishery resources, have assumed considerable interest as well as importance in the recent times. Pollution from metals is a vital problem affecting the estuaries and inshore regions (Rushinadha *et al* 2016) [26]. Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bio-accumulate in aquatic ecosystems (Censi *et al*., 2006) [6]. Advancement in technology as well as increase in population have led to environmental concerns relating from indiscriminate dumping of refuse and discharge of industrial effluents, petroleum waste water, and crude oil spills replete with most common heavy metals in our ecosystems (Adedji & Okocha 2011; Jones & Cherian 1990) [1, 15].

Heavy metals in the environment are potentially harmful to most organisms at some levels of exposure and absorption (Yoshida *et al*., 2006; Soltani *et al*., 2000) [32, 29]. Heavy metals are natural components of the earth's crust and they can enter the water and food cycles through a

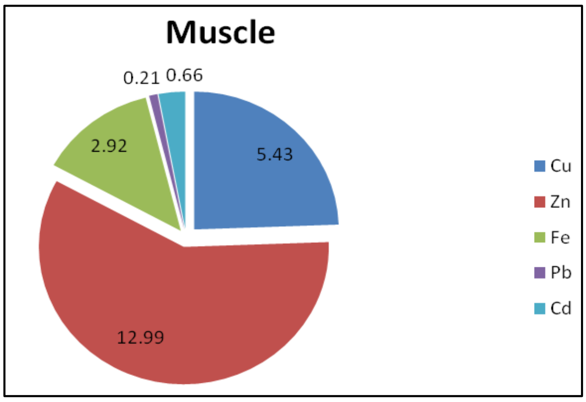
variety of chemical and geochemical processes (Adedeji & Okocha 2011; Biney *et al.*, 1999) [1]. Also anthropogenic pollutants are the main sources of heavy metal contamination in the ocean (Hamilton & Hafman 2003) [13]. Among the contaminants, heavy metals should be highlighted due to the consequences of their bioaccumulation in aquatic ecosystems (Nadmitov *et al.*, 2015) [19], in which such as phytoplankton was accumulated by heavy metals (Dashtiannasab *et al.*, 2012) [8].
The current study aspire to highlight the levels of five metals namely, copper (Cu), zinc (Zn), iron (Fe), lead (Pb) and cadmium (Cd) in muscle and liver parts of shrimp (*Plesionika martia*), contributing to the effective monitoring of both environmental quality and the health of the organisms collected from the Visakhapatnam fishing harbour, east coast of India.

Material and methods

The shrimp (*Plesionika martia*) samples were collected from the Visakhapatnam fishing harbour, east coast of India during the period of March 2018 to February 2019. Sampling was conducted at the frequency of twice a month for two consecutive years. Samples for heavy metals were digested in teflon containers using a microwave digester (Ethos plus High Performance Microwave Labstation, Milestone, USA). Three grams of sample was weighed in to 100 ml teflon vials and digested overnight with 7ml of pure nitric acid (AR grade, specific gravity: 1.38, Qualigens, India) and 3 ml of hydrogen peroxide. The microwave parameters were 700 W power for 1 h (40 min heating and 20 min ventilation) were shown in table 1. The digested contents were transferred to acid washed polypropylene bottles and made up to 100 ml with double distilled water and subjected to various metal analyses in Atomic Absorption Spectrophotometer (GBC 932AA, GBC Scientific Instruments, Australia) following the AOAC method AOAC (2000) [2].

Results

The mean value of each component attributed the heavy metal accumulation in shrimp (*Plesionika martia*) species which were collected from the Visakhapatnam fishing harbour, Andhra Pradesh coast, east coast of India.



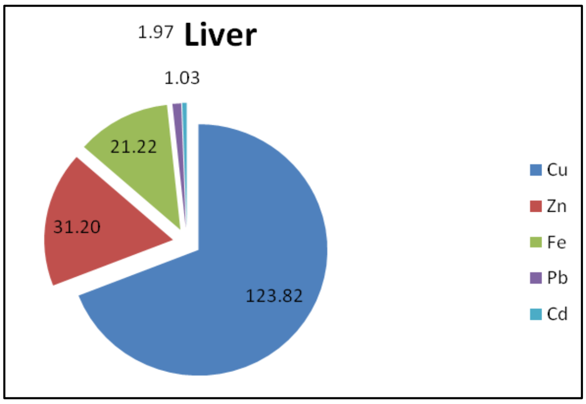


Fig 1: Overall mean metal magnification of muscle and liver part of *Plesionika martia*

In the current study, the overall mean metal concentration of muscle was Zn>Cu>Fe>Cd>Pb, whereas the magnification of mean metal concentration in liver part were accumulated as Cu>Zn>Fe>Pb>Cd which has shown in figure 1 respectively. The heavy metal accumulation in seasonal wise variation of shrimp (*Plesionika martia*) species in this study was represented in table 1 and table 2. In the muscle part, the metals like Copper, iron and cadmium was accumulated more content in post-monsoon season followed by pre-monsoon season and monsoon season whereas the concentration of zinc and lead metals were accumulated more in monsoon season followed by post-monsoon season and pre-monsoon season. In the part of the liver, heavy metals like copper, zinc, lead and cadmium were accumulated more content in the monsoon season followed by pre-monsoon season and post-monsoon season while iron was found more concentration in monsoon season followed by pre-monsoon season and post-monsoon season respectively.

Table 1: Seasonal variation of heavy metal accumulation in the tissue part of *Plesionika martia*

	Cu	Zn	Fe	Pb	Cd
Pre-Monsoon	4.53	11.68	2.45	0.12	0.36
Monsoon	4.11	14.61	2.27	0.26	0.25
Post-monsoon	7.63	12.67	4.04	0.25	0.59

Table 2: Seasonal variation of heavy metal accumulation in the liver part of *Plesionika martia*

	Cu	Zn	Fe	Pb	Cd
Pre-Monsoon	120.44	30.56	17.39	1.95	0.98
Monsoon	143.39	33.15	21.48	2.59	1.25
Post-monsoon	107.63	29.89	24.78	1.36	0.86

Discussion

The bioaccumulation pattern of heavy metals in shrimp muscle followed the same spatiotemporal trend as that of water. Heavy metal contamination of the environment has been occurring for centuries, but its extent has increased markedly in the last 50 years due to technological developments and increased consumer use of materials containing these metals. Pollution by heavy metals is a serious problem due to their toxicity and ability to accumulate in the biota (Islam and Tanaka, 2004) [14]. There is still a general concern about the impact of metals in the aquatic environment (Grosell and Brix, 2005) [12]. This trend of order of metal accumulation among shrimp tissues was also observed by other authors investigating the same shrimp species (Páez-Osuna and Tron-Mayen, 1996) [21].
The main sources of copper in the coastal waters are antifouling paints (Goldberg, 1975) [10], particular type of algaecides used in different aquaculture farms, paint manufacturing units, pipe line corrosion and oil sludges (32 to 120 ppm). Ship bottom paint has been found to produce very

high concentration of copper in sea water and sediment in harbors of Visakhapatnam fishing harbour, east coast of India (Bellinger and Benham, 1978; Young *et al*., 1979) [3, 33].

The primary sources of zinc in the present geographical locale are the paint manufacturing units, which are mainly concentrated in the industrial sector. Reports of high concentrations of zinc were also highlighted in the similar environment by earlier workers (Mitra and Choudhury, 1992; Mitra and Choudhury, 1993; Mitra, 1998) [17, 18, 16].

The excess iron can be harmful to health, and excess may be toxic to shrimp due to the formation of iron "flocs" on the gills, which results in gill clogging and respiratory trouble (Dalzell and Macfarlane, 1999; Peuranen *et al*., 1994) [7, 22]. Wu and Yang (2011) [31] identified that Cu and Fe mean concentrations in liver are significantly higher than levels noted in muscle of white shrimp *Litopenaeus vannamei*.

Cadmium is one of the contaminant that health authorities are most concerned about, due to the long biological half-life in humans. A high concentration of cadmium causes several health problems to humans. Cadmium and its compound along with mercury and some other dangerous metals are included in the blacklist (NAS-NRC, 1982) [20]. Ingestion of cadmium produces shock acute renal failure when the amount exceeds 350 mg (Cefalu and Hu, 2004) [5].

Lead is a toxic heavy metal, which finds its way in coastal waters through the discharge of industrial waste waters, such as from painting, dyeing, battery manufacturing units and oil refineries, etc. Antifouling paints used to prevent growth of marine organisms at the bottom of the boats and trawlers also contain lead as an important component. When compared with the recommended value of WHO (1989) [30] in context to consumption of prawn (2 ppm for Pb), the concentrations in the shrimp species was below this level. According to the Seafood Standards, maximum allowable limits for Pb accumulation of shrimps are 0.5 ppm (The Seafood Standards, 2003) [28].

Conclusion

The result of the present study indicated that *Plesionika martia* from the Visakhapatnam fishing harbour, east coast of India, were safe to consume since the metal (Cu, Zn, Fe, Pb and Cd) concentrations were below international admissible limits for human consumption. But it may be suggested that continuous care must be taken, especially according to the season, to bio-monitor the heavy metal levels if they exceed the maximum permitted concentrations for human consumption. Although livers are not consumed, they may represent good bio-monitors of metals present in the surrounding environment.

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