



## HEAVY METALS OCCURRENCE IN THE TISSUES OF MARINE PRAWN *Penaeus monodon* (FABRICIUS 1798) AND WATER ALONG THE COASTLINE OF TAMIL NADU (CHENNAI)

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### AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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### ABSTRACT

This current study aimed to gauge the cluster of heavy metals, Copper, chromium, manganese, Cadmium, Lead, and zinc were determined in seawater, marine prawn's hepatopancreas and muscle tissue. The trials were collected from three diverse locations along the coastline of Tamil Nadu (Chennai); Kasimedu, Lighthouse, and Muttukadu. Atomic Absorption Spectrophotometer was performed for heavy metal analysis. The mean cluster of heavy metals in water at all trail places follows in descending order of Mg > Zn > Cd > Cu > Pb > Cr during the period July-September 2019. The spreading range of heavy metals in the prawn samples was as follows: hepatopancreas > muscle. The present analysis recorded that there were variances in heavy metal levels between diverse places. This indicates the ability of crustaceans to accumulate heavy metals to detectable levels. Metal bioaccumulation by shrimps can be affected by the chemical composition of the seawater. Variations in heavy metal clusters among diverse places are probable to have ensued from hydrodynamics, metal bioaccessibility of the environment, change in tissue composition, stations of collection and sources of pollution within the Bay of Bengal, Chennai coast.

**Keywords:** Heavy metals; *Penaeus monodon*; hepatopancreas; Atomic Absorption Spectrophotometer (AAS); Chennai.

### 1. INTRODUCTION

The sea-belts are mostly inhabited and civilized with the industries. A marine diet such as prawn, mussel, crab, and fish are mouth-watering and procedure an imperative fundamental part of the daily diet. It has been found that heavy metal endorsement occurs right from adjacent marine water through the permeable

outer body surface and from food along with the seawater to the muscle and hepatopancreas through the gut [1,2]. Fish, prawn, and crab form a vital bond as potential transfer media to animal and human beings [3]. Statistics on the heavy metal pollution on the coastline are crucial as they cause severe environmental health threats [4,5,6].

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Heavy metals are existing in natural aquatic sources at fluctuating clusters. The most possibly vicious of these rudiments are heavy metals, viz., Cd, Hg, Cr, and Pb, and few metalloids such as Se and As. Some crustaceans at concentrations under threshold level can adjust body intensities of crucial metals like manganese, copper, and zinc [7,8,9]. Heavy metals have an abundant attraction for sulfur and outbreak sulfur bonds in proteins and enzymes of marine creatures thus halting the latter. Other susceptible sites are protein, the carboxylic acid ( $-CO_2H$ ) and amino ( $-NH_2$ ) groups. They also lean towards precipitate phosphate bi compounds or catalyze their disintegration [10].

In Chennai city, heavy metal involvement may be plagiaristic from several anthropogenic and natural sources. Heavy metals such as; arsenic, selenium, lead, chromium, copper, cadmium, manganese, zinc, and mercury has been establishing to enter seawater by sewage and other wastewater ejections such as; chilling water discharge, power plant, automobile emissions, petrochemical, and petroleum industrial wastes, solid waste landfills and storm drain outfalls. In tallying to these origins, trace metals have also been found to enter into indigenous marine water suck up on airborne and waterborne particulate material. This current study has been carried out to gauge the concentration levels of, Copper, cadmium, lead, chromium, manganese, and zinc in various tissues; namely hepatopancreas, and muscle of the *Penaeus monodon*.

## 2. MATERIALS AND METHODOLOGY

### 2.1 Sampling Sites

The study area consists of three different locations (Kasimedu, Lighthouse and Mutukaddu) along the coastline of Chennai, Tamil Nadu. Live prawns (*Penaeus monodon*) and seawater samples were collected with the help of local anglers of all three locations.

Kasimedu fishing harbor (13.1333390 N, 80.3016120 E), is one of the foremost fishing grounds for catching fishes and crustaceans situated at Kasimedu, Chennai, India. It is about 8 km north of Chennai central. This site was nominated as the unhygienic site for the present study as it is encircled by the Chennai port, where oil effluence is more severe than other parts of Chennai and this site is allied with many municipal drainage exposures.

Lighthouse (13.0384770 N, 80.281599 0 E), is located in the middle of Marina, a metropolitan seashore in the metropolitan city of Chennai, India, along the coastline of Chennai, Tamil Nadu. The coastline runs from the fort. st. George (in the north) to Besantnagar (in the south), an expanse of 13 Kms, creating it the longest metropolitan beach in India and the world's second lengthiest. This location was selected as the polluted site for the present study as it is highly connected with the municipal and sewage pollution.



Fig. 1. Map of the sampling sites

Muttukadu (12.7920310 N, 80.2516970 E) is about a one and half an hour drive south of Chennai. Kovalam coastline is situated 40 km alien from Chennai. Kovalam estuary is located on the east seashore of India and is about 36 km south of Chennai. It runs analogous to the seacoast and spreads to a distance of 21 km. It was nominated as the unpolluted place for the current investigation as it is bounded by great vegetation and it far away from modern industrial, agricultural, municipal, and sewage pollution.

## 2.2 Sampling and Analytical Techniques

The marine water and marine prawn samples were collected from all 3 experimental sites during July-August 2019. The live prawn samples were washed away carefully with cleaned water to eradicate the sediments and debris. The prawns were packed into a 4°C thermocol box and transported into the experimental laboratory. Their total length and weight were recorded. The marine prawns of *Penaeus monodon* (length  $11.05 \pm 0.83$  cm and weight  $25.99 \pm 2.06$  gm). The prawn samples were stored at -20°C in the deep freezer until analysis, to reduce all the accomplishments and metabolism of the *Penaeus monodon*. The marine water trials were collected 10 cm under the water apparent using a water sampler and stored in pre-cleaned 500ml plastic used water bottle. The *Penaeus monodon* was chosen due to more economic importance and the accessibility of the species at the Bay of Bengal coastal, Chennai.

To determination the heavy metals concentrations all collected samples were prepared.

### 2.2.1 Digestion procedure for water samples

100 ml of a blended sample was transferred to a prewashed beaker. Then 2 ml of strong  $\text{HNO}_3$  and 5 mL of strong HCl were added. The sample is covered with a pre-cleaned watch glass and warmed up on a hot plate at 90°C while waiting for the volume has been reduced to 15-20 ml. The beaker was discarded from a hot plate and let to cool. The beaker and watch glass were scrubbed with distilled water and spin the sample to eliminate silicates and other unsolvable ingredients that could block the nebulizer. Purification should be done at best if there are unsolvable ingredients that may block the nebulizer; this additional step is answerable to cause sample adulteration unless the filter and filtering tool is carefully cleaned and pre-rinsed with dilute  $\text{HNO}_3$ . Modify the absolute volume to 100 ml with reagent water. Finally estimated by Atomic absorption.

### 2.2.2 Digestion procedure for tissue samples

Before the digestion procedure, samples were dried for 72 hours at 65°C through hot air oven and

homogenized using ceramic mortar and pastel and reserved in an airtight container. 10 grams of the dehydrated, homogenized samples were weighed into a 250 ml conical flask. 20ml of Perchloric acid ( $\text{HClO}_4$ ) and 20 ml of Nitric acid ( $\text{HNO}_3$ ) in a proportion of 1:1 then adjoin to the sample. The mixer was boiled in a digester until the volume condensed to 5 ml with temperature, not beyond 160°C. The excess was energized with 5 ml 20% Hydrochloric acid ( $\text{HCl}$ ), Filtered using Whatman no.1 filter paper, and prepared up to the 100 ml scratch with deionized water [11,12]. The filtered samples were directly initiated into atomic absorption spectrometry (Perkin Elmer 800) for the estimation of the heavy metals. The blanks were executed corresponding with all analysis and the blank values were lesser than 0.5% of the sample signals. To maintain the precision of the analysis, standards analysis has been done for each fifth sample. International Reference Standards DORM-3 was run along with the samples and the obtained values are reported in Table 1.

## 3. RESULTS

### 3.1 Heavy Metals in Water Samples

The cluster of heavy metals in water serene from three different places is given in Table1 and the graphical illustration in Fig. 2. The maximum cluster of cadmium ( $1.2 \pm 0.21$ mg/L) and Zinc ( $2.04 \pm 0.32$  mg/L) are observed in water trials collected from Kasimedu. The maximum cluster of copper ( $0.61 \pm 0.33$  mg/L) and Manganese ( $4.74 \pm 0.21$  mg/L) are observed in water trials collected from Muttukadu. It is noticed that the below detectable level (BDL) of chromium and lead is observed in water trials collected from Lighthouse and Kasimedu respectively. Both Chromium and Lead observed in water trials collected from Muttukadu are below the detectable level (BDL).

### 3.2 Heavy Metals in Muscle tissue of *Penaeus monodon*

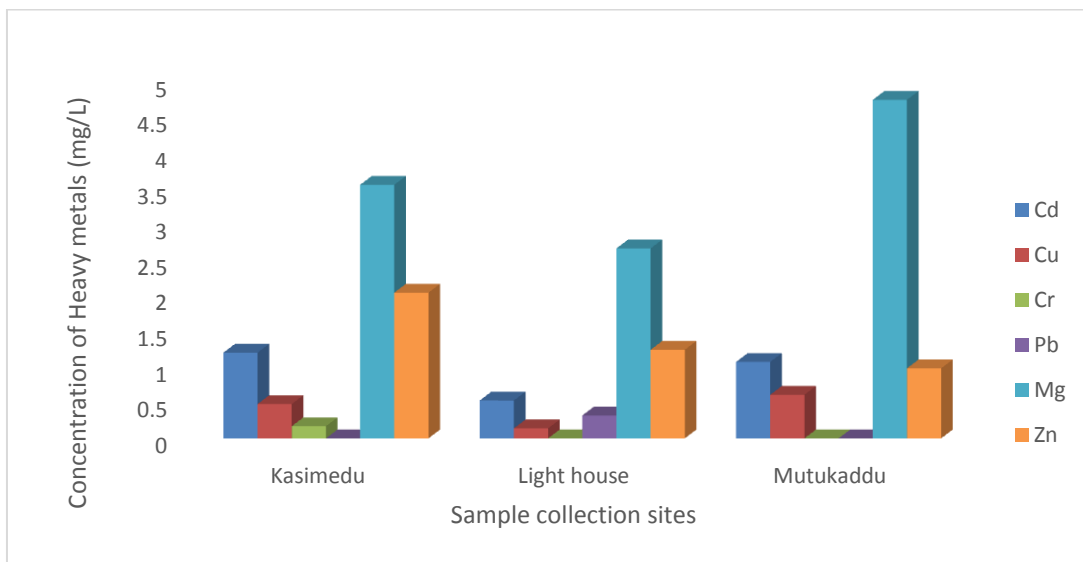
The cluster of heavy metals in the muscle tissue of *Penaeus monodon* is serene from 3 different places are given in Table 2 and the graphical illustration in Fig. 3. It is observed that the concentration of cadmium in the Lighthouse sample ( $1.06 \pm 0.21$  mg/Kg) slightly higher than the Kasimedu sample ( $1.01 \pm 0.11$ ) and Muttukadu sample ( $0.96 \pm 0.05$ ) contain less concentration than earlier. The chromium is only observed in the sample collected from Kasimdu ( $0.29 \pm 0.01$ ). The maximum concentration of copper ( $0.92 \pm 0.011$ ) observed in the samples collected from Kasimedu. It is noticed that the maximum concentration of manganese ( $2.47 \pm 0.07$

mg/Kg) and zinc ( $1.69 \pm 0.23$  mg/Kg) are observed in prawn muscle samples collected from Muttukadu and Lighthouse respectively. An equal concentration of Lead ( $0.14 \pm 0.10$ ) observed in prawn muscle samples

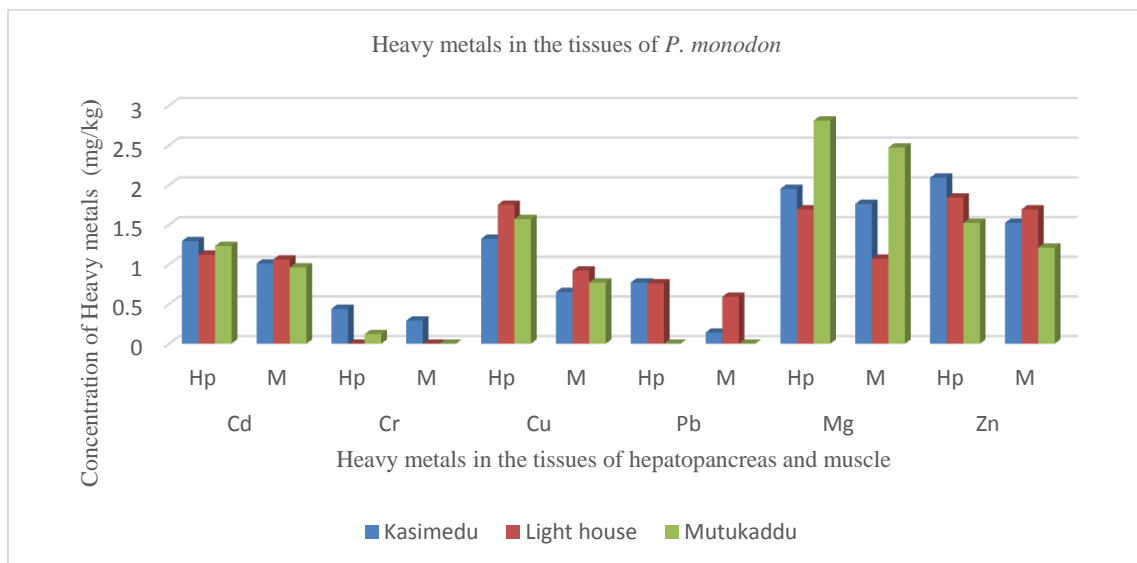
collected from Kasimedu and Lighthouse. Below detectable level (BDL) concentration of Lead is observed in samples collected from Muttukadu.

**Table 1. Cluster of heavy metals in water serene from different locations (Kasimedu, Lighthouse, and Muttukadu) of the Bay of Bengal of Tamil Nadu (Chennai)**

Location	Heavy metals concentration in water (mg/L)					
	Cd	Cu	Cr	Pb	Mg	Zn
Kasimedu	$1.2 \pm 0.21$	$0.48 \pm 0.11$	$0.17 \pm 0.09$	BDL	$3.55 \pm 0.06$	$2.04 \pm 0.32$
Light house	$0.53 \pm 0.08$	$0.14 \pm 0.24$	BDL	$0.32 \pm 0.33$	$2.66 \pm 0.15$	$1.24 \pm 0.23$
Muttukadu	$1.07 \pm 0.14$	$0.61 \pm 0.33$	BDL	BDL	$4.74 \pm 0.21$	$0.98 \pm 0.05$



**Fig. 2. Graphical representation of heavy metals in seawater serene from three different locations**



**Fig. 3. Graphical representation of heavy metals heavy metals cluster in the hepatopancreas and muscle tissues of Penaeus monodon from three different locations**

**Table 2. Cluster of heavy metals in muscle tissue of *Penaeus monodon* serene from three different locations**

Heavy metals in the muscle tissues of <i>Penaeus monodon</i> (mg/kg)						
LOCATION	Cd	Cr	Cu	Pb	Mg	Zn
Kasimedu	1.01±0.11	0.29±0.01	0.65±0.07	0.14± 0.10	1.76±0.14	1.52±0.11
Light house	1.06±0.21	BDL	0.92±0.011	0.14± 0.10	1.07±0.14	1.69±0.23
Muttukau	0.96±0.05	BDL	0.77±0.16	BDL	2.47±0.07	1.21±0.06

**Table 3. Cluster of heavy metals in hepatopancreas tissue of *Penaeus monodon* serene from three different locations**

Heavy metals in the hepatopancreas tissues of <i>Penaeus monodon</i> (mg/kg)						
LOCATION	Cd	Cr	Cu	Pb	Mg	Zn
Kasimedu	1.29±0.03	0.44±0.07	1.32±0.05	0.77±0.02	1.95±0.02	2.09±0.21
Light house	1.12±0.09	BDL	1.75±0.23	0.76±0.22	1.69±0.09	1.84±0.01
Mutukaddu	1.23±0.014	0.12±0.20	1.57±0.08	BDL	2.81±0.19	1.52±0.04

### 3.3 Heavy Metals in Hepatopancreas tissue of *P. monodon*

The maximum concentration of cadmium (1.29±0.03 mg/Kg) and chromium (0.44±0.07 mg/Kg) detected in samples serene from Kasimedu. The maximum concentration of copper (1.75±0.23 mg/Kg) detected in the samples serene from the lighthouse. The maximum cluster of lead (0.77±0.02 mg/Kg) detected in the samples collected from Kasimedu. The maximum concentration of manganese (2.81±0.19 mg/Kg) and zinc (2.09±0.21 mg/Kg) observed in the samples collected from Muttukadu and Lighthouse respectively. It is noticed that the below detectable level of chromium and lead are observed in water trials collected from Lighthouse and Muttukadu respectively.

## 4. DISCUSSION

The sound possession of heavy metals in the environment hangs on a large scope on whether they arise in forms that can be taken up by microorganisms, plants, or animals [13]. Therefore, the current study was undertaken to gauge the heavy metals of Cd, Mg, Pb, Cu, Cr, Zn in the tissues (Hepatopancreas and Muscle) of the *Penaeus monodon* and water. An extensive range of diverse heavy metal concentrations was observed in the water trials from three different places (Kasimedu, Lighthouse, and Muttukadu). In *Penaeus monodon* the spreading array of heavy metals are in increasing order; Hepatopancreas > Muscle. Results from this investigation showed Mg is higher clusters in the tissues of prawn and the chromium is the least concentration in every sample from all three locations. This remark may be due to the major functional transformations in their body. In this current study,

the presences of heavy metals in hepatopancreas are more than the Muscle tissue. This is also supported by AH Bunt et al. [14]; K Vijayaraman et al. [15]. The deviation is also a warning of the degree to which specific species pick up granular matter from adjacent water while feeding. The maximum clusters of four heavy metals (Cadmium, manganese, copper, and zinc) in the tissue of *Penaeus monodon* was observed in trials collected from Lighthouse. It may be due to the discharge of unprocessed run-off from numerous domestic sewage connected near Lighthouse. Comparatively, Manganese has more concentration in the hepatopancreatic tissue of *Penaeus monodon* all the trials. As far as the prominence of seafood in the human diet is concerned, it is essential that the biological nursing of water and prawn should be done timely to safeguard the safety of seafood intake. The harmful dumping of industrial effluents and domestic sewage should be accomplished to avoid such tarnishing [16,17]. The road near to the seashore should have proper rainwater collecting facility otherwise; there could be a long-term degradation of sensitive and essential breeding and nursery habitats of coastal marine organisms, which could lead to a long-term reduction in the commercially important species such as *Penaeus monodon*. In addition, the laws legislated to protect the environment should be enforced effectively.

## 5. CONCLUSION

In conclusion, the variances in the pattern of heavy metal occurrence in various tissues of the crab, *Penaeus monodon*, and the increase of Cd, Cu, Mg, and Zn concentrations are likely associated with the modern urbanization model including industries, the discharge of unprocessed run-off from numerous domestic sewage to the marine environment. This

clearly indicates the ability of crustaceans to accumulate heavy metals to detectable levels. Metal bioaccumulation by shrimps can be affected by the chemical composition of the seawater. Variations in heavy metals cluster among diverse places are probable to have ensued from hydrodynamics, metal bioaccessibility of the environment, change in tissue composition, stations of collection, and sources of pollution within the Bay of Bengal, Chennai coast.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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