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Mercury concentration in molluscs and sediments from Uppanar Estuary, Southeast Coast of India

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ABSTRACT

This research was designed to evaluate the mercury concentration in sediment, shell and tissue of the molluscs Meretrix meretrix, Crassostrea madrasensis and Cerithidea cingulata from two stations of Uppanar Estuary, Southeast coast of India. The concentration of mercury analyzed exhibited not much variation in sediment, tissue and shell of the study animal from all the 2stations. Mercury levels ranged from 1.2 to 1.8 µg/g dry weight in sediment samples and from 0.6 to 3.4 ppm in the shell and tissue of the molluscs. Even though no high levels of Hg were determined in the sediment and organisms, possible hazard may occur in the future depending on the agricultural and industrial development in this area. As suggested by many reported studies found in the literature, regular biomonitoring of the mercury concentration at these sites is needed since Meretrix meretrix, Crassostrea madrasensis is a popular commercial bivalve in India.

Keywords: Uppanar, Mercury, sediments, mollusc and shell.

INTRODUCTION

Mercury is a source of metal pollution both in inorganic and organic forms. Mercury, a highly toxic substance, occurs in the nature environment. It can be released into the air as a result of human or volcanic activities and then transported globally via air circulation. The mercury in the atmosphere was returned into soil and oceans via wet precipitation. Over the last century anthropogenic emissions have tripled the concentrations of Hg in the atmosphere and in the surface ocean [1]. Due to the bioaccumulation character, mercury, particularly methyl mercury, has the tendency of magnification in the food chain. Therefore, the mercury in the edible marine organism in the marine food chain can be transferred into human bodies [2]. The greater the seafood consumed, the higher the mercury intake is [3]. That indicates that seafood consumption is related to mercury intake. Excessive mercury intake may cause the permanent harm to the

central nervous system [4], such as behavioral disorders and deficiencies in immune system and development [5]. There is widespread recognition that mercury (Hg) and its compounds pose a significant threat to human health. The characteristic properties of these compounds include extremely high toxicity, resistance to environmental degradation which leads to persistence in the environment, accumulation within organisms and magnification up the food chain, and susceptibility to long distance transport. Mercury is very toxic to humans, and the recommended safe levels in drinking water are lower than for any other metal [6]. The purpose of the study is to determine the mercury levels Mercury (Hg) and it is one of the most important pollutants because of its effect on marine organisms and which is potentially hazardous for humans. The results of the study will be used to determine whether there is a significant health risk arising from shellfish consumption.

Study Area

The Uppanar estuary is situated at Cuddalore which is about 25 km away from the Parangipettai coast. Uppanar estuary is also an open type estuary and the width of the mouth is around 30 m. The Cuddalore fishing harbour is situated near the mouth of the Uppanar estuary, which is one among the important fishing harbours of Tamil Nadu. SIPCOT industrial park (State Industries Promotion Council of Tamil Nadu) is located on the northern bank of Uppanar estuary covering an area of about 520 acres with 44 industries, which include chemicals, petrochemicals, pharmaceutics, pesticides, fertilizers and metal processing industries **(Fig 1)**.

Fig 1: Map Showing the Study Area

Station 1- SIPCOT: (Lat. 11^0 41' N; Long 79^0 45' E): It is situated near where the SIPCOT industrial units are discharging. Municipal and domestic sewage from the nearby Cuddalore town and coconut retting effluents are also released here.

Station 2– Landing centre: (Lat 11^0 44' N; Long 79^0 46' E): This station lies near the mouth of the estuary, which is nearly 3 km away from station 1, and in close proximity to the fishing harbour.

MATERIALS AND METHODS

Total Hg in the sediment samples, tissues and shells of three different species of molluscs such as *Cerithidea cingulata*, *Crassostrea madrasensis* and *Meretrix meretrix* collected from two stations of Uppanar Estuary, Southeast coast of India was analysed. Hg was determined by strong acid (HNO3/H2SO4/HCl) digestion, addition of bromine chloride, reduction with sodium borohydride and analysis via hydride generation atomic absorption spectroscopy.

Sediment

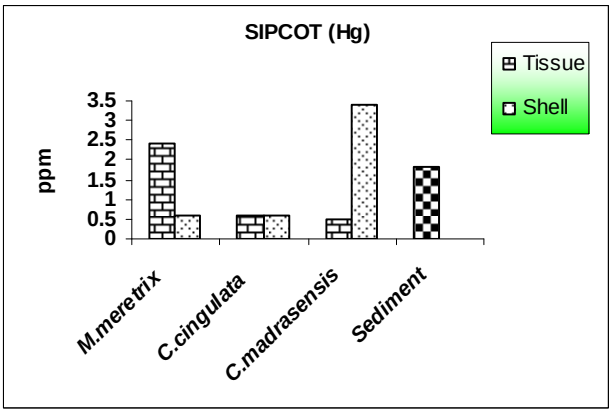
Sediment samples were collected using a pre cleaned and acid washed PVC corer and immediately kept in pre cleaned and acid washed polythene bags, which were sealed and kept in an ice box until further analysis in the laboratory. Sediment samples were washed with metal free double distilled water. The sediment samples were then dried in an oven at 60ºC for 5-6 hours. Dried sediment samples were ground in a glass mortar and reduced into fine particles.

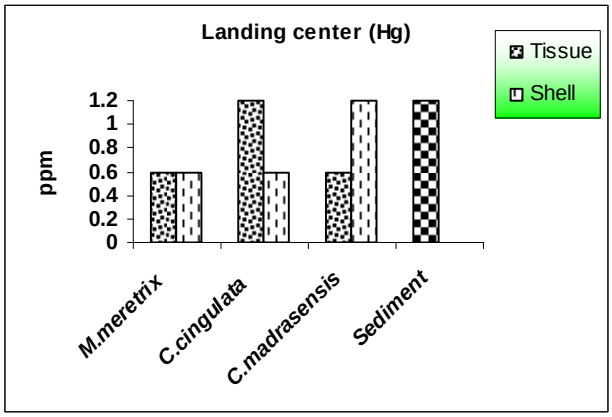
Tissue and shell

The molluscs were collected by hand picking. The soft tissue was removed from the shells with a plastic knife and dried at 60ºC. The dried tissue was reduced into fine powder in a pestle and mortar and was stored in dessicator for further analysis. The shell of individual species of molluscs was also finely ground. The resulting powder was selected, using a plastic sieve with 0.2mm opening size and was stored in dessicator for further analysis.

RESULTS AND DISCUSSION

The concentration of the mercury in the dry weight sample of sediment ranged from (1.2 to 1.8ppm), tissue ranged from (0.4 to 2.4 ppm), while in the shell samples it was (0.6 to 3.4 ppm). **(Fig 2 & 3)**. In Station 1 highest value of mercury concentration recorded in *M. meretrix* (2.4 ppm) and the lowest in *C. madrasensis* (0.4ppm) in the tissue. At the same time the shell recorded the maximum mercury content in *C. madrasensis* of (3.4ppm) and the lowest concentration in both *M. meretrix* and *C. cingulata* (0.6ppm) **(Fig. 1)**. In Station 2 highest value of mercury was recorded in *C. cingulata* (1.2ppm) and the lowest value in both *C. madrasensis*, *M. meretrix* (0.6 ppm) in the tissue. The shell recorded the maximum content of mercury in *C. madrasensis* (1.2ppm) and minimum equally in *M. meretrix* and *C. cingulata* (0.6ppm) **(Fig. 2).** The sediment concentration in station I (1.8ppm) followed by station II (1.2ppm) **(Fig. 1&2).**





Mercury is toxic heavy metal group and toxicity reflects an exogenous influence that may be related to environmental pollution. However, when the level of Hg in fish muscle was 5µg/g (wet weight) can be associated with emaciation, decreased coordination, loss of appetite, and mortality in fish themselves, while concentrations of 15µg/g are required for adverse effects in predators that eat the fish [7]. In our study, a concentration of Hg does not reach to this level, so it does not pose a problem for the studied organisms themselves and the consumers. Harmful effects occur at dietary levels 5.5 µg/g [8]. Despite these apparently low levels of mercury in tissue and shell (0.6 to 3.4 µg/g dry weight), they are still a potential public health concern[9], since mercury is a toxic metal that bioamplifies through food webs. While low concentrations of mercury were found in sediments (1.2 to1.8 µg/g dry weight).

The concentration of metal in mussel tissues is the result of a balance between the tissue growth-rate and the metal accumulation rate. If the tissue growth rate exceeds the accumulation rate, the concentration of mercury decreases with mussel size, while the opposite occurs when the mussel grows more slowly than the rate of metal accumulation[10]. The mercury levels of fishes that commonly consumed by Taiwanese ranges from 0.008 to 0.198 mg/ kg. The mercury levels of shellfishes and cephalopods, ranging from 0.002 to 0.061 mg/kg, which is than the present investigation [11]. As compared with the mercury levels of similar species reported in the literatures, the mercury level of the shrimp is lower than UK and is about 1/10 of Italy and Japan [12] . Range of the mercury level of shellfishes was close to Canada (0.024-0.051 mg/kg) and Japan (0.050-0.152 mg/kg) [13].

Mercury levels were below the 0.5 µg/g -1wet weight limit recommended by the FAO/WHO and WHO in edible parts of the fish samples and the 0.5-1 mg/kg limit for different fish products. Mercury is not produced in India and the entire requirements of this metal are imported. Nevertheless, the industrial activity is responsible for high concentrations of Hg in the air (up to 41.5 ng/m3). Consumption of wheat and rice stored with mercury tablets, used as a preservative, can increase Hg intake to 0.1-0.4 mg Hg/day.

The occurrence and distribution of mercury in water, particulate matter and sediment samples from three different biotopes, namely estuary, backwater and mangrove, have been studied on the East Coast of India. The estuarine water contained 0.0015-0.0045 ppm mercury white the

backwater had 0.002-0.0025 ppm and the mangrove water 0.003-0.0035 ppm. The mercury content of the particulate matter was 0.15-0.4 ppm, 0.28 ppm in the estuarine water, 0.13-0.30 ppm in the backwater and 0.18-0.35 ppm in the mangrove water. The range of concentrations of mercury in sediments was from 0.1-0.33 in the estuary, from 0.13-0.28 in the backwater and from 0.13-0.25 in the mangrove. Oysters of average wet body-weight had mercury contents ranging from 0.32 to 0.72 ppm. The levels of mercury in natural sea-water is reported to be 0.0003 ppm but in polluted waters the concentration can go as high as 0.03 ppm. On this basis, the concentration of mercury in the estuarine region was 5-15 times of the backwater, 5-8 times of the mangrove, and 10-12 times that of normal seawater [14] .The mercury content of the sediments in the biotopes was comparable with values reported for Lake Erie sediments [15].

CONCLUSION

Thus the present studied metal (Hg) is in the acceptable range of concentration compared with the previous studies. Overall, the findings demonstrated that the molluscs are safe for human consumption and that the ecosystems where they were harvested do not pose any hazard to man in terms of health risk. However, caution should be taken if the bivalves are continuously used; especially children have about five times more gastrointestinal absorption rate of adults.

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