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International Journal of Current Research
Vol. 7, Issue, 01, pp.11981-11984, January, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

DETERMINATION OF HEAVY METAL TOXICITY IN LAKE WATER USING ANALYTICAL TECHNIQUE

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ARTICLE INFO

Article History:
Received 10th October, 2014
Received in revised form
19th November, 2014
Accepted 05th December, 2014
Published online 31st January, 2015

Key words:

Water quality, Pollutants, Heavy metals, Climate change, Idol immersion.

ABSTRACT

Recent investigations into the level of heavy metal enrichment in the water of Varal Devi Lake in Bhiwandi have indicated that significant contamination has occurred over the past few years. Elevated levels of Manganese have been observed in most parts of the lake causing toxicity. Current levels of manganese in the Varal Devi Lake water have arisen from natural sources and due to anthropogenic activities (Idol Immersion). These results reiterate the importance of identifying the causes of toxicity in assessments of water contamination. The results obtained were compared with standards prescribed by WHO (1993) and BIS (10500-1991). It was found that the concentration of heavy metal is above the water quality standards. The findings of the study revealed that the water quality degraded after the immersion of idols.

INTRODUCTION

Pollutants discharged directly or indirectly into water bodies without any treatment causes pollution. Water pollution also occurs due to the discharge of municipal sewage, domestic and industrial waste without any treatment. This brings considerable changes in the water quality in addition to many religious activities which has now become a threat to the ecosystem (Mukerjee Aniruddhe, 2000). Water is very precious and significant for all lives on the earth. Without water there will be no existence of any form of life. Sea, rivers, lakes are natural resources of water. Water pollution is a major global problem. The issues of water getting polluted are becoming increasingly important to environment particularly with respect to human health and food security. Festivals are an integral part of rich and diverse cultural heritage of India. In India idol immersion is another anthropogenic activity. Traditionally Ganesh idols were sculpted out of earth and after worshipping returned back to the earth by immersing it in the nearby water body. This symbolized the cycle of creation and dissolution in nature (Rupinder Kaur, 2012). The idols are made of clay, plaster of paris, cloth, paper, wood, thermocol, jute, adhesive materials and synthetic paints, etc. Of all the materials used in making the idols, thermocol is non-biodegradable while paints contain heavy metals such as Chromium, Lead, Cadmium, Mercury, Iron, Copper and Zinc. The chemical paints used to decorate the idols increases heavy metal concentration and acidity in the water (Kausik Kumar Das *et al.,* 2012). Lead and Chromium, which also adds through SINDUR in the water bodies, are very toxic even in very small quantity for human beings through the process known as Bioaccumulation and Biomagnifications. When immersed, these colours and chemicals dissolve slowly leading to significant alteration in the water quality (Kausik Kumar Das *et al.,* 2012).

In India, a lot of religious activities take place all around the year. Most of the Temples and ritual places are located near the aquatic resources like ponds, lakes, rivers etc .To study the extent of Manganese metal pollution in lake water, Varal Devi Lake, situated at Dhamankarnaka, Bhiwandi has been selected. The city of Bhiwandi, known for its textile industry, has the largest number of power looms in the country and is called the "Manchester of India". The city is known for power loom, carpets and silk fabrics. Bhiwandi is in the district of Thane, in the western state of Maharashtra, India. Economy of Bhiwandi is mostly dependent on the power loom industry. Aim of the research work was to analyze the lake water in one area of Bhiwandi to determine the Manganese metal content. This lake water is used for drinking purposes and the local inhabitants use it for fishing and other recreational activities.

This lake receives domestic raw sewage from surrounding habitation. Activities like washing of cattle, clothes, bathing, idol immersion etc are responsible for high concentration of hazardous chemicals in the lake. Domestic waste water contributes the largest source of heavy metal concentration in

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the lake. Immersion of idols is an anthropogenic activity which is responsible for adding pollution load in the lake water (Mukerjee Aniruddhe, 2000).

Typically, the Ganapati idols that have glossy, shiny finish have been coloured using synthetic paints. These paints contain toxic ingredients that get released into the water and soil after immersion. For example, the golden colour used for the crown gets its colour from Chromium compounds, the green, yellow colours from lead and lead compounds. These toxic chemicals have a harmful effect on plants, animals and humans. (Mukerjee Aniruddhe, 2000). Increase in concentration of heavy metals like As, Cr, Cd, Hg, Mn, Ni, Pb due to immersion of idols in the lake waters have been reported (Ram S. Lokhande *et al.,* 2011). Manganese is not found as a free element in nature; it is often found in combination with iron, in many minerals. It is a metal with important industrial use in metal alloys particularly in stainless steel. Manganese(II) reacts with iron(II) to induce a strong green color in glass by forming less-colored iron(III) and slightly pink manganese(II), compensating for the residual color of the iron(III). Large amounts of manganese are used to produce pink colored glass.

Manganese is used in industrial processes and in various consumer products. The major man-made sources of environmental manganese include municipal wastewater discharge, sewage sludge, emissions generated during making alloy, steel and iron production and to a lesser extent by emissions from the combustion of fuel additives. The primary man-made sources of atmospheric manganese worldwide are secondary non-ferrous metal production, coal burning and municipal waste incineration (Bouchard, Maryse *et al.,* 2010). Incineration of sewage sludge was estimated to be the third largest worldwide anthropogenic source of manganese emissions to the atmosphere (Elsner, Robert and Spangler John, 2005). In biology, manganese (II) ions function as cofactor of a large variety of enzymes with many functions. Manganese enzymes are particularly essential in detoxification of superoxide free radicals in organisms that must deal with elemental oxygen. Manganese also functions in the oxygen-evolving complex of photosynthetic plants. The element is a required trace mineral for all known living organisms. In larger amounts, and apparently with far greater activity by inhalation, it can cause a poisoning syndrome in mammals, with neurological damage which is sometimes irreversible. Excessive exposure or intake may lead to a condition known as manganism, a neurodegenerative disorder that causes dopaminergic neuronal death and Parkinsonian- like symptoms (Bouchard, Maryse *et al.,* 2010; Elsner, Robert and Spangler John, 2005; Yin *et al.,* 2010).

MATERIALS AND METHODS

Pre-immersion samples were collected three weeks prior to commencement of immersion activities during morning hours. During idol immersion samples were collected thrice. Post-immersion samples were collected till six weeks after the completion of immersion activities during morning hours. The samples were collected from three stations which is used for idol immersion and sampling stations are marked as S1, S2 and S3. (July 2013 to October 2013) in triplicate and analyzed for heavy metal content as per Standard Methods (Puri *et al.,* 2011). S1, S2 and S3 indicate the following stations in the lake water.

- First Ganpati Immersion point, Near Lake View Restaurant (Site S1)
- Second Ganpati Immersion Ghat, Kamat Ghar Gaon, Chandan Baug, Near Peace Park (Site S2)
- Third Ganpati Immersion point, Phenapada, Phulegaon (Site S3)

The water samples were collected for analysis of heavy metals. The heavy metals were preserved by adding1.5 ml of concentrated HNO_3 in one liter of water sample and bringing down the pH to near about 2 and analyzed using UV-Visible Spectrophotometer (ELICO UV Visible Spectrophotometer SL 159) (Puri *et al.,* 2011; Ashvin *et al.,* 2013).

Observations

Determination of Manganese

Table 1. Amount of Manganese

Periods	Amount of Manganese in µg/cm^3		
	S1	S2	S3
Before Immersion	0.996±5.3944	1.066±0.1158	1.133±0.1153
During Immersion	1.166±0.0573	1.35±0.15	1.45±0.0866
Post Immersion	1.58±0.0692	1.58±0.0692	1.580±0.06928

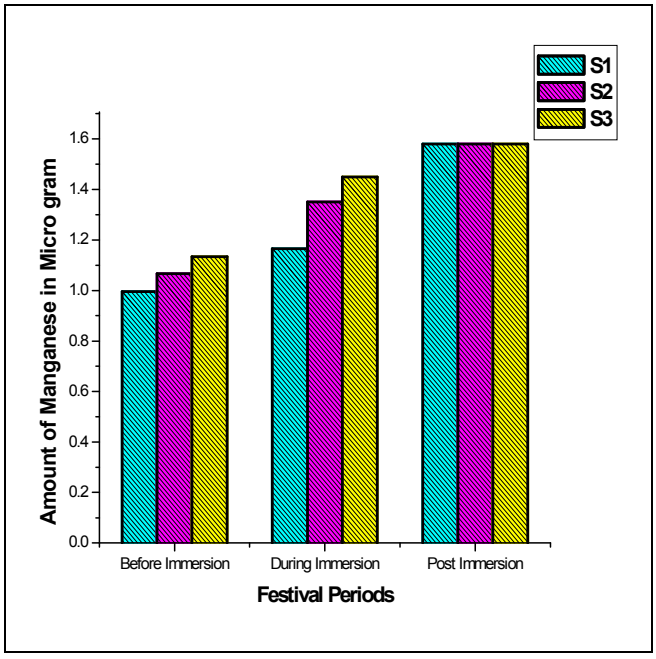

Fig. 1. Graph of Amount of Manganese in µg/cm^3 Vs Festival Periods

RESULTS AND DISCUSSION

Amount of Manganese before idol immersion is in the range of 0.996 µg/ml to1.133 µg/ml and during immersion it is in the range of 1.166 µg/ml to1.450 µg/ml, after idol immersion the concentration is 1.580 µg/ml. Manganese concentrations is

greater than the standards set by WHO and ISI. This indicates heavy metal toxicity in the water. Beyond this limit, taste and appearance are affected and it has adverse effect on domestic use and water supply structure. Concentration of Manganese was greater in all water samples than the standards set by WHO and ISI.

Table 2. Amount of Manganese

Periods	Amount of Manganese in µg/ cm^3			WHO µg/cm^3	BIS µg/ cm^3
	S1	S2	S3		
Before Immersion	0.996±5.3944 V=29.05	1.066±0.1158 V=0.0134	1.133±0.1153 V=0.0132	0.5	0.1
During Immersion	1.166±0.0573 V=0.0032	1.35±0.15 V=0.0225	1.45±0.0866 V=0.0073		
Post Immersion	1.58±0.0692 V=0.0047	1.58±0.0692 V=0.0047	1.580±0.06928 V=0.0047		

(±SD, V=Variance)

Amount of Manganese obtained by immersion of 400.0gram of multi coloured Ganesh Idol in double distilled water under laboratory conditions. After 48 hours the concentration of Manganese was determined spectrophotometrically and is given as follows.

Table 3. Concentration of heavy metal

S.No.	Heavy Metals	Concentration in µg/cm^3
01	Manganese	2.200

This result is obtained when multicoloured idol is used. Similarly there are idols made up of only one colour for example: orange. In this way different colours are used which is determined by surveys. For example an idol weighing 400 grams when dissolved in 3000cm^3 of double distilled water gives 2.200 µg/cm^3 of Manganese heavy metal. The total population of Bhiwandi is 1,125,897 from whole population of Bhiwandi if 10% people immerse idols at the three stations of Varal Devi Lake. If one family immerses an idol of 400 grams and if 10%of the population does the same, then $4.5035*10^4$ Kilo gram of idols will be immersed every year in the lake having area of 5 Kilometers.

Table: Amount of heavy metal contributed by the idols each year

S.No.	Heavy Metals	Concentration of heavy metals obtained by 400 grams of idol in µg/cm^3	Concentration of heavy metal obtained by $4.5035*10^4$ Kg of idol in µg/cm^3
01	Manganese	2.200	247692.5

Conclusion

The bio-accumulation of heavy metals in the biological system transfers the toxic elements from the producer to consumer level which can be a future health hazard (Mukerjee Aniruddhe, 2000). Heavy metals are important environmental pollutants and their toxicity is a problem of increasing significance for ecological, evolutionary, and environmental reasons (Kausik Kumar Das *et al.,* 2012). The heavy metal load in the reservoir indicates the heavy metal toxicity which varies at different festival conditions. Most of the heavy metals, if present beyond permissible limits in water are toxic to human beings, aquatic flora and fauna (Puri *et al.,* 2011). Waterborne manganese has a greater bioavailability than dietary manganese. Higher levels of exposure to manganese in drinking water are associated with increased intellectual impairment and reduced intelligence quotients in school-age children (Kausik Kumar Das *et al.,* 2012; Elsner, Robert and Spangler, John 2005; Finley, John Weldon; Davis, Cindy 1999). We find that Manganese is present in relatively higher concentrations as compared to their permissible limits (set by WHO and ISI). As Varal Devi lake is also used for fishing purposes, it is quite evident that this heavy metal may enter the food chain, and thus through bio magnifications enter the human body as well. Periodical monitoring of the water quality is thus required to assess the condition of water body and immediate steps should be taken to check the anthropogenic activity around the lake. This will be helpful in saving the lake from heavy metal pollution (Paustenbatch *et al.,* 2003: Ram *et al.,* 2011).

Acknowledgements

We are very thankful to the Management of KME Society, Principal and staff of the Physical Chemistry Laboratory of GM Momin women's college Bhiwandi for permitting us to conduct the research work.

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