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Analysis of Heavy Metals in fish,water and sediment from Bay of Bengal

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ABSTRACT : *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). The samples were collected near seashore of Bay of Bengal from 5 different locations in North Tamilnadu like Pulicat, Ennore, Marina, Mahabalipuram and Kalpakkam during the period June-August 2012. The maximum concentrations of heavy metals in fish Arsenic (0.429 mg/kg), Cadmium (0.418 mg/kg), Chromium (0.713 mg/kg), Lead (0.716 mg/kg), and Mercury (0.078 mg/kg) were observed in samples collected from Ennore. Maximum heavy metal concentrations in water are Arsenic (0.034 mg/l - Ennore), Cadmium (0.028 mg/l- Pulicat), Chromium (0.063 mg/l - Ennore), Lead (0.016 mg/l- Kalpakkam) and Mercury (0.019 mg/l - Marina). Highest concentrations of Arsenic (1.841 mg/kg), Cadmium (1.374 mg/kg) and Lead (1. 814 mg/kg) in sediment were observed in samples collected from Ennore and that of Chromium (1.569 mg/kg) and Mercury (0. 673 mg/kg) in Marina.*

KEY WORDS : *Atomic Absorption Spectrophotometer (AAS), Concentration, Chennai, Heavy metals, Spotted Seer fish*

I. INTRODUCTION

There are more definitions for the word ”Heavy metal”, but none has obtained widespread acceptance. The different criteria used to define “heavy metal” are density, atomic weight, atomic number and position in the periodic table [1]. The definitions for “heavy metal” in terms of density (specific gravity) is “metal whose density is approximately 5.0 or higher” [2] .In terms of atomic weight (relative atomic mass), it is defined as “the metallic element with high atomic weight (e.g., mercury, chromium, cadmium, arsenic, and lead) which can damage living things at low concentrations and tends to accumulate in the food chain” [3].“Any element with an atomic number greater than 20” is the definition of “heavy metal” in terms of atomic number [4].Heavy metals are found naturally in the earth, and become concentrated as a result of human caused activities. Common natural sources of heavy metals are volcanic activities, forest fires, erosion of rocks etc. The anthropogenic sources of heavy metals are mining and industrial wastes, lead –acid batteries, vehicle emission, fertilizers, paints and treated woods. Some heavy metals like Iron, cobalt, copper, manganese, zinc etc. are required by humans, but excessive levels can be damaging to the organism. Some other heavy metals such as mercury and lead are highly toxic and their accumulation over time in the bodies of animals can cause serious illness [5]. Generally, humans are exposed to these metals by ingestion (drinking or eating) or inhalation (breathing). Working or living in and around the industrial area will increase the risk of exposure to heavy metals. Heavy metal toxicity can result in various ill health effects in humans. Inorganic arsenic is carcinogen and can cause cancer of skin, lungs, liver and bladder.

Ingestion of very high levels may result in death. Cadmium and cadmium compounds are also known human carcinogens. Breathing high levels of cadmium may cause severe damage to the lungs. Ingestion of high level severely irritates the stomach causing vomiting and diarrhea. Long term exposure to Chromium can cause damage to liver, kidney circulatory and nerve tissues, as well as skin irritation. Exposure to high levels of Mercury can permanently damage the brain, kidneys, and developing fetuses. Exposure to high levels of lead can severely damage the brain and kidneys and ultimately cause death. [6]Many of our rivers, lakes, and oceans have been contaminated by pollutants. Some of these pollutants are directly discharged from industrial plants and municipal sewage treatment plants, some come from polluted runoff in urban and agricultural areas, and some are the result of historical contamination. The pollutants that enter the water cause undesirable changes which affect the ecological balance of the environment. Among all the pollutants, accumulation of heavy metals is of global importance because of its adverse impact on environment and human health. Fish is a valuable food item in human diet and source of protein.

The concentration of heavy metals in aquatic organisms is higher than that present in water through the effect of bio concentration and bio magnification and eventually threaten the health of human by sea food consumption [7]. Fishes are widely used as bio indicators of marine pollution by metals [8]. So determination of heavy metal concentration in fishes is very important as far as human health is concerned. The objective of this study is to determine the concentration of some trace metals in Spotted Seer fish, water and sediments collected from Bay of Bengal from 5 different locations in North Tamilnadu (Pulicat, Ennore, Marina, Mahabalipuram and Kalpakkam) during the period June-August 2012

II. METHODOLOGY

2.1. 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. A map showing the study area is given in Fig.1.

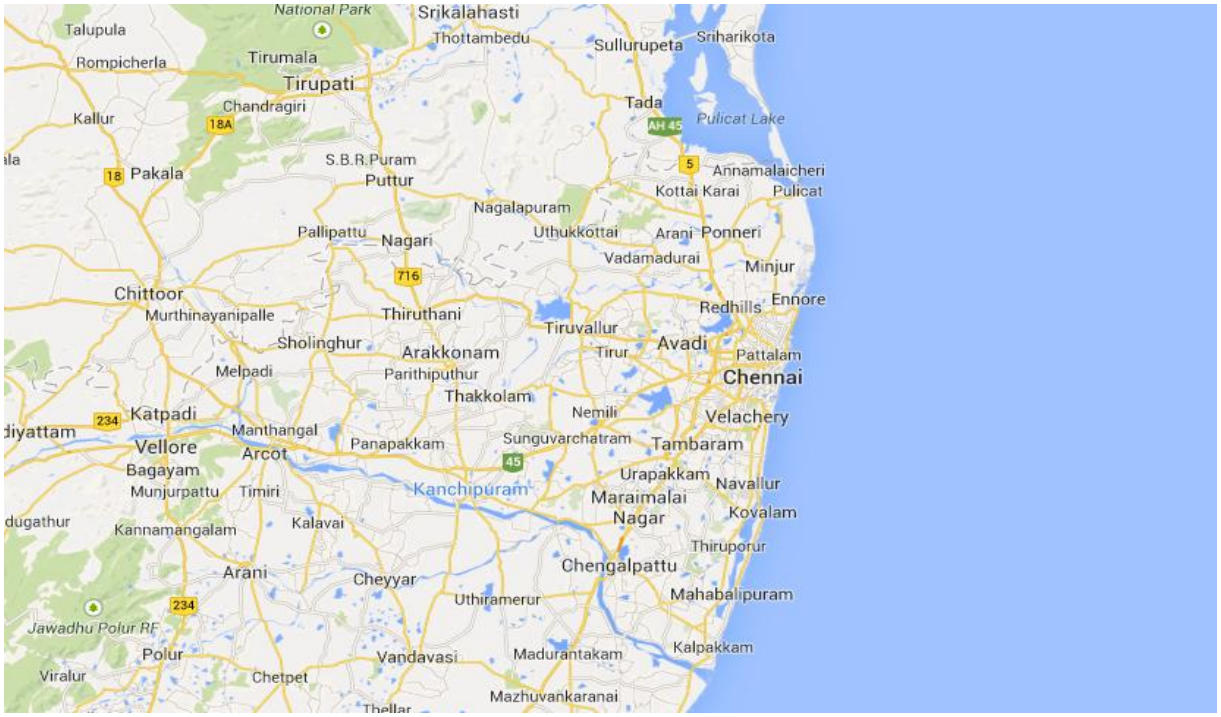

Figure 1. Map showing the study area

Figure 2.

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. It is the second leading brackish lagoon in India–covering a total area of 720 sq km of which 84% comes in Andhra Pradesh and 16% in Tamil Nadu, which once nurtured rich flora and fauna. But, in recent years, the discharge of effluent from various industries imparted severe stress on its ecosystem. Several studies have already been conducted related to the heavy metal contamination in this area. [9] [10] [11]. 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. [12] [13 [14] 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[15].

Marina Beach is an urban beach in the city of Chennai, Tamilnadu, 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 (8.1 mi), 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.

Materials and Methods : The water, sediment and spotted seer fish samples were collected during June – August 2012 from all the 5 locations within 500 meters from the seashore. The physico-chemical 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^o for the analysis. The fish samples were thawed, and then dried in a hot air oven at 60^{o}C. After removing the moisture content, the weight was taken again.

Digestion procedure for fish samples : 15 gm of fish sample was taken and the ashing was done at 500^{o}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 was made up to 25 ml with distilled water.

Digestion procedure for water samples : For As, Cd, Cr and Pb: 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 was 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).For Mercury (Hg): 100ml water sample was taken in a beaker and 5 ml Sulphuric Acid (H_2SO_4), 2.5 ml Nitric Acid (HNO_3) and 15 ml Pottassium Permanganate ($KMNO_4$) were added. Then it was placed in a hot plate for 15 minutes for digestion. Then 8 ml Pottassium Persulphate ($K_2S_2O_8$) was added and heated in 100^{0}C water bath for 2 hours. After cooling, 6 ml Sodium Chloride Hydroxylamine Sulphate was added. After discoloration, 5 ml stannous chloride (SnCl2) was added.

Digestion procedure for sediment samples : 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 Whattman filter paper No.41 and was collected in 100 ml standard flask. Heavy Metal concentrations were determined by Atomic Absorption Spectrophotometer (AAS).

III. RESULTS AND DISCUSSIONS

Fish : The maximum and minimum concentrations of selected heavy metals in fish caught from different locations are given in Table 1 and the graphical representation of the maximum concentration in Fig.2. It is observed that the maximum concentration of Arsenic (0.429 mg/kg), Cadmium (0.418 mg/kg), Chromium (0.713 mg/kg), Lead (0.716 mg/kg), and Mercury (0.078 mg/kg) were observed in Ennore.

Table 1. Concentrations (Minimum and maximum values) of H.M. in fish caught from different locations (mg/kg)

	As		Cd		Cr		Pb		Hg	
Location	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Pulicat	BDL	0.42	0.032	0.382	0.03	0.585	BDL	0.521	BDL	0.072
Ennore	BDL	0.429	0.034	0.418	0.112	0.713	BDL	0.716	BDL	0.078
Marina	BDL	0.302	BDL	0.368	0.033	0.518	BDL	0.616	BDL	0.064
Mahabalipuram	BDL	0.264	BDL	0.312	0.031	0.411	BDL	0.318	BDL	0.06
Kalpakkam	BDL	0.254	BDL	0.407	BDL	0.308	BDL	0.486	BDL	0.064

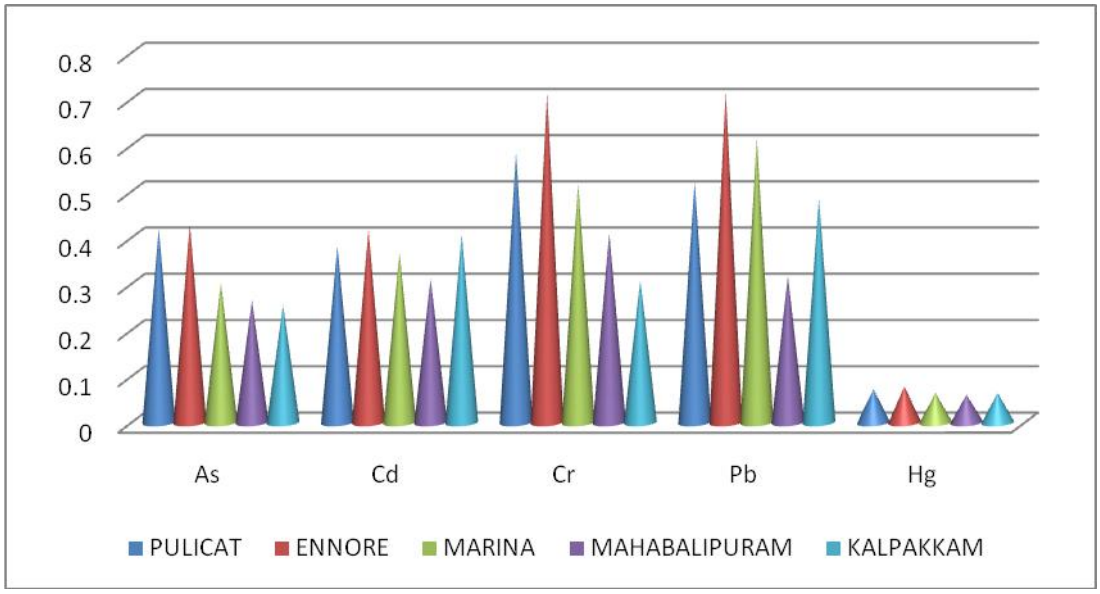

Figure 3. Maximum concentration of H.M. in fish caught from different locations (mg/kg)

Water : The concentrations of heavy metals in water collected from 5 different locations are given in Table 2 and the graphical representation in Fig.3. The maximum concentration of Arsenic (0.034 mg/l), and Chromium (0.063 mg/l) were observed in Ennore. Maximum concentration of Cadmium (0.028 mg/l), Lead (0.016 mg/l) and Mercury (0.019 mg/l) were observed in Pulicat, Kalpakkam and Marina respectively.

Table 2. Concentrations of H.M. in water collected from different locations (mg/lit)

Location	As	Cd	Cr	Pb	Hg
Pulicat	0.024	0.028	BDL	0.014	0.01
Ennore	0.034	0.027	0.063	0.015	0.009
Marina	0.016	0.012	0.022	0.012	0.019
Mahabalipuram	0.013	0.013	0.026	0.014	0.009
Kalpakkam	0.012	0.023	0.02	0.016	0.01

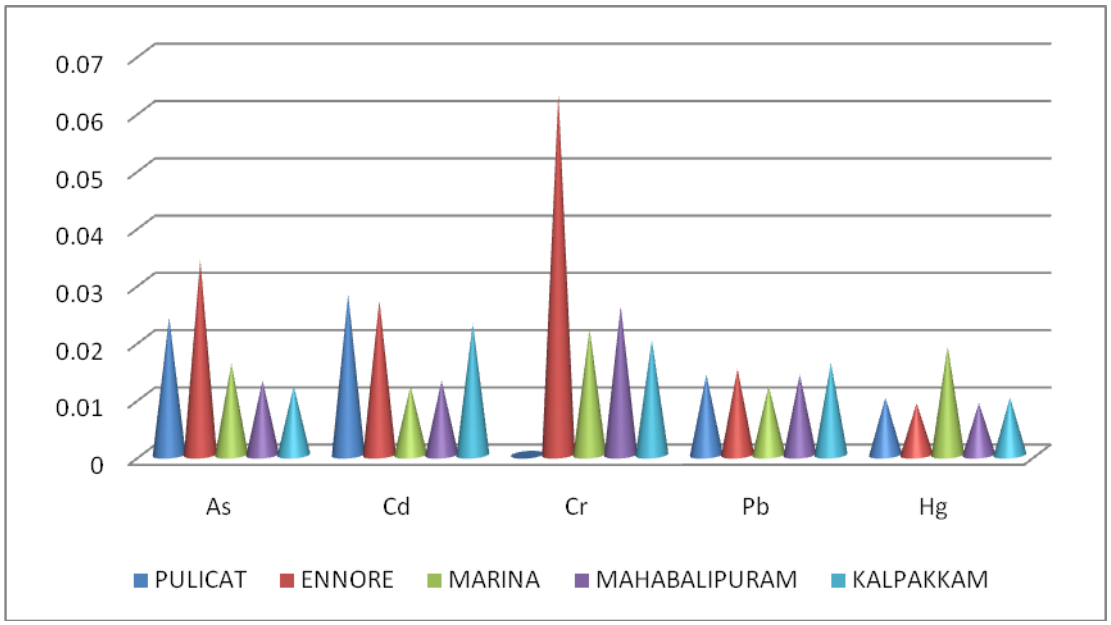

Figure 4. Concentration of H.M. in water collected from different locations (mg/lit)

Sediment L: The concentrations of heavy metals in sediments collected from 5 different locations are given in Table 3 and the graphical representation in Fig.4. The maximum concentration of Arsenic (1.841 mg/kg), Cadmium (1.374 mg/kg) and Lead (1. 814 mg/kg) were observed in Ennore. Maximum concentration of Chromium (1.569 mg/kg) and Mercury (0. 736 mg/kg) were observed in Marina.

Table3. Concentrations of H.M. in sediment collected from different locations (mg/kg)

Location	As	Cd	Cr	Pb	Hg
Pulicat	1.18	1.317	1.113	0.468	0.284
Ennore	1.841	1.374	1.157	1.481	0.394
Marina	0.508	1.067	1.569	0.363	0.673
Mahabalipuram	0.636	0.564	0.919	0.412	0.318
Kalpakkam	0.518	1.247	0.542	0.241	0.194

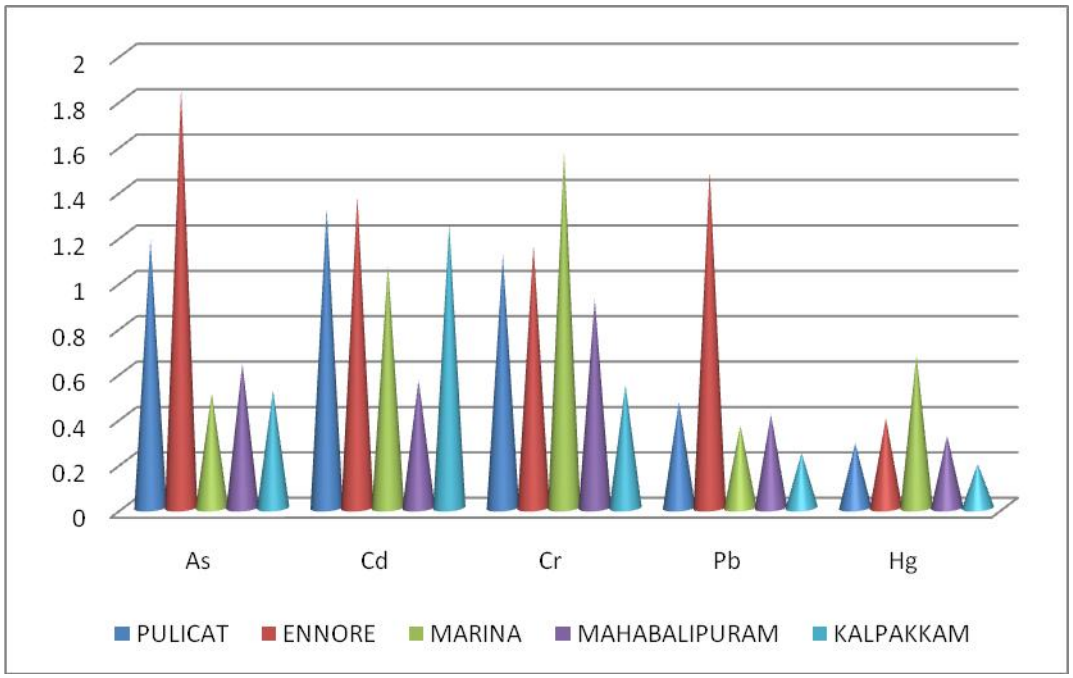

Figure 5. Concentration of H.M. in sediment collected from different locations (mg/kg)

IV. CONCLUSION

It is observed from this study that the maximum concentrations of all the five heavy metals in the fish are high in samples collected from Ennore. Maximum concentrations of two heavy metals (Arsenic and Chromium) in water and 3 heavy metals (Arsenic, Cadmium and Lead) in sediment are observed in Ennore. It may be due to the discharge of untreated effluent from various industries located near Ennore. As far as the importance of fish in human diet is concerned, it is necessary that the biological monitoring of water and fish should be done periodically to ensure the safety of sea food consumption. The safe disposal of industrial effluents and domestic sewage should be practiced to avoid such contamination. Also, the laws enacted to protect the environment should be enforced effectively.

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