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Evaluation of Iron and Manganese Levels from Ramgarh Lake, Gorakhpur, U.P., India

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ABSTRACT

Natural waters vary in chemical composition and the factors controlling the composition include physical, chemical and biological processes. Water is one of the most important natural resources for all the living organisms because it is required for various metabolic activities. In addition, water is required for various domestic purposes, irrigation and power generation and the industries. Amongst various organic components, the iron and manganese are an important trace metal required for all the biological systems. The occurrence of iron and manganese, in the present study, was reported from Ramgarh Lake in Gorakhpur, India. Two sampling stations were selected for the present study. The iron and manganese have several effects due to their high concentration. The study was carried out for one year (January 2017 to December 2017). The significance of iron and manganese is discussed in the present investigation.

INTRODUCTION

The environment is a system of physical, chemical and biological factors and dynamic equilibrium. The indiscriminate industrial, domestic water discharged into natural water system has created the hazards to the aquatic life. Water is the most versatile, vital and essential component for all life forms. It is abundant on our planet occurring as a universal solvent, an indispensable component of nature holding both biotic and abiotic entities in a complex, dynamic and delicate ecological balance by virtue of its unique capacity existing in solid, liquid and gaseous states. Energy and water are indeed two essential components for the propagation of life. Quality of water, therefore, bears profound significance for conditioning the quality of life and environment in both aquatic and terrestrial.

The increasing industrialization, urbanization and development activities to cope with the population explosion have brought inevitable water crisis (Rao & Rameshwari 1998). The discharge of industrial effluent into the natural water bodies causing severe water pollution. Alteration in the chemical composition of a natural aquatic environment by industrial effluents usually induces changes in the aquatic ecosystem particularly aquatic organisms. Pollution is befouling the environment by man's activities particularly by the disposal of solid, gaseous and liquid waste products. Most of our water bodies, rivers and streams have become polluted and unfit for human use. Ramgarh Lake in Gorakhpur district is no exception. Gorakhpur city and several villages and residential colonies are settled around the Ramgarh Lake. The load of pollutants is increasing day by day in Ramgarh Lake and this poses a formidable challenge to water quality. (Srivastava et al. 2006, 2007).

Food and water are the main sources of our daily requirements of essential metals. These (with the addition of air) are also the media through which we are constantly exposed to the various toxic metals. The body, through urine and faeces, exerts metals, which are in excess, otherwise, there may be a chance of their accumulation in various body tissues. Metals are indestructible poison. Their dispersion into streams, rivers and oceans for a long duration may be highly dangerous, because they may affect the production of atmospheric oxygen, contaminate the water and affect the life of freshwater ecosystem influenced by air-heavy metals and addition from anthropogenic sources. At present, several metals are believed to be essential for life; some of them are iron, copper, zinc, manganese, cobalt, molybdenum, selenium, chromium, nickel, tin and vanadium, etc. Metals usually considered to be toxic at 'physiological dose' may be stimulatory or essential in very minute doses depending upon the environment and state of the organism.

The indispensability, deficiency or toxicity of metal is manifestations of dose response effect. However, environmental conditions, natural and biological factors, such as age, sex, species differences, stress, and relationship of one metal with the other metal and metal ion imbalance in biological system, in turn influences the toxicity of metal. Uptake of heavy metals through food chain in human beings may cause various physiological disorders, like hypertension, sporadic fever, renal damage, cramps, etc. The bioaccumulation of metal toxicants in plants and fish depends on availability and persistence of the contaminants in water and the physic-chemical properties of the toxicants. Iron is the second most abundant metal after aluminium in the earth's crust. Iron is an essential trace metal, required as a constituent of oxygen-carrying and oxidative-reductive micro molecules, such as haemoglobin, myoglobin and cytochrome. Manganese is a greyish similar to the appearance of cast-iron. Manganese, an essential element for animals and man, occurs in the cells of all living organisms. It is the twelfth most abundant element and the fifth most abundant metal. Manganese is also an essential trace element required by the plants. In some waters, it may limit either directly or indirectly the growth of algae. The present study has been carried out to find the levels of iron and manganese in Ramgarh lake in Gorakhpur.

MATERIALS AND METHODS

The Ramgarh lake is spread over 669.73 ha near Gorakhpur city on Gorakhpur-Deoria highway, which lies between Lat. 26°13'N-27°29'N and Long. 83°05'E-83°56' E. The height above sea level ranges from 107 meters in northwest to 93 meters in the southeast. The lake receives urban sewage through a wide network of the drain during the past few years. The water of this lake is widely used for agricultural, irrigation, domestic and industrial purposes. The lake is useful for fish culture and, nearly 20 to 25 villages water supply is carried out from the lake. Metals transported from the nearby silts, rocks, etc., can play a vital role in supplying micro-metals for the human consumption. It is very important to investigate a few metals, which are very essential for our life. Hence, we selected the useful two metals present in the lake. For the present analytical study, we divided the lake into two parts. A good population of submerged aquatic plants is found in this area.

The study of iron and manganese content from the Ramgarh Lake was undertaken and it was estimated by spectrophotometer method. The water samples from both sampling stations were brought to the laboratory regularly in clean containers at early hours. Standard methods prescribed by APHA (2012) were applied for the collection and analysis of the water samples. The concentration of iron and manganese was measured on a spectrophotometer at a specific filter. Results were expressed as mg/L and compared with permissible levels.

RESULTS AND DISCUSSION

Several heavy metals are essential for the growth and survival of plants and animals. These are originated from both natural and anthropogenic sources (Wintz et al. 2002). The results obtained in the present work are illustrated in Tables 1 and 2. The iron concentration of the water sample-1 varied from 0.65 mg/L to 1.69 mg/L. Sample-2 showed iron content ranging between 1.32 to 1.98 mg/L (Fig. 1). The mean values for the sample-1 and 2 were 1.17 mg/L and 1.67 mg/L, respectively. Overall results showed the minimum iron content in monsoon and maximum in summer season. Iron is an essential heavy metal for higher plants and algae, particularly for photosynthesis. Higher concentration of iron in water imparts a bitter taste and inky flavour (Khurshid et al. 1997, Rana et al. 2016). Iron in surface water is generally present in the ferric (Fe^{+3}) state. The maximum allowable concentration of iron in drinking water is 1.0 mg/L, according to WHO (2004) report. Indian Standard Institute (ISI) and Indian Council of Medical Research (ICMR), the permissible concentration of iron and manganese in drinking water is 1.0 and 0.3 mg/L, respectively. In the present investigation, the mean iron concentration was observed more than the permissible limit. Increased concentration of iron has earlier been reported in river Kali and Hindon waters (Ajmal & Razi-Uddin 1988) and in river Ganga (Ray 1989).

Sharma et al. (2000), monitored the iron content in the 13 drinking water sources from a predominantly rural area of Goalpara district (Assam). They reported 0.02 to 1.50 mg/L iron concentration, which is quite low from the present investigation. Mohapatra & Singh (1999), reported iron content in Mahanadi river water fluctuates between 0.468 and 2.18 mg/L with a mean value of 1.35 mg/L. Nag & Das (1995) analysed surface drinking water in the Purulia district of West Bengal and reported iron content from 0.1 to 13.22 mg/L. However, the mean value was found to be 0.2 mg/L. Manganese is an essential element which does not occur naturally as a metal but is found in various salts and minerals frequently in association with iron compounds (Dwivedi & Tiwari 1997, Srivastava & Pandey 2008, Priyadarshinee & Verma 2016). In the present investigation, sample-1 showed the minimum manganese ion content (0.24 mg/L) in the month of June and maximum value (0.47 mg/L) in the month of December. Sample-2 showed lowest manganese concentration (0.37 mg/L) in the month of June and highest (0.58 mg/L) in the month of December (Fig. 2). The average

concentration was 0.36 mg/L and 0.47 mg/L for Sample-1 and 2, respectively. The permissible limit for manganese set by WHO is 0.05 mg/L. Both water samples have higher mean values than the permissible limit.

Some workers previously reported manganese levels of river water. Sinha (2004), monitored the Mn^{+2} content in water of Sai river at Rai Bareilly, and reported that it varied from 0.08 to 2.2 mg/L. They further reported that manganese in high concentration becomes toxic to plants also. Manganese is found as a cofactor in several enzyme systems. It plays a role in the proper functioning of flavour-proteins and in the synthesis of cholesterol, haemoglobin and in many other important metabolic processes (Tale & Bhosle 2010, Ingole et al. 2016). The water samples having more than 0.1 mg/L of manganese for long exposure is harmful for all animals (WHO 1988). Israili (1991), analysed water of Ganga river from eight different sampling stations and reported that Mn^{+2} content varies from 35.0 to 211.0 µg/L. Furthermore, Israili & Khurshid (1991) studied the distribution of heavy metals in Yamuna river water, which they observed within the permissible limit. Dwivedi & Tiwari (1997) studied Mn^{+2} content of Ganga river and reported the mean Mn^{+2} values ranged from 19.1 to 15.2 µg/L.

From the present investigation, both iron and manganese ion values were observed higher than the permissible limit due to the discharge of sewage, municipal and small-scale industrial waste. Thus, the toxic impact of sewage rendering the lake water unsuitable for sustenance and propagation of aquatic life and unfit for animal and human consumption. Authorities should make concrete efforts, particularly effective and feasible plans for the treatment of waste released into lake.

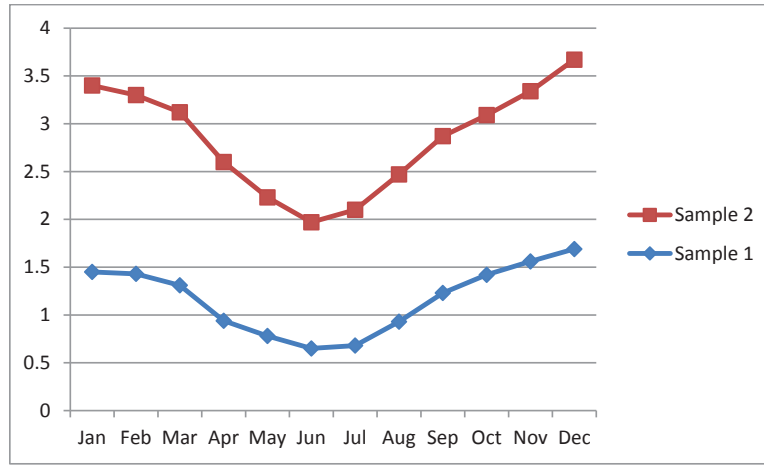

Fig. 1: The iron levels (mg/L) from Ramgarh Lake during January to December 2017.

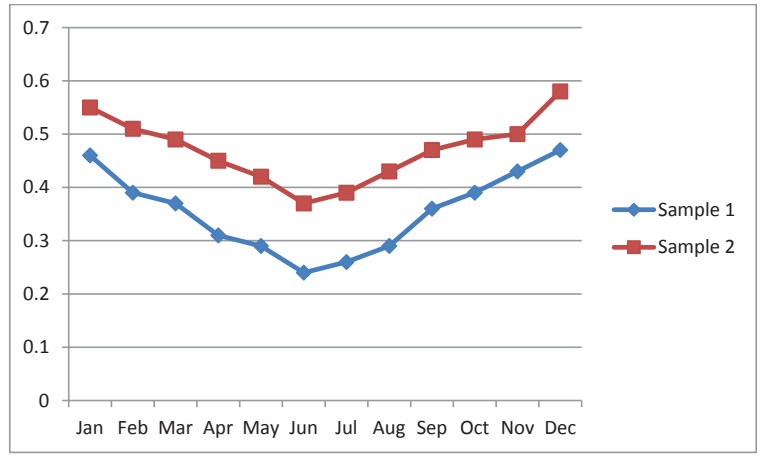

Fig. 2: The manganese levels (mg/L) from Ramgarh Lake during January to December 2017.

Table 1: The iron levels from Ramgarh Lake during January to December 2017 in mg/L.

Month	Sample-1	Sample-2
January	1.45 ± 0.12	1.95 ± 0.16
February	1.43 ± 0.13	1.87 ± 0.17
March	1.31 ± 0.12	1.81 ± 0.16
April	0.94 ± 0.10	1.66 ± 0.15
May	0.78 ± 0.09	1.45 ± 0.13
June	0.65 ± 0.05	1.32 ± 0.14
July	0.68 ± 0.06	1.42 ± 0.13
August	0.93 ± 0.07	1.54 ± 0.14
September	1.23 ± 0.11	1.64 ± 0.15
October	1.42 ± 0.10	1.67 ± 0.14
November	1.56 ± 0.12	1.78 ± 0.18
December	1.69 ± 0.11	1.98 ± 0.16

All the values have been represented as mean ± SEM of three replicates

Table 2: The manganese levels from Ramgarh Lake during January to December 2017 in mg/L.

Month	Sample-1	Sample-2
January	0.46 ± 0.02	0.55 ± 0.06
February	0.39 ± 0.02	0.51 ± 0.05
March	0.37 ± 0.02	0.49 ± 0.05
April	0.31 ± 0.03	0.45 ± 0.04
May	0.29 ± 0.03	0.42 ± 0.04
June	0.24 ± 0.02	0.37 ± 0.04
July	0.26 ± 0.01	0.39 ± 0.03
August	0.29 ± 0.02	0.43 ± 0.03
September	0.36 ± 0.02	0.47 ± 0.04
October	0.39 ± 0.03	0.49 ± 0.05
November	0.43 ± 0.03	0.50 ± 0.04
December	0.47 ± 0.04	0.58 ± 0.04

All the values have been represented as mean ± SEM of three replicates

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