

Determination of Cadmium in water, sediment and Spotted Seer fish

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Abstract- The objective of the study is to determine the concentration of Cadmium in water, sediment and the marine species Indo-Pacific king mackerel popularly known as spotted seer fish (*Scomberomorus guttus*) collected near seashore of Bay of Bengal from 5 locations (Pulicat, Ennore, Marina, Mahabalipuram and Kalpakkam) in North Chennai in 4 different seasons (Summer, Monsoon, Post-Monsoon, and Winter). The concentrations of Cadmium in each sample were determined using AAS method. The study shows that the higher concentration of Cadmium in fish is observed in fish collected from Ennore during Post-Monsoon season. Also, the higher concentration of cadmium in water and sediments are found in Pulicat in Monsoon season and Ennore in Post-Monsoon season respectively.

Keywords – Heavy metals, concentration, Atomic Absorption Spectrophotometer(AAS), Chennai, spotted seer fish, Cadmium, fish, sediment, water

I. INTRODUCTION

Cadmium is an extremely toxic metal commonly found in industrial workplaces. Due to its low permissible exposure limit, overexposures may occur even in situations where trace quantities of cadmium are found. Cadmium is used extensively in electroplating, although the nature of the operation does not generally lead to overexposures. Cadmium is also found in some industrial paints and may represent a hazard when sprayed. Operations involving removal of cadmium paints by scraping or blasting may pose a significant hazard. Cadmium is also present in the manufacturing of some types of batteries. Exposures to cadmium are addressed in specific standards for the general industry, shipyard employment, construction industry, and the agricultural industry. Food is another source of cadmium. Plants may only contain small or moderate amounts in non-industrial areas, but high levels may be found in the liver and kidneys of adult animals. Cigarettes are also a significant source of cadmium exposure. Although there is generally less cadmium in tobacco than in food, the lungs absorb cadmium more efficiently than the stomach. Acute exposure to cadmium fumes may cause flu like symptoms including chills, fever, and muscle ache sometimes referred to as "the cadmium blues." Inhaling cadmium-laden dust quickly leads to respiratory tract and kidney problems which can be fatal (often from renal failure). Ingestion of any significant amount of cadmium causes immediate poisoning and damage to the liver and the kidneys. 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. Also Fishes are widely used as bio indicators of marine pollution by metals (Evans et al. 1993). So determination of heavy metal concentration in fishes is very important as far as human health is concerned. The samples (Spotted Seer fish, water and sediments) were collected in the seasons Summer (March-May, 2012), Monsoon (June – August, 2012), Post-Monsoon (September – November, 2012) and Winter (December 2012 – February 2013) from Pulicat, Ennore, Marina, Mahabalipuram and Kalpakkam. The aim of the study was to determine the concentration of Cadmium in fish muscle, water and sediment and to analyze it with respect to the seasons and locations.

II. METHODOLOGY

A. Study Area

The study area consists of 5 different locations (Pulicat, Ennore, Marina, Mahabalipuram and Kalpakkam) along the coast of Bay of Bengal in North Tamilnadu.

Pulicat (Pazhaverkadu) is a historic seashore town in Thiruvallur District, of Tamil Nadu. It is about 60 km north of Chennai and 3 km from Elavur, on the barrier island of Sriharikota, which separates Pulicat Lake from the Bay of Bengal.

Ennore is a suburb in Chennai, India. Ennore is situated on a peninsula and is bounded by the Korttalaiyar River, Ennore creek and the Bay of Bengal. The creek separates Ennore from the Ennore Port. Ennore creek carries high load of heavy metals (Kannan et al., 2007). The treated effluents of the Madras Refinery Ltd, through the Buckingham canal and the Madras Fertilizers Ltd, through the Red Hills surplus channel, reach the Ennore backwater (Sreenivasan and Franklin, 1975).

Marina Beach 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.

Mahabalipuram lies on the Coromandel Coast which faces the Bay of Bengal. It is around 60 km south from the city of Chennai. It is an ancient historic town and was a bustling seaport during the time of Periplus and Ptolemy.

Kalpakkam is a small town in Tamil Nadu, situated on the Coromandel Coast 70 kilometres south of Chennai Nuclear facilities. Madras Atomic Power Station is located at Kalpakkam. It is a comprehensive nuclear power production, fuel reprocessing, and waste treatment facility that includes plutonium fuel fabrication for fast breeder reactors (FBRs). It is also India's first fully indigenously constructed nuclear power station. It has two units of 220 MW capacities each.

B. *Materials and Methods*

The spotted seer fish samples (minimum 10 number of samples), water and sediment were collected from all the 5 locations in 4 different seasons, Summer (March-May, 2012), Monsoon (June – August, 2012), Post-Monsoon (September – November, 2012) and Winter (December 2012 – February 2013) within 500 meters from the seashore. The physiochemical parameters like Temperature, pH, Salinity and Dissolved oxygen were 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 (HNO_3) 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 (HNO_3) 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. Cadmium concentration was determined by Atomic Absorption Spectrophotometer (AAS).

2 gm of dry sediment was taken in a digestion vessel, 10 ml of 1:1 Nitric acid (HNO_3) 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 HNO_3 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% H_2O_2 were added. Heated until effervescence subsides and vessel was cooled. 30 % H_2O_2 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. Cadmium concentration was determined by Atomic Absorption Spectrophotometer (AAS).

III. RESULTS AND DISCUSSIONS

A. *Fish*

The concentrations of Cadmium in Spotted Seer fish caught from 5 different locations 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 Cadmium (Cd) in Ennore(0.441 mg/kg), Marina(0.423 mg/kg) and mahabalipuram (0.417 mg/kg) are observed in Post-Monsoon season. Maximum concentration in Pulicat(0.426 mg/kg), and kalpakkam (0.407 mg/kg) are is observed in Winter and Monsoon seasons respectively.

B. *Water*

The concentrations of Cadmium in water collected from 5 different locations in 4 different seasons are given in Table 2 and the graphical representation in Figure 2. It is observed that the maximum concentration of Cadmium (Cd)

in Pulicat (0.028 mg/l), Ennore(0.027 mg/l), Mahabalipuram (0.013 mg/l) and Kalpakkam (0.023 mg/l) are observed in Monsoon season. Maximum concentration in Marina (0.014 mg/l) is observed in Summer season.

C. Sediment

The concentrations of Cadmium in sediments collected from 5 different locations in 4 seasons are given in Table 3 and the graphical representation in Figure 3. The maximum concentration of Cadmium in Pulicat (1.317 mg/kg) and Kalpakkam (1.247 mg/kg) are observed in Monsoon season. Concentrations of Cd in Marina (1.246 mg/kg) and Mahabalipuram (0.878 mg/kg) are observed in summer season and that in Ennore (1.815 mg/kg) is observed in Post-Monsoon season.

TABLE I. MINIMUM AND MAXIMUM VALUES CONCENTRATIONS OF CADMIUM IN FISH CAUGHT FROM DIFFERENT LOCATIONS IN DIFFERENT SEASONS (MG/KG)

Season	Pulicat		Ennore		Marina		Mahabalipuram		Kalpakkam	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Summer	0.032	0.423	0.042	0.383	BDL	0.382	BDL	0.368	BDL	0.321
Monsoon	0.032	0.382	0.034	0.418	BDL	0.368	BDL	0.312	BDL	0.407
Post-Monsoon	0.083	0.417	BDL	0.441	0.032	0.423	BDL	0.417	BDL	0.308
Winter	BDL	0.426	BDL	0.364	BDL	0.418	BDL	0.268	BDL	0.241

TABLE II. CONCENTRATION OF CADMIUM IN WATER COLLECTED FROM DIFFERENT LOCATIONS IN DIFFERENT SEASONS (MG/L)

Seasons	As	Cd	Cr	Pb	Hg
Summer	0.018	0.02	0.014	0.01	0.017
Monsoon	0.028	0.027	0.012	0.013	0.023
Post-Monsoon	0.021	0.022	0.012	0.011	0.015
Winter	0.015	0.018	0.01	0.01	0.012

TABLE III. CONCENTRATION OF CADMIUM IN SEDIMENT COLLECTED FROM DIFFERENT LOCATIONS IN DIFFERENT SEASONS (MG/KG)

Seasons	As	Cd	Cr	Pb	Hg
Summer	1.184	1.12	1.246	0.878	1.096
Monsoon	1.317	1.374	1.067	0.564	1.247
Post-Monsoon	0.831	1.815	1.034	0.872	1.147
Winter	1.293	1.613	0.948	0.783	1.041

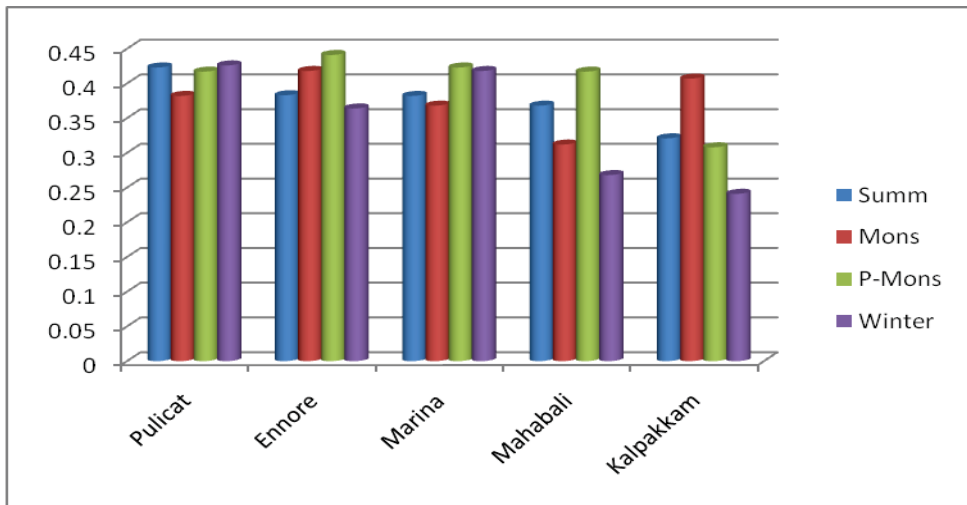


Figure 1. Maximum Concentration of Cadmium in fish caught from different locations in different seasons (mg/kg)

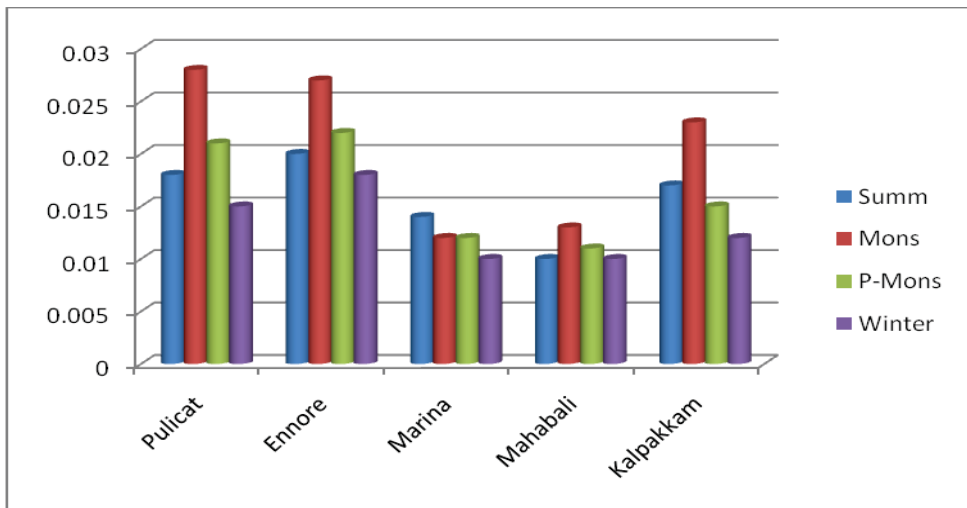


Figure 2. Concentration of Cadmium in water collected from different locations in different seasons (mg/l)

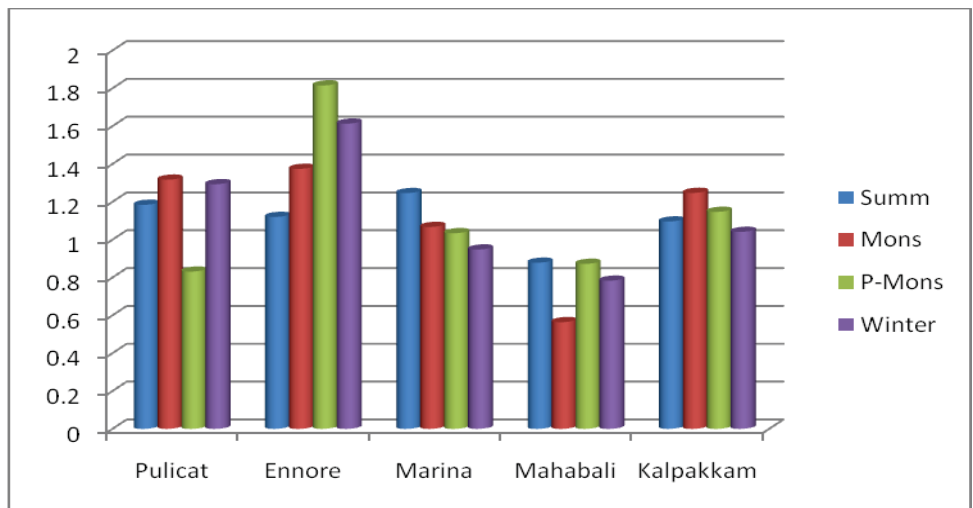


Figure 3. Concentration of Cadmium in sediment collected from different locations in different seasons (mg/kg)

IV.CONCLUSION

It is observed from this study that there is no much seasonal variation in concentrations of the Cadmium in fish samples, however the concentration in three locations are higher in Post-Monsoon season. The higher concentrations of Cd in water in most of the locations are observed in monsoon season. This may be mainly due to the run off during the monsoon. The maximum concentrations of Cd in sediment are observed in various seasons in different locations. Maximum Cd concentration in fish and sediment are observed in Ennore in Post-Monsoon season. This shows the higher concentration of Cd in the effluents discharged from various industries located near Ennore.

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