

SEASONAL VARIATION IN HEAVY METAL DISTRIBUTION NEAR MARINA SEA SHORE, CHENNAI

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Abstract

The objective of the study is to reveal the seasonal variations of heavy metal concentrations in fish, water and sediment collected near seashore of Bay of Bengal in Marina, the longest urban beach in India. The concentrations of 5 heavy metals (Arsenic (As), Cadmium (Cd), Chromium (Cr), Lead (Pb) and Mercury (Hg)), were determined in water, sediment and marine species, Indo-Pacific king mackerel popularly known as Spotted Seer fish (*Scomberomorus Guttus*) from Marina sea shore in 4 different seasons. The concentrations of heavy metals in each sample were determined using AAS method. The study shows that there is no much seasonal variation in concentrations of the heavy metals in fish samples. The higher concentrations of most of the heavy metals in water samples were observed in monsoon season and sediment samples in summer season.

Keywords: Heavy metals, Marina, Atomic Absorption Spectrophotometer (AAS), Chennai, spotted seer fish, sediment, water

I. INTRODUCTION

Heavy metals occur naturally in the ecosystem with large variations in concentration. Living organisms require varying amounts of "heavy metals". Iron, cobalt, copper, manganese, molybdenum, and zinc are required by humans, but excessive levels can damage the organism.^[1] Other heavy metals such as mercury, plutonium and lead are toxic metals and their accumulation over time in the bodies of animals can cause serious illness. Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver and other vital organs. Long-term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy and multiple sclerosis.

Fish is a valuable food item and source of protein. The concentration of heavy metals in aquatic organisms is higher than that present in water due to the effect of bio concentration and bio accumulation and eventually threaten the health of human by sea food consumption ^[2]. Also, fishes are widely used as bio indicators of marine pollution by metals^[3]. So

determination of heavy metal concentration in fishes is very important as far as human health is concerned. The samples (fish, water and sediments) were collected in 4 seasons Summer (March-May, 2012), Monsoon (June – August, 2012), Post-Monsoon (September – November, 2012) and Winter (December 2012 – February 2013) within 500 meters from Marina sea shore. The aim of the study was to determine the Heavy metal concentrations in fish muscle, water and sediment and to analyze it with respect to the seasons.

II. METHODOLOGY

Study area

Marina sea shore is an urban beach in the city of Chennai, India, along the Bay of Bengal, part of the Indian Ocean. The beach runs from near Fort St. George in the north to Besant Nagar in the south, a distance of 13 km, making it the longest urban beach in the country and the world's second longest. Marina Beach used to be famous for its beauty, good atmosphere, and rich ecosystems. However, from the middle of the 20th century, the beach and water has become polluted. An increase of plastic bags, human

waste and other pollutants have transformed many parts of the beach polluted. Many colonies along the coast release their untreated sewage straight into the sea.^[4] On the 20 kilometre coastline from Srinivasapuram on Marina Beach to Neelankarai further south are at least 10,000 households that discharge sewage through crude channels into the water. Not all of these are fishing hamlets and slums; many are upper- and middle-class waterfront neighbourhoods whose residents have not yet received sewage connections from CMWSSB, the city's official water supply and sewerage board. The board provides an unofficial estimate of 50,000 to 100,000 litres of waste being sent into the ocean every day through these illegal channels. In recent years, many voluntary organizations have taken up the project of cleaning up the Marina Beach and the water for protecting the ecosystem. The samples were collected from the fish catchment area nearby Marina sea shore of Bay of Bengal in North Chennai, India.

Materials and methods

The water, sediment and spotted seer fish samples were collected during the period March 2012 to February 2013 in 4 seasons; Summer, Monsoon, Post-Monsoon and Winter within 500 meters from the seashore.^{[5][6]} The physico-chemical parameters like Temperature, pH, Salinity and Dissolved oxygen are measured. The fish samples were washed thoroughly with distilled water to remove the sediments and debris. The length and weight of each sample were measured. Then the edible parts were separated and frozen at -20° for the analysis. The fish samples were thawed, and then dried in a hot air oven at 60°C. After removing the moisture content, the weight was taken again. 15 gm of fish sample was taken and the ashing was done at 500°C for 16 hours. After cooling, 2 ml of Nitric Acid (HNO₃) and 10 ml of 1 molar Hydrochloric Acid (HCl) were added. After digestion, samples were filtered using Whatman filter paper No. 41, and the filtrate is made up to 25 ml with distilled water.

100 ml water sample was taken in a beaker and 0.5 ml Nitric Acid (HNO₃) and 5 ml Hydrochloric Acid (HCl) were added. Then it is kept in a hot plate for digestion. After digestion, it was made up to 10 ml. Heavy Metal concentrations were determined by Atomic Absorption Spectrophotometer (AAS).

2 gm of dry sediment was taken in a digestion vessel; 10 ml of 1:1 Nitric acid (HNO₃) was added and covered with watch glass. It was heated at 95±5 degree C for 10-15 min without boiling. After cooling, 5 ml concentrated HNO₃ was added and refluxed for 30 minutes. The step was repeated until no brown fumes come. The solution was allowed to evaporate to nearly 5 ml by heat without boiling. After the sample has cooled, 2 ml of water and 30% H₂O₂ were added. Heated until effervescence subsides and vessel was cooled. 30 % H₂O₂ was added in 1 ml aliquots with warming until the effervescence is minimal. The sample was covered with a ribbed watch glass and continued until the volume has been reduced to 5 ml. 10 ml HCL was added and refluxed for 15 min at 95±5 degree C. The digestate was filtered through Whatman filter paper No.41 and was collected in 100 ml standard flask. Heavy Metal concentrations were determined by Atomic Absorption Spectrophotometer (AAS)^[7].

III. RESULTS AND DISCUSSIONS

Fish

The concentrations of heavy metals in spotted seer fish caught in 4 different seasons are given in table 1 and the graphical representation of the maximum concentration in Figure 1. It is observed that the maximum concentration of Arsenic (0.302 mg/kg) and Lead (0.616 mg/kg) were observed in Monsoon season, Cadmium (0.423 mg/kg) and Chromium (0.711 mg/kg) in Post-Monsoon season and Mercury (0.092 mg/kg) in summer season.

Water

The concentrations of heavy metals in water collected in 4 seasons are given in Table 2 and the graphical representation in Figure 2. The maximum concentration of Arsenic (0.016 mg/l), Chromium (0.022 mg/l), Lead (0.012 mg/l) and Mercury (0.019 mg/l) were observed in monsoon season. The Maximum concentration Cadmium (0.014 mg/l) was observed in summer season.

SEDIMENTS

The concentrations of heavy metals in sediments collected in 4 seasons are given in Table 3 and the graphical representation in Figure 3. The maximum concentrations of Arsenic (0.879 mg/kg), Cadmium (1.246 mg/kg) Lead (0.848 mg/kg) in sediment were observed in summer season. The maximum concentrations of Chromium (1.664 mg/kg) and Mercury (0.673 mg/kg) were observed in post-monsoon and monsoon seasons respectively.

IV. CONCLUSION

It is observed from this study that there is no much seasonal variation in concentrations of the heavy metals in fish samples. The higher concentrations of most of the heavy metals in water are observed in monsoon season. This may be mainly due to the addition of heavy metals by run off during the monsoon. The higher concentrations of three heavy metals in sediment are observed summer. Also, it is observed that, all the values of HM concentrations are within the permissible limit of W.H.O.

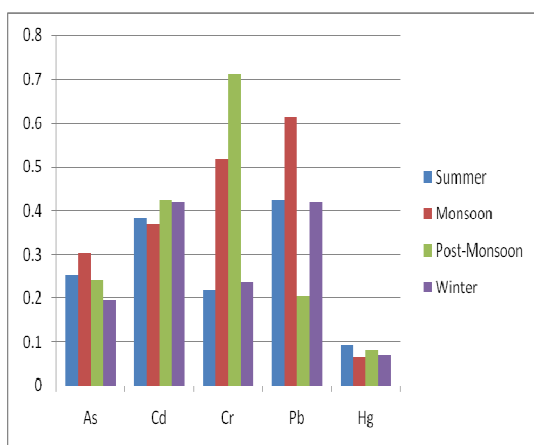


Fig 1. Maximum concentration of H.M. in fish collected in different seasons (mg/kg)

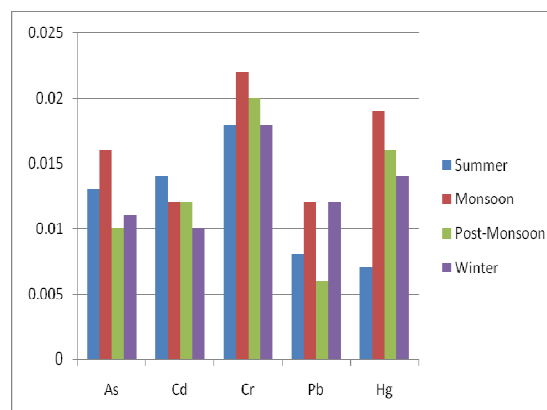


Fig 2. Concentration of H.M. in water collected in different seasons (mg/l)

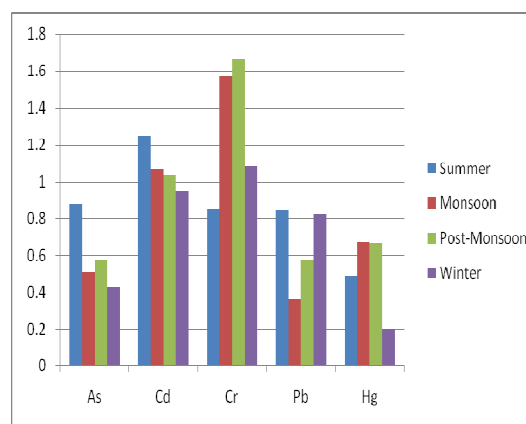


Fig 3. Concentration of H.M. in sediment collected in different seasons (mg/kg)

Table 1. Minimum and maximum concentrations of H.M in fish caught in different seasons (mg/kg)

Seasons	As		Cd		Cr		Pb		Hg	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Summer	BDL	0.251	BDL	0.382	BDL	0.219	BDL	0.423	BDL	0.092
Monsoon	BDL	0.302	BDL	0.368	0.033	0.518	BDL	0.616	BDL	0.064
Post-Monsoon	BDL	0.24	0.032	0.423	BDL	0.711	BDL	0.203	BDL	0.08
Winter	BDL	0.193	BDL	0.418	BDL	0.236	BDL	0.418	BDL	0.069

TABLE 2. CONCENTRATIONS OF H.M IN WATER COLLECTED IN DIFFERENT SEASONS (mg/L)

Seasons	As	Cd	Cr	Pb	Hg
Summer	0.013	0.014	0.018	0.008	0.007
Monsoon	0.016	0.012	0.022	0.012	0.019
Post-Monsoon	0.01	0.012	0.02	0.006	0.016
Winter	0.011	0.01	0.018	0.012	0.014

Table 3. Concentrations of H.M in sediment collected in different seasons (mg/kg)

Seasons	As	Cd	Cr	Pb	Hg
Summer	0.879	1.246	0.853	0.848	0.486
Monsoon	0.508	1.067	1.569	0.363	0.673
Post-Monsoon	0.572	1.034	1.664	0.574	0.668
Winter	0.427	0.948	1.083	0.824	0.203

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