

Seasonal Variation in Heavy Metal Distribution in Fish, Water and Sediment

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Abstract— The objective of the study is to reveal the seasonal variations in fish, water and sediment collected near seashore of Bay of Bengal with respect to heavy metal contamination. 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 Pulicat situated in the Northern coast of Tamilnadu (India) in 5 different seasons. The concentration of heavy metals in each sample were determined using Atomic Absorption Spectrophotometer (AAS). The study shows that the concentrations of most of the heavy metals in fish are higher in summer season, water in monsoon season, and sediments in post-monsoon season.

Keywords— Heavy metals, concentration, Atomic Absorption Spectrophotometer(AAS), Spotted Seer fish, Seasonal variations, Pulicat, sediment, water

I. Introduction

The rapid industrialization and economic development cause the generation of massive amount of domestic waste water and industrial effluents which are transported by rivers and discharged into the sea. The pollutant that enters 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 due to its adverse impact on human health. Some heavy metals like Iron, Cobalt, Copper, Manganese, Molybdenum and Zinc are essential to the humans body to maintain the metabolism, but its excessive levels can be damaging to the organism. But, some heavy metals such as Mercury, Plutonium, and Lead are toxic metals that have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of animals can cause serious illness.

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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 (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, a coastal stretch of Tamilnadu which is located 60 kms North of Chennai. 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. Materials and methods

The water, sediment and fish samples were collected within 500 meters from the seashore. The physiochemical 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 (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. Placed it 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 (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. Heavy Metal concentrations were determined by Atomic Absorption Spectrophotometer (AAS)

III. Results and Discussions

A. 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 (As), Cadmium (Cd), Chromium (Cr), Lead (Pb), and Mercury (Hg), are in Summer (0.472 mg/kg), Winter (0.426 mg/kg), Summer (0.736 mg/kg), summer (0.563 mg/kg) and summer (0.077 mg/kg) respectively.

TABLE I. CONCENTRATIONS (MINIMUM AND MAXIMUM VALUES) OF H.M. IN FISH CAUGHT IN DIFFERENT SEASONS (MG/KG)

Season	As		Cd		Cr		Pb		Hg	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Summer	BDL	0.472	0.032	0.423	0.042	0.736	BDL	0.563	BDL	0.077
Monsoon	BDL	0.42	0.032	0.382	0.03	0.585	BDL	0.521	BDL	0.072
Post-Monsoon	BDL	0.382	0.083	0.417	0.036	0.518	BDL	0.368	BDL	0.064
Winter	BDL	0.404	BDL	0.426	BDL	0.436	BDL	0.224	BDL	0.059

TABLE II. CONCENTRATION OF H.M. IN WATER COLLECTED IN DIFFERENT SEASONS (MG/L)

Seasons	As	Cd	Cr	Pb	Hg
Summer	0.021	0.018	0.028	0.016	0.006
Monsoon	0.024	0.028	BDL	0.014	0.01
Post-Monsoon	0.02	0.021	0.032	0.015	0.008
Winter	0.017	0.015	0.016	0.015	0.006

TABLE III. CONCENTRATION OF H.M. IN SEDIMENT COLLECTED IN DIFFERENT SEASONS (MG/KG)

Seasons	As	Cd	Cr	Pb	Hg
Summer	0.682	1.184	1.368	1.344	0.322
Monsoon	1.18	1.317	1.113	1.224	0.284
Post-Monsoon	1.548	0.831	1.387	1.372	0.286
Winter	0.524	1.293	1.216	1.168	0.186

B. 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 (0.024 mg/l), Cadmium (0.028 mg/l), and Mercury (0.01 mg/l) are observed in monsoon season. Maximum concentration of Lead (0.016 mg/l) and Chromium (0.032 mg/l) are observed in summer and post-monsoon seasons respectively.

C. Sediment

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 concentration of Arsenic (1.548 mg/kg), Chromium (1.317 mg/kg) and Lead (1.372 mg/kg) are observed in post-monsoon. Maximum concentration of Cadmium (1.317 mg/kg) is observed in monsoon and Mercury (0.322 mg/kg) in summer seasons.

Figure 1. Maximum Concentration of H.M. in fish (mg/kg)

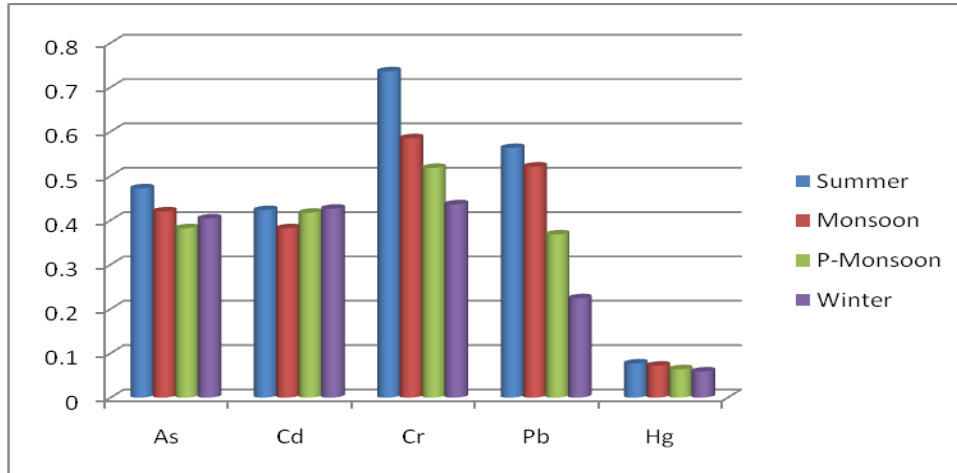


Figure 2. Concentration of H.M. in water (mg/l)

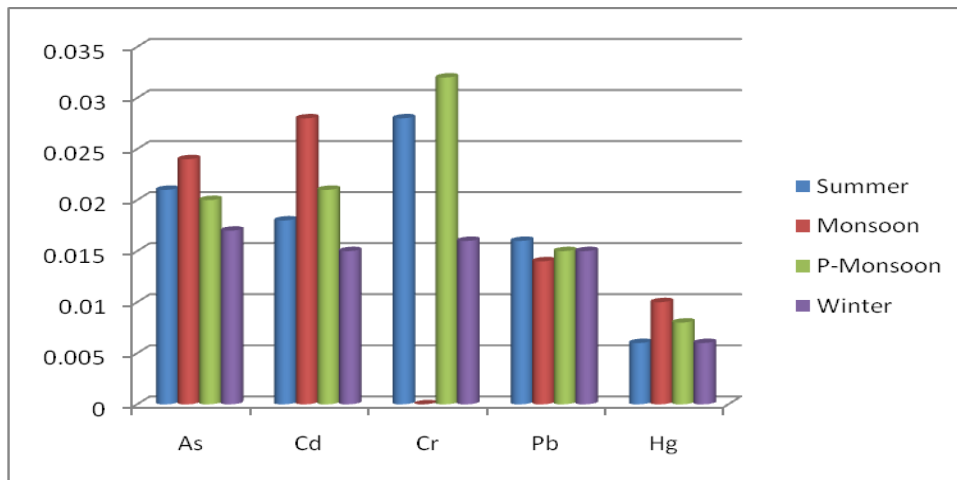
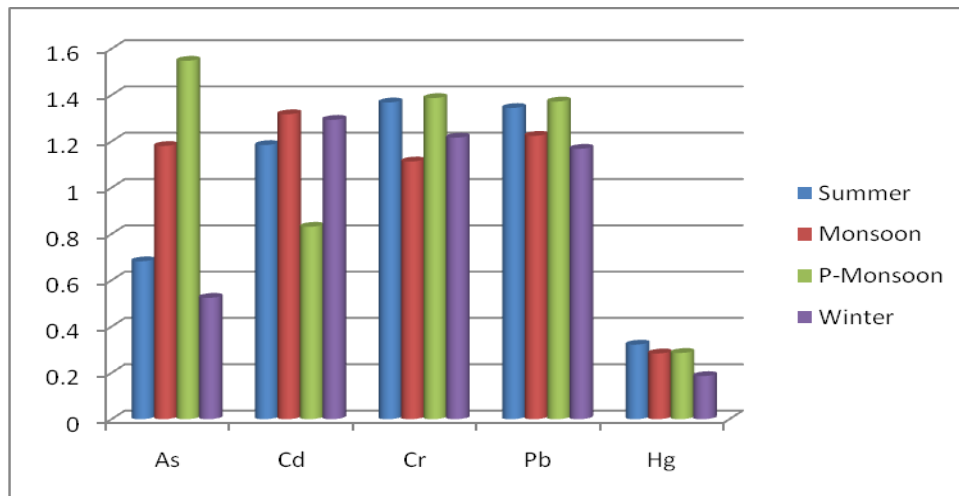


Figure 3. Concentration of H.M. in sediment (mg/kg)



iv. Conclusion

It is observed from this study that there is no much seasonal variation in concentrations of the heavy metals in fish samples, however the concentration of some metals are higher in summer season. The concentrations of most of the heavy metals in water is observed in monsoon season. This may be mainly due to the addition of heavy metals by run off during the monsoon. The concentrations of most of the heavy metals in sediment is observed in post-monsoon season and this may be due to the settlement of H.M. from the water.

References

- [1] Jayaprakash, M., Srinivasalu, S., Jonathan, M.P., and Mohan, V. 2005. A baseline study of physicochemical parameters and trace metals in water of Ennore Creek, Chennai, India. *Mar. Poll. Bull.*, 50: 583-589.
- [2] Kannan, K.S. and Krishnamoorthy, R. 2006. Isolation of mercury resistant bacteria and influence of abiotic factors on bioavailability of mercury-A case study in Pulicat Lake north of Chennai, South East India. *Sci. Tot. Environ.*, 367: 341-363.
- [3] Kannan, K.S., Lee, K.J. Krishnamoorthy, R., Purusothaman, A., Shanthi, K. and Rao, R. 2007. Aerobic chromium reducing *Bacillus cereus* isolated from the heavy metal contaminated Ennore Creek sediment, North of Chennai, Tamilnadu, South East India. *Res. J. Microbiol.*, 2(2): 130-140.
- [4] Padmini, E. and Kavitha, M. 2005a. Contaminant induced stress impact on biochemical changes in brain of estuarine grey mullets. *Poll. Res.*, 24: 647-651.
- [5] Varma, P. U. and Reddy, C. V. G., Seasonal variation of the hydrological conditions of the Madras coastal waters. *Indian J. Fish.*, 1959, 6, 298-305.
- [6] Murthy, RKV. & Rao BK. (1987). Survey of meiofauna in the Gautami-Godavari estuary. *J Mar Biol Assoc India*, 29, 37-44.
- [7] Nammalwar, P. (1992). Fish bioassay in the Cooum and Adyar estuaries for environmental management, In K.P. Singh & U.J.S Singh (Eds), *Tropical ecosystems Ecology and management (359-370)*. Delhi, India : Wiley Eastern.
- [8] Nieboer, E. & Richardson DHS. (1980). The replacement of the nondescript term 'heavy metals' by a biologically and chemically significant classification of metal ions. *Environ Poll Bull*, 1, 3-26.
- [9] Batvari, B . P. D., K amala Kannan, S., Shanthi , K., K rishnamoorthy, R., Lee, K. J., & Jayaprakash, M. (2008). Heavy metals in two fish species (*Carangoides malabaricus* and *Belones tronglurus*) from Pulicat Lake, North of Chennai, South east coast of India. *Environmental Monitoring and Assessment*, 145, 167-175.
- [10] Ahmad, M. K., Islam, S. , Rahman, S. , Haque, M. R. and Islam, M. M. Heavy Metals in Water, Sediment and Some Fishes of Buriganga River, Bangladesh. *Int. J. Environ. Res.*, 4(2):321-332, Spring 2010
- [11] Murthy, RKV. & Rao BK. (1987). Survey of meiofauna in the Gautami-Godavari estuary. *J Mar Biol Assoc India*, 29, 37-44.
- [12] Nammalwar, P. (1992). Fish bioassay in the Cooum and Adyar estuaries for environmental management, In K.P. Singh & U.J.S Singh (Eds), *Tropical ecosystems Ecology and management (359-370)*. Delhi, India : Wiley Eastern.
- [13] Nieboer, E. & Richardson DHS. (1980). The replacement of the nondescript term 'heavy metals' by a biologically and chemically significant classification of metal ions. *Environ Poll Bull*, 1, 3-26.