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ASSESSMENT OF HEAVY METALS IN DRINKING WATER IN A TRIBAL BELT OF GODDA DISTRICT, (SANTAL PARGANA), JHARKHAND

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ABSTRACT

Heavy metals constitute an important group of parameters in monitoring drinking water quality. They have hazardous impact on aquatic life and human beings if exceeded the standard prescribed permissible limit. Metals such as Pb, Cr, Cd, Zn, Cu, Fe, Se and As have been estimated in drinking water samples of tribal belt in Boarijore block of Godda district under Santal Pargana of Jharkhand state. The data revealed that Pb, Cr, Se, Fe and As exceeded the permissible limit in groundwater and surface water samples while Cd, Cu and Zn values were well within the standard limits. The water samples of dug well (S2) in Beldiha village under investigation have arsenic contamination (0.50 mg/L) and exceeded the maximum permissible limit of 0.05 mg/L which is a serious concern for tribal health. Overall general health status of the Paharia tribes was found not satisfactory. Most of them suffered from mild to severe gastrointestinal disorder. Banana peels can purify water contaminated with toxic heavy metals. The absorption properties of certain heavy metals as to the banana peels powder was the most effective and applicable for Pb, Cr, Cd, Zn and Fe.

INTRODUCTION

Heavy metal content in the drinking water has become a matter of serious concern as it has adverse effect on human health when exceeded the standard permissible limit. It may enter the drinking water sources through dissolution from soil of various geological strata and discharge of industrial and agricultural wastes. Heavy metals at high concentration are harmful pollutant because of their non-degradable nature, bio-magnification and persistence in nature causing certain biochemical effects on the body. Thus, heavy metals are one of the most important inorganic pollution parameters.

In order to assess the concentration of heavy metals in drinking water of tribal belt in Godda district, certain water sources in villages of Boarijor Block was selected for the study. Investigation on heavy metals in water have been worked out in different parts of country of which the observation of Munshi et al. (1998), Pradhan (2000), Pandey et al. (2005), Kakati (2012) and Malik et al. (2012) deserve special mention in the present investigation as no detailed study about heavy metal in drinking water of tribal belt in Godda district of Santhal Pargana (Jharkhand) has been undertaken till now.

STUDY AREA

Godda district is situated under Santal Pargana of Jharkhand state between latitude of $24^0 25' - 25^0 10'$ North and longitude of $87^0 10'$-$87^0 28'$ East at an altitude of 400-600m. The district is an upland hilly tract with backbone of Rajmahal hill range. Total geographical area of the district is 2110 km^2. The area under investigation is located in Boarijore block about 55 km north east of the district headquarter including tribal villages namely Anamo, Beldiha, Chotaboarijore and Babuchuri situated at different situations of Rajmahal hill. The availability of drinking water is inadequate in these villages with acute scarcity of pure and safe water. The tribal of these villages are mostly dependent on seasonal and perennial hill streams. Besides, few dug wells and tube wells are the common sources of drinking water.

MATERIALS AND METHODS

Water samples of dug wells, tube wells and hill streams were collected from identified sampling stations. The location and source of water samples are given in Table 1.

Table1. Locations of sampling stations

Tribal village	Source
Anamo	Tubewell (S1)
Beldiha	Dugwell (S2)
Chota Boarijore	Dugwell (S3)
Babuchuri	Hill stream (S4)

Data in parenthesis indicate number of sampling stations

Water samples were collected from the tribal villages in PVC bottles with necessary precaution. The samples were filtered through Whatmann filter paper and then acidified with nitric acid at pH 2.0. For digestion and pre concentration of the water samples, standard methods (APHA 1998) were followed. The total concentration of the metals (Pb, Zn, Cd, Cr, Fe, Se, Cu and Se) was determined by atomic absorption spectroscopy (AAS- Varian spectra, double beam optics) through commercial services provided by Sophisticated Analytical Institute Facility (SAIF) of Bose Institute, Kolkata. The results obtained were compared with the standard prescribed by WHO (1996) and BIS (1998).

RESULTS AND DISCUSSION

The results of average values of heavy metals are given in Table 2. The values of groundwater (tube well and dugwells) and surface water (hill streams) showed wide variations.

Lead

The maximum value of Lead (0.146 mg/L) was recorded in bore well sampling point S1 followed by 0.100 mg/L in Sampling point S4 (hill stream). Its value at S2 and S3 was 0.085 mg/L and 0.098 mg/L respectively. Lead value ranged between 0.085-0.146 mg/L in ground water and 0.100mg/L in surface water stand quite above the permissible limit of 0.05 mg/L. Lead is one of the hazardous and potentially harmful polluting agent. It inhibits the formation of hemoglobin by reacting with –SH group and interfering with many enzyme functions. The concentration from 0.10 to 10.0 mg/L has been found to inhibit the growth of algae. (Drusilla et al. 2006)

The lead content of natural water is usually very low so its limit up to 0.1mg/L provides an adequate factor of safety (Cole 1979). The presence of lead at higher concentration in almost all the sources in the present investigation may be attributed to the domestic waste discharge and surface run off.

Chromium

Chromium concentration in drinking water varied from 0.197 to 0.386 mg/L in groundwater and 0.235 mg/L in surface water samples. All the values exceeded the permissible limit of 0.05 mg/L. Drinking water having 5.0 mg/L of chromium are toxic to the animal but the toxicity is more at hexavalent chromium. In this range it is carcinogenic (Sahu 1991).

Cadmium

Cadmium concentration varied from 0.0015 to 0.002 mg/L in the groundwater and 0.003 mg/L in surface water. The values were well within the permissible limit of 0.01 mg/L. Drinking water having more than 0.1 mg/L of cadmium can cause bronchitis, anaemia and renal stone formation in animals (WHO 1996). Biologically, cadmium is non essential, non beneficial element recognized to be of high toxic potential (Train 1979).

Zinc

The highest value of zinc (0.604 mg/L) was observed in S1 and then in S2 (0.279 mg/L) and S3 (0.210 mg/L). Hill stream (S4) point exhibited lower value (0.171 mg/L). Zinc concentration of the ground water (tube well and dug well) was found comparatively higher than the surface water (hill stream).

All the values recorded were well within the permissible limit of 5.0 mg/L. Zinc at concentration above 5.0mg/L can cause undesirable astringent taste and unsuitable for drinking purpose. Zinc is an essential element for the effective functioning of various enzyme system; deficiency of which

Table 2. Mean value of heavy metals content (mg/L) in water samples of tube well (S1), dug wells (S2 & S3) and hill stream (S4)

Metal	S1	S2	S3	S4	Permissible Limit	
					WHO	BIS
Pb	0.146	0.085	0.098	0.10	0.10	0.10
Cr	0.197	0.230	0.386	0.235	0.01	0.05
Cd	0.0015	0.0015	0.002	0.003	0.01	0.01
Zn	0.604	0.279	0.210	0.171	5.0	5.0
Cu	0.0014	0.0025	0.0016	0.0081	0.05	0.05
Fe	2.337	3.531	1.384	1.255	0.1	0.1
As	0.042	0.500	0.053	0.034	0.05	0.05
Se	0.014	0.040	0.021	0.060	0.01	0.01

Table 3. Heavy metal content after use of banana peel absorbent

Metal	S1	S2	S3	S4	Permissible limit
Pb	0.109	0.057	0.027	0.091	0.10
Cr	0.017	0.023	0.030	0.026	0.05
Cd	0.0010	0.0012	-0.002	-0.0006	0.01
Zn	0.460	0.145	0.130	0.169	5.0
Fe	2.305	0.710	1.397	1.065	0.1

leads to growth retardation and immaturity among children and anaemia, a condition known as "Zinc deficiency Syndrome" common in Egypt and Iran.

Copper

The concentration of copper in drinking water ranged between 0.0014-0.0025 mg/L in groundwater sample and 0.0081 mg/L in surface water sample, which was quite below the permissible standard limit of 0.05 mg/L.

The concentration of copper in natural water are not known to have adverse effects on human body though copper in excess of 1.0-5.0 mg/L impart some astringent taste to water.

Iron

Iron concentration ranged between 1.384-3.531 mg/L in the groundwater and 1.255 mg/L in the surface water. The maximum value of iron (3.531 mg/L) was noted in well water (S2). All the values of iron far exceeded the permissible limit of 0.1 mg/L. Iron contents more than 0.05 to 1.0 mg/L usually impart a metallic taste to water. Though it has not been associated with any adverse physiological effects but higher concentration of iron in the drinking water is undesirable from the aesthetic stand point. It usually produces yellowish or, reddish brown stain when present in excess amount.

Arsenic

Arsenic concentration was observed maximum in the well water (S2) (0.50mg/L) followed by tube well S3 (0.053 mg/L). The stream water exhibited lesser amount (0.034 mg/L) of arsenic. Thus arsenic content was quite above the standard limit (0.05 mg/L) in well water (S2) while rest of the values at S1, S3 and S4 were within the permissible limit. It is highly toxic element often associated with the ores of copper, lead, cobalt, iron, gold and silver. At higher concentration it may cause dermatitis and probably skin cancer.

However, there is no serious report of arsenicosis from the area till date, but long term use of arsenic contaminated water for drinking and cooking may lead to carcinogenic effect and skin lesions.

Selenium

Selenium value recorded in groundwater sample are comparatively lower (0.014-0.040 mg/L) than the surface water (stream) sample (0.06 mg/L) and slightly exceeded the prescribed standard limit of 0.01 mg/L.

Selenium in drinking water above 0.01 mg/L may have toxic effects as it causes inflammation in gastro-intestinal tract with long term effects on kidney, liver and lungs (WHO 1996). However, selenium is an essential micronutrient required in small amount by human body. Occurrence of selenium in well, tube well and stream water revealed the fact that it is widely distributed in the earth's crust (Trivedy and Goel 1995). It is also found in coal and igneous rock of the lithosphere and the area under investigation is located in coal belt of Santhal Pargana. Thus, the presence of selenium in both groundwater and surface water was probably the result of huge coal deposition and coal mining in this region.

While considering the heavy metal concentration, most of them like Pb, Cr, Fe, Se and As exceeded their standard prescribed limits. It can be concluded that groundwater (well and tube well) and surface water (stream) as the major source of potable water for the tribals of this area is not safe while considering the heavy metal content. The overall health status of the tribals in Boarijore block area of the Godda district appeared to be poor and unsatisfactory. Illiteracy and lack of awareness about their health and environment, acute scarcity of drinking water sources and improper sanitation are certain major factors responsible for poor general health of the tribals.

Recognizing the problems of heavy metals pollution in drinking water certain simple and conventional and cheap method for optimal removal of heavy metal can be achieved. Environmental planning and water management is essential to remove the danger of toxic and hazarduous pollutant. Utilization of bio materials for uptake of heavy metals from dilute aqueous solution has been proposed by many researches (Kratchovil and Volesky 1998, Kiran et al. 2005, Basak and Das 2013). Use of sun dry powder of banana peels as absorbent appeared to be effective in removal of heavy metals like Pb, Cr, Cd, Zn and Fe. Gustava Castro (2011) observation appeared in Amercian Chemical Society suggested that the banana peels act as water purifier.

Sun dry powder of banana peels was used as absorbent for heavy metal removal. Based on the results recorded in Table-3, It can be concluded that powder of banana peels used as absorbent showed maximum removal of heavy metal content like Pb, Cr, Zn, Fe from the aqueous solutions. The efficiency of heavy metals removal showed maximum percentage of removal of chromium (75.1 to 92.22 %) and lead (25.34 to 72.44%) at all the sampling spots. Overall banana peels was very efficient in the removal of lead, chromium, cadmium, zinc and iron from drinking water of the study area.

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