Original Paper

# Assessment of Mercury Contamination of Eloor Region of Periyar River in Kerala by Dithizone Method

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**ABSTRACT**

Pollution in Periyar River in Kerala is increasing rapidly and mercury is a major pollutant that is released by the industries situated on its banks. Mercury toxicity is difficult to diagnose and can eventually result in conditions such as Minimata disease if not controlled.

An attempt has been made in this study to assess the extent of mercury contamination in the river by dithizone method and compare it with the maximum permissible level for river water. A comparison has also been attempted to assess the extent of mercury contamination of Periyar with that of other contaminated rivers of India.

A total of 40 water samples each were collected from 10 different locations of Periyar river at surface level and at 1 metre depth. The samples were analysed by dithizone method of heavy metal extraction with the help of spectrophotometer.

The mean mercury value obtained (at both levels) was 0.03 mg/L, which is 30 times more than the permissible level allowed in water (0.001 mg/L). The values obtained at 1m depth are slightly higher than at the surface. The mercury levels are comparable to that of polluted tributaries of other rivers such as Ganga and Yamuna in north India.

It is imperative that the use of out-dated, inefficient methods of water treatment should be replaced with controlled release of mercury through separate sewer systems, and employing membrane cells, chitosan and granulated slag as adsorbents.

**Key Words:** Mercury; Pollution; Periyar river; Dithizone

## Introduction

Rivers have been witnesses to the evolution of human civilization. Man has been using rivers in innumerable ways and at the same time fouling it with garbage. This is sounding the death knell of many rivers. One such example is the Periyar river in Kerala which is bearing the brunt of effluent discharge from the numerous factories situated on its banks. Periyar is a major source of water for residents of Cochin. There have been reports of mass death of fish, and increased incidence of ailments like asthma, cancer and congenital malformations, which may have a link to its pollution.[1] Mercury, a known pollutant of rivers, is released into Periyar by the factories situated in the area. Chronic mercury toxicity is difficult to diagnose because initial symptoms are vague comprising headache, paraesthesias, amnesia and depression.[2]

In order to assess the effects of mercury on human health, it is essential to estimate the concentrations of mercury in water and blood, and unfortunately there is not enough information about mercury in water to establish a standard.[3] In this study an attempt has been made to estimate the level of mercury in Periyar river water by dithizone method. This preliminary study can form the basis for more extensive studies in the future.

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## Materials and Methods

The study was undertaken on the water of Periyar river as it passes through Eloor industrial region of Ernakulam district of Kerala (within which Cochin city is located). A total of 40 water samples were collected from 10 different locations, both from the surface and at 1 m depth.

All samples were collected and stored in plastic bottles and taken to the analytical toxicology laboratory of Amrita Institute of Medical Sciences, Cochin. Analysis was done by dithizone method of heavy metal extraction, which involves complexation of mercury with the chelator dithizone and reading the absorbance by spectrophotometer.[4]

### Equipment:

1. Spectrophotometry: UV-visible double beam (2201 Systronics)
2. Separator funnels: 250 ml with stopcocks
3. Glassware: Cleaned with acid

**Reagents**: Mercury-free redistilled water, stock mercury solution (1 mg/ml), standard mercury solution (1 ml = 1 mcg mercury), potassium permanganate solution (5%), concentrated sulphuric acid, hydroxylamine hydrochloride solution (5%), stock dithizone solution (100 mg per 100 ml of chloroform), and dithizone working solution (every 10 ml diluted with 500 ml of chloroform).

### Procedure:

1. Preparation of calibration curve: Pipetting of 0, 5,10,15, 20, and 25 mcg of mercury was done into separate beakers. To each beaker 50 ml water, 0.1 ml $KMnO_4$ solution and 1 ml conc. $H_2SO_4$ was added. It was refluxed at 50 $^0$C for 30 minutes. One or more drops of $NH_2OH.HCl$ solution was added to discharge the pink colour. Extraction was done with dithizone solution. Mercury dithizonate solution was transferred to a cuvette and absorbance was recorded at 490 nm. Absorbance versus concentration of mercury plot was subsequently drawn (using Microsoft Excel.).
2. Treatment of sample: 50 ml samples were used and the procedure mentioned above was carried out. An absorbance blank consisting of all reagents was put in place. Mercury content was read from the calibration curve.

## Results

The results obtained after spectrophotometric analysis were converted to mercury value from the calibration curve already obtained. Mean value of mercury obtained from surface water was found to be 3.6 mcg/dl. The mean value was found to be 0.03 mg/L at both the levels. The values obtained were compared with the normal permissible level of mercury in water (0.001 mg/L) as ratified by the Bureau of Indian Standards as well as by Environmental Protection Agency. The level of mercury was found to be 30 times more than the permissible levels and the results were statistically significant ($p \leq 0.001$). Mercury levels at 1m depth were found to be slightly higher than in the surface water.

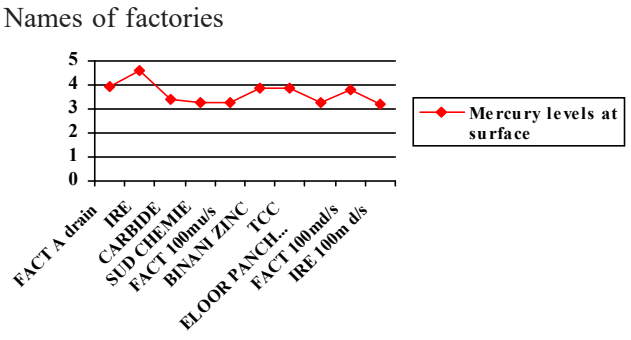


**Fig 1:** Mercury levels at the surface

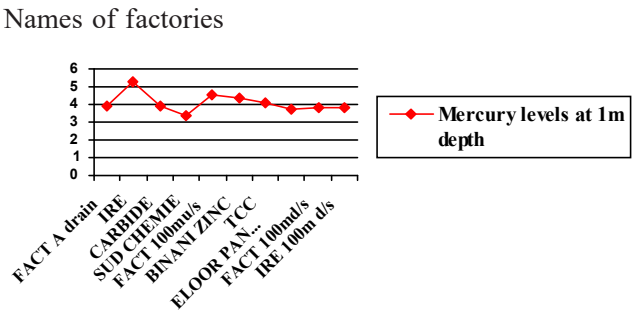


**Fig 2:** Mercury levels at 1m depth

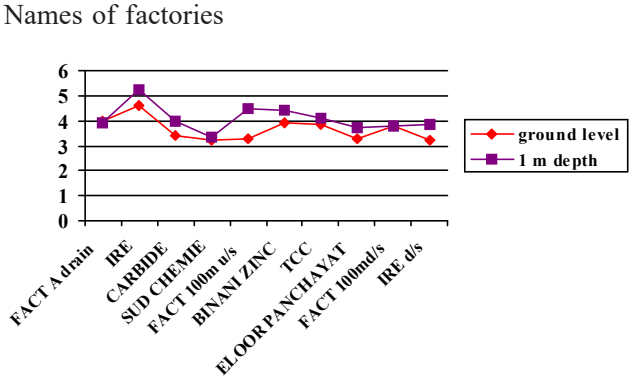


**Fig 3:** Comparison between mercury levels obtained at 1m depth and on the surface

The extent of mercury contamination of Periyar was compared with that of some other contaminated rivers of India.[5] (**Fig 4**).

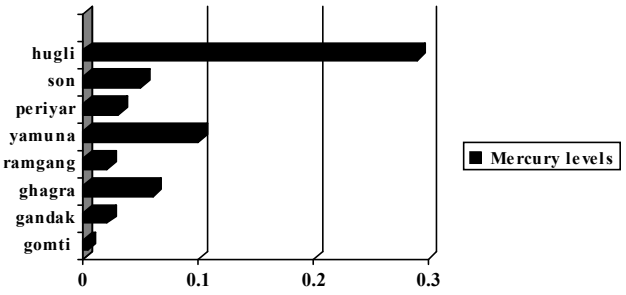


**Fig 4:** Comparison of mercury levels in different rivers

The mercury levels were also compared with that of other rivers near industrial areas where mercury is released in effluents (**Fig 5**). Even after treatment of the effluents in Eloor, the mercury levels remained quite high in this region.

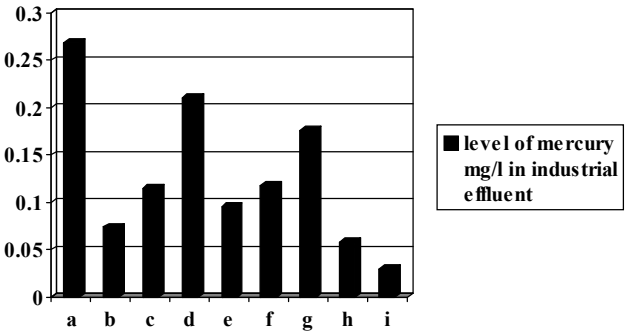


**Fig 5:** Comparison of mercury levels in industrial effluent of different areas. **a** - Permissible limit in water, **b** - Industrial area Panipat (Haryana), **c** - Barsai Road, Panipat (Haryana), **d** - Machua village, Vatva (Gujarat), **e** - Lali village, Vatva (Gujarat), **f** - Chiri village, Vapi (Gujarat), **g** - Sarangpur village, Ankleshwar (Gujarat), **h** - Bapunagar, Ankleshwar (Gujarat), **I** - Pocharam village, Patancheru (Andhra Pradesh)

## Discussion

Dithizone method of heavy metal extraction is a simple and effective method for mercury extraction even in minute quantity.[7] In this study done on the water of Periyar river of Kerala, the mean level of mercury was found to be 0.03mg/L, which is 30 times more than the permissible level in drinking water. Symptoms of toxicity can occur at blood mercury concentration of 5mcg/dl (0.05 mg/L). Periyar river is not only a source of fish for the local populace, but the water is also used for drinking and cooking purposes by the immediate residents on its banks. Since the levels are dangerously high, urgent measures need to be taken to contain the situation.

As mercury levels are higher at 1m depth as compared to the surface, the process of contamination appears to be a long-term process, and it may be hypothesized that the levels will be higher at increased depths, and in the riverbed. The mercury levels seen in Periyar are comparable to those of some other rivers in north India which similarly have industries located on their banks, although the values are not that high. Even after mercury was treated and released in Periyar, the levels are comparable to other areas where mercury was released untreated. This indicates that either the treatment methods for mercury are not efficient or the ETPs are not used properly.

This is a preliminary study meant to attract scientific focus in this region. This study raises the issue of use of outdated, inefficient methods of water treatment resulting in inadequate separation of mercury from water. Recommendations include switching over to non-mercury alternatives (use of membrane cells), control of mercury release through separate sewer system, and using chitosan and granulated slag as adsorbents for mercury. This also opens up avenues for exploration of other contaminants in Periyar river and assess the harm that could be impacting the health of the local populace. Limitations of this study include small sample size and inability to test for mercury in the riverbed.

## Acknowledgement

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