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ORIENTAL JOURNAL OF CHEMISTRY
An International Open Free Access, Peer Reviewed Research Journal
www.orientjchem.org

ISSN: 0970-020 X
CODEN: OJCHEG
2015, Vol. 31, No. (3):
Pg. 1835-1839

Investigation of Toxic Heavy Metals in Drinking Water of Agra City, India

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http://dx.doi.org/10.13005/ojc/310368

(Received: June 12, 2015; Accepted: August 13, 2015)

ABSTRACT

Water quality of Agra city is impaired by the presence of large number of industries in the city. From the observed data it is found that drinking water of Agra city is contaminated with toxic heavy metals like chromium, copper, cadmium, lead, and nickel. Among all these heavy metals, chromium is found to be in comparatively large amounts because most of the leather industries located in Agra city adopt chrome tanning procedure as their basic step for dehairing and dehiding. Presence of high concentration of chromium and other heavy metals in drinking water pose deleterious effects on the health of human beings therefore it becomes necessary to employ certain technological methods to keep the concentration of such toxic heavy metals within their desirable limits.

Key words: Chrome tanning, Water quality, Pollution, Permissible limits, Desirable limits.

INTRODUCTION

Metals are ubiquitous in the environment. It can be accumulated in three basic reservoirs like water, sediment and biota. Sources of heavy metals in river mainly include natural occurrence derived from parent material and human activities. Anthropogenic inputs are associated with industrialization and agriculture activities such as atmospheric deposition, waste disposal, waste incineration, urban effluent, vehicle exhaust, fertilizer application and long terms application of sewage, sludge in river (Bilos *et al*, 2001' Koch *et al*., 2001) The major sources of contamination of natural waters with pesticides include direct application of the insecticides runoff from agricultural fields, discharges of waste water from fecal and urban drains, disposal of containers and equipment washing etc. The pesticides applied may find their way to water resources through runoff sedimentary transport or leaching into ground water during rainfall irrigation. Pesticides do not remain their site but after entering aquatic environment, affecting abundance and diversity of non-target species producing complex affects on the altering tropic interactions (Rand *et al*, 1995). Further, many pesticide eventually end up in groundwater and transformation products may remain for years (Belfroid, *et al*., 1998). According to World Bank, current estimates for population growth indicates that the human population of the region will double in the next 20-40 years, while global demand for dwindling water resources will continue to rise at almost twice that rate. In India, overall, water demand will increase from 552 BCM to 1050 BCM by 2025, which will require the use of all available water resources in the country. Of the present water usages, 92.94% is devoted to agriculture; already six of India's twenty major river basins fall below the water scarcity threshold of 1000 cubic meters per year with five more basins to added to the list within the next three decades. The rapid increase in agro-chemical use in the past five decades has contributed significantly to the pollution of both surface and ground water resources.

Among all the harmful pollutants of water, heavy metals bring about the most dangerous form of water pollution

Heavy metals comprise an ill- defined group of approximately 65 metallic elements of density greater than 5 they have diverse physical, chemical, and biological properties, but generally, all of them exert toxic effects on living beings when present in concentration above the desirable limits. Although elevated levels of toxic heavy metals occur in some natural locations, on an average, their presence is generally low. Most of the naturally occurring, high concentrations of heavy metals occur in an immobilized form in sediments .Sediments conserve important environmental information (Van Gunter, *et al*., 1997) and are increasingly recognized as both a carrier and a possible source of contamination in aquatic system. Pollutants are transferred between the sediment and overlying water which are in a state flow of dynamic balance affected by the tidal flow, the bed sediment and suspended sediment in water is continuously falling to the river bed to become part of the bed load while the bed erodes and become suspended sediment simultaneously. In this processes the suspended sediment may absorb the pollutants in water and deposit them on the bottom and the bed sediment may release the pollutant from the bottom during resuspention by the tide and waves (Liu, C *et al*, 2003). and ores, and are biologically unavailable. However, ore mining and many other modern industries have also disrupted natural biogeochemical cycles and have caused increased deposition of heavy metals in the terrestrial and aquatic environment. Major sources of heavy metal pollution are combustion of fossil fuel, brewery, and distillery wastes; biocides and preservatives, refining, cleaning, plating etc.

Common pollutants among heavy metals are copper, chromium, cadmium, lead, nickel, mercury. The concern for these pollutants comes from the following reasons:

1. Harmful effects on environment, particularly biotic community.
2. Public concerns due to outbreaks of mercury, lead and cadmium poisoning.

Therefore, it becomes the need of an hour to detect the quality of the drinking water and analyze its heavy metal content to prevent any kind of heavy metal poisoning in living beings.

MATERIALS AND METHODS:

Regional Site description: Agra, the city of Taj (27 10'N 78 02'E) is located in the north central part of India having 1,271,000 of total population. It is bounded by the arid Thar desert of Rajasthan on two third of its periphery. The city is famous for its leather industry all over the world. Presence of large number of tanneries lead to high water pollution load as the waste water from the tanneries is ultimately discharged into the river Yamuna, the ultimate source of water for Agraites. Alongwith tanneries, various other industries like that of metal plating and metal refining are also located in the vicinity of the city which adds to the misery.

Sample collection

Various samples are collected from different locations to analyze the physio-chemical quality of drinking water of Agra city. Both ground water and municipal water samples are taken into consideration. Water samples from river Yamuna have also been collected to analyze the load of heavy metal pollution.

Analysis of toxic heavy metals by AAS

The analysis was carried out using the Atomic Absorption Spectrometer (AANALYST100). Analysis of toxic heavy metals requires the preparation of standard metal solutions (five standard solutions of 0.01, 0.1, 1, 10 and 100ppm concentration) of metals such as Cr, Ni, Cu, Cd, Pb were prepared for instrument calibration. After instrument standardization water sample is aspirated into flame after adjusting the final burner position until flame is similar to that before aspiration of the solvent.

Water sample that is to be analyzed needs to be digested with conc. HNO3 before introducing it to the nebuliser (Atomiser). Digested water sample when aspirated into the flame gives the mean value of concentration of respective metal in the sample.

RESULTS AND DISCUSSION

The observed data clearly indicates that the heavy metals like chromium, copper, and lead exceed their respective permissible limits in the drinking water samples of Agra city. From the table above the concentration of various heavy metals can be compared in different water samples. This value of concentration of respective heavy metal is then compared with permissible limits as described by ISI to identify the extent of pollution (Gurdeep raj *et al*.,).

Chromium in the groundwater samples ranged from 0.3 – 0.4 mg/l whereas the desirable limit of chromium in drinking water should be 0.05 mg/l as per Central Pollution Control Board. The water sample from river Yamuna is having maximum concentration of chromium, which is about ten times than the desirable one.

Along with this water of river Yamuna is also found to be highly contaminated with copper with the concentration 0f of about 7 mg/l. However, the concentration of copper is within the desirable limits for the water supplied by municipality for drinking purpose.

The river water and the ground water of Agra city is also contaminated with lead. The concentration of lead in municipality water is slightly higher than the permissible limits.

The concentrations of other heavy metals like mercury, zinc, iron are within their prescribed limits

The statistical data for individual heavy metal for drinking water samples of Agra city is given in **table1**

Toxicological impact on environment:

It has been found that the chromium is a cause of occupational allergic contact dermatitis and the trivalent form of Chromium is considered to be the sensitizing agent. Hexavalent chromium may be released from chromium metal by the corrosive action of sweat and penetrate the skin. Cr (VI) compounds may lead to ulceration and perforation of the nasal septum.

Acute exposure causes respiratory effects viz., ulcerated perforation of nasal septum. Chromium ulcers or chrome holes are characteristic lesions

Apart this, intoxication by copper salts results in vomiting, hypertension, coma and death. Excess hepatic copper causes hepatitis leading to

Table 1

S. No	Toxic heavy metal	ISI Standard	Concentration in ground water sample	Concentration in river water sample	Concentration in municipal water sample
1 .	Chromium	0.05	0.307	0.662	0.082
2.	Copper	1.0	2.6599	7.085	0.5201
3.	Lead	<0.05	0.167	0.428	0.074
4.	Cadmium	0.01	0.589	0.865	0.011
5.	Iron	<0.03	0.0245	0.001	0.001
6 .	Mercury	0.001	<0.001	<0.001	<0.001
7 .	Zinc	5.5	3.42	1.16	1.14
8.	Silver	0.05	0.01	0.008	0.008

cirrhosis, hepatic failure and ultimately death. Copper may initiate hepatic peroxidation through hydroxyl radical formation.

Presence of lead even in small concentrations can cause defective haemoglobin synthesis by inhibiting Fe incorporation into protoporphyrin which results in lower haem concentration thereby leading to anaemia. Lead poisoning also includes abdominal pain and lesions of the central and peripheral nervous systems (SVS Rana, *et al.*).

Electroplating industry of Agra adds Cadmium also to the drinking water. Since chronic exposure to even low levels of trace elements can lead to health problems. Cadmium is found to play a role in the production of arteriosclerosis, hypertension, and the cardiovascular diseases. Acute toxicity in humans often lead to pneumonitis. The main biochemical finding in Cd toxicity is proteinuria as a result of renal damage. Cadmium also affects the activities of several enzymes ultimately disrupting various biochemical pathways of human systems (SC Bhatia *et al.*)

CONCLUSION

It is evident from the above investigation that the drinking water of Agra city is highly contaminated with toxic heavy metals which may give rise to harmful effects to the public health.

After analyzing the drinking water of the city it can be easily stated that the inhabitants of the city are highly prone to all such health complications hence it becomes very necessary to combat this toxic heavy metal pollution as soon as possible.

Suggestions

So far Biotechnology has provided various efficient methods and procedures for removal and recovery of metals from industrial wastes. Biotechnology employs the enzyme action for removal of various toxic heavy metals. Here in Agra city, the high concentration of Cu and Pb can be reduced by using microorganisms like *Bacillus subtilis*. Fixed bed reactor packed with the granules of this microorganism is an efficient metal recovery agent and it can easily remove toxic metals like Ni, Cd, Hg etc. along with Pb and Cu. The use of other novel microorganism in the management of hazardous wastes such as heavy metals and other pollutants has also been thought of. Such methods provide an economical way to control water quality effectively

Application

It will help the Citizens Of Agra to know the quality of potable water available in the City.

ACKNOWLEDGEMENTS

The authors are thankful to Department of Chemistry, St. John's College, Agra for providing the necessary facilities for conducting the experiments.

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