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Determination of Heavy Metals in Groundwater in Mehkar, Buldana District, Maharashtra, India

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ABSTRACT

Water Quality is one of the most important concerns. Quality of water is an important criterion for evaluating the suitability of water for drinking and irrigation. Metal contamination in water is a major component in the determination of water quality. The heavy metals levels up to ppb levels in drinking water quality may cause saviour health problems and also cause cancer. In this study, we made an attempt to know the concentration of six heavy metals in ground water in different locations of Mehkar, Buldana District, Maharashtra up to ppb levels. For this study, 10 groundwater samples were collected in November 2015 and preserved by adding 2-3 drops of nitric acid. These samples were subjected to analysis for six elements like Cd, Pb, Cr, Cu, Zn and Fe by using Atomic Absorption Spectroscopy (AAS). The concentrations of these metals in the study area were compared with drinking water quality limits are given by the World Health Organization (WHO), 4th edition in 2011.

1.0 INTRODUCTION

Natural resources are important wealth of our country, water is one of them. Water is wonder of nature. “No life without water” is common saying depending upon the fact that water is one of the naturally occurring essential requirement of all life supporting activities [1]. Water is one of the essentials that support all living things such as plants and animals. It is obtained from two principal natural resources, surface water (such as fresh water, lakes, river, stream etc.) and ground water (such as well and bore well). In India, most of the population is dependent on groundwater as the source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to become polluted and create health problems [2]. One of the most important environmental issues today is groundwater contamination and between the diversity of contaminants that affecting water resources [3-4]. The quality of these groundwater resources is affected by the characteristics of the media through which the water passes on its way to the groundwater zone of saturation [5]. Safe and good quality drinking water is the basis for good human health. Water provides some elements, but when polluted it may become the source of undesirable substances that are dangerous to human health [6]. Heavy metals in the form of Arsenic, Cadmium, Lead & Mercury are exceptionally toxic and harmful to human health [7]. They are found in effluents and leeches from metallurgic industries, glassware’s, ceramic industries, pesticides and fertilizer manufacturing industries, petroleum refining and other chemical industries [8]. The most contaminants of groundwater are heavy metals like Aluminium, Cadmium, Lead, Mercury, Copper, Ferrous, Zinc etc. Childhood exposure to some metals can result in learning difficulties, memory impairment, damage to the nervous system and behavioral problems such as aggressiveness [9]. Cadmium is extremely toxic even in low concentration and long-term exposure to it also causes renal damage. Lead has the ability to replace calcium in bone to form site for long term replacement. Heavy metals also cause irregularity in blood composition; badly affect vital organs such as kidney and liver [10-11]. Increased urbanization and industrialization are to be blamed for an increased level of trace metals in our waterway. Many dangerous chemical elements if released into the environment accumulate in soil and sediments of water bodies [12]. The majority of water bodies in India need to be treated before using it in domestic applications by various means. Groundwater contains high amount of various ions and heavy metals above limit prescribed by WHO [13]. So if we were using such type of water as potable water then it leads to various water borne diseases. Considering the above aspects of groundwater contamination and literature survey reveals that no water quality management studies are made in this region so far. Hence, the present study was undertaken to investigate the impact of groundwater quality of some borehole water samples in Mehkar city of Buldana district Indian state of Maharashtra.

Site Description

Study area Mehkar city is lies within longitude 20^0 9' 0'' N and 76^0 34' 30'' E. Mehkar is a city and municipal council in Buldana district in the Indian state of Maharashtra. Mehkar is situated on the bank of the Painganga river which provides multiple recreational activities.

2.0 MATERIALS AND METHODS

Analytical grade reagent and distilled water would use throughout the study. All glass wares and plastic containers used were washed with double distilled water followed by 20% Nitric acid and then again rinsed with distilled water.

2.1 Sample Collection and sample digestion

The water samples were collected by following standard sample collection protocols and guideline. Special precautions were taken during the collection of samples. Before collecting the samples, the sample containers are washed with double distilled water and dried in metal free area. At each sampling location, water samples were collected in pre-cleaned container. The bottles were rinsed three times with the groundwater sample of particular location and collected the final sample to avoid contamination and 0.5 ml supra grade HNO_3 is added to acidify the samples and also to prevent loss of metals. All the collected water samples are preserved at 4^0C until used. The details of sampling location have been shown in Table no.1.

Table No: 1. Sampling sites in Mehkar City

S. No	Sample location	Source	Sample Code
1	Shivaji Nagar	Borehole Water	S1
2	Teacher Colony	Borehole Water	S2
3	Milind Nagar	Borehole Water	S3
4	Ambedkar Nagar	Borehole Water	S4
5	Mali Peth	Borehole Water	S5
6	Indira Nagar	Borehole Water	S6
7	Ram Nagar	Borehole Water	S7
8	Santaji Nagar	Borehole Water	S8
9	AnnabhauSathe Nagar	Borehole Water	S9
10	GawaliPura	Borehole Water	S10

2.2 Standard Preparation

The stock solutions of Cadmium, Lead, Zinc, Chromium, Copper and Ferrous were prepared by dissolving in a liter volumetric flask appropriate amount of metal compound with 65% of HNO_3. The mixture was shaken and flask made up to 1 liter mark with the HNO_3 for each metal. Calibration solutions of target metal ions were prepared from standard stock by serial dilution.

2.3 Sample Analysis

The digested water samples were analyzed for the presence of Cadmium (Cd), Lead (Pb), Zinc (Zn), Chromium (Cr), Copper (Cu) and Ferrous (Fe) using the M/S Perkin Elmer USA model No: AA 300 Atomic Absorption Spectrophotometer. The calibration plot method was used for analysis. The air acetylene was the flame used and hollow cathode lamp of corresponding element was the resonance. The digested samples were analyzed in triplicates with the average concentration of metals being displayed in mg/l by the instrument after extrapolation from standard curve. The flame composition and wavelength of absorption for respective metal shown in Table no. 2.

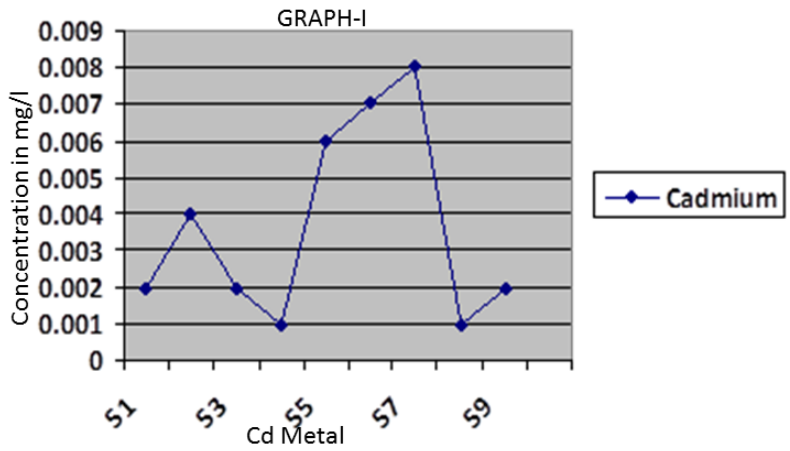
Table No: 2 Flame composition and wavelength of respective metals absorption.

Metals	Flame Composition	Wavelength of Absorption (nm)
Cd	Air- C_2H_2 AAS	228.8
Pb	Air- C_2H_2 AAS	283.3
Zn	Air- C_2H_2 AAS	213.9
Cr	Air- C_2H_2 AAS	357.9
Cu	Air- C_2H_2 AAS	324.7
Fe	Air- C_2H_2 AAS	248.3

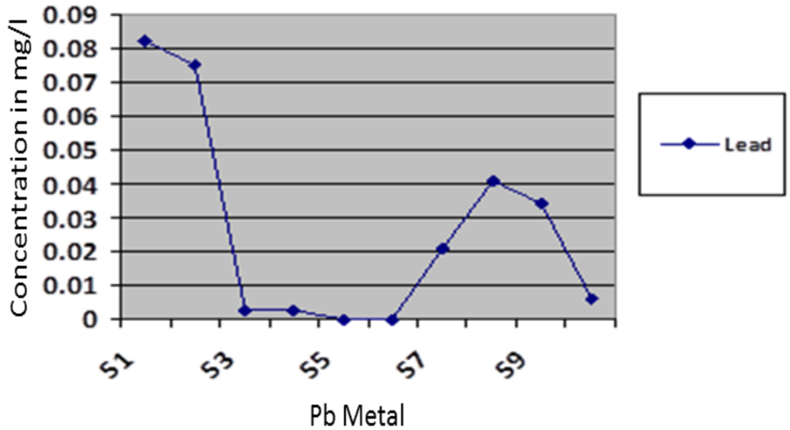
3.0 RESULTS AND DISCUSSION

Atomic absorption technique is very useful for determination of trace levels of metals in given water samples. Table No. 3 shows results of AAS analysis of water samples.

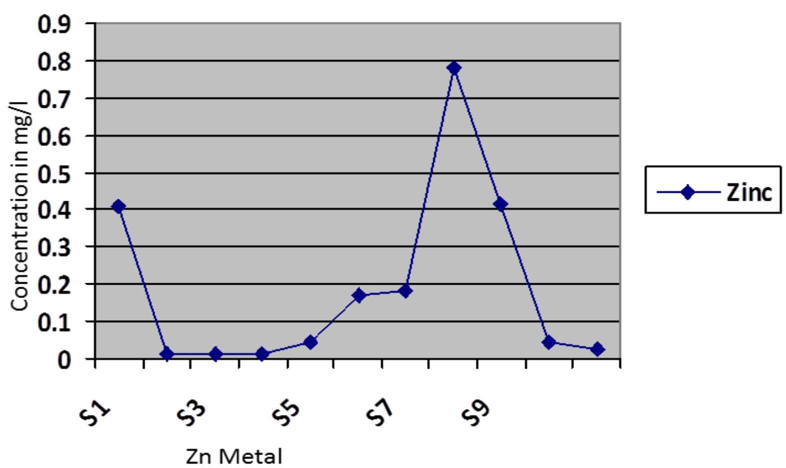
Cadmium (Cd): In the analysis of water samples collected for Cadmium, except S10 all samples contain detectable levels of Cadmium. All samples contain Cd below maximum contaminant level (0.03mg). The presence of cadmium is a cause of concern because cadmium has carcinogenic properties [14] as well as long biological half-life [15] leading to chronic effects as a result of accumulation in the liver and renal cortex [16]. The concentration levels of cadmium in all the samples are shown in Table no. 3 and comparison levels of cadmium in study area are shown in Graph- I.



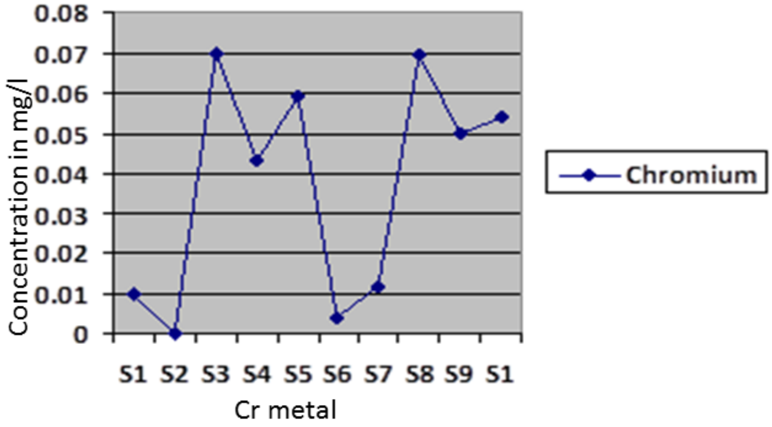
Lead (Pb): Water samples collected for analysis of lead, seven samples were shown presence of lead and out of this seven samples S1, S2, S7 and S9 contain lead in level above the maximum contaminant level (0.01 mg/l) with maximum contaminant detected being 0.082 mg/l for S1. Lead exposure even at low level may cause increase in Blood Pressure [17] as well as with reduced intelligent quotient in children [18]. The concentration levels of lead in all the samples are shown in Table no. 3 and comparison levels of leads in study area are shown in Graph- II.



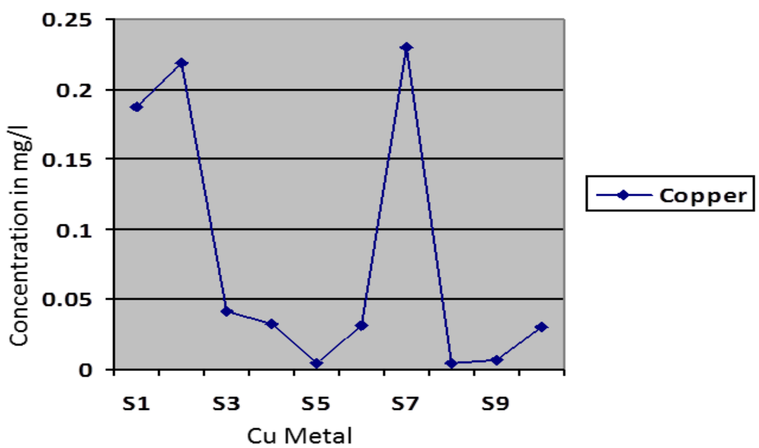
Zinc (Zn): Zinc is an essential requirement for healthy body, excess zinc can be harmful and cause zinc toxicity. Zinc in a large amount, for a short period of exposure time it can cause stomach cramps, nausea and vomiting [19]. In the present study all water samples were containing zinc. All of them were in concentration below the maximum contaminant level. The minimum concentration of zinc was 0.011 mg/l (S2) with maximum concentration 0.782 mg/l (S7). The concentration levels of zinc in all the samples are shown in Table no. 3 and comparison levels of zinc in study area are shown in Graph- III.



Chromium (Cr): The minimum and maximum concentration of Cr was 0.004 mg/l to 0.070 mg/l respectively. Whereas the maximum allowable limit for chromium as per WHO guidelines 0.05mg/l. Chromium concentration level in studied samples S3, S5, S8 and S10 are exceeding than compared to WHO standards. The concentration levels of chromium in all the samples are shown in Table no. 3 and comparison levels of chromium in study area are shown in Graph- IV.



Copper (Cu): In the present investigation copper is found in all the water samples except S5 in the range between 0.004 mg/l – 0.219 mg/l. Sampling sites S1, S2 and S3 have Cu level above the limit prescribed by WHO. High level of Cu in drinking water can cause vomiting, abdominal pain and diarrhoea has been reported that Cu leached into drinking water from copper pipes [20]. The concentration levels of copper in all the samples are shown in Table no. 3 and comparison levels of copper in study area are shown in Graph- V.



Ferrous (Fe): The minimum and maximum concentration of Fe was 0.072 mg/l to 2.806 mg/l respectively. Whereas the maximum allowable limit for chromium as per WHO guidelines 0.30 mg/l. Ferrous concentration level in all studied samples are exceeding than compared to WHO standards except S1. The concentration levels of ferrous in all the samples are shown in Table no. 3 and comparison levels of ferrous in study area are shown in Graph- VI.

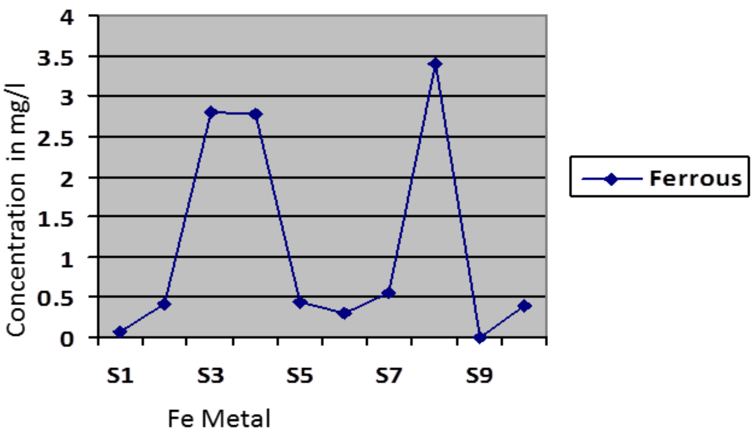


Table No: 3 Table showing concentration of different heavy metals in sampling sites in Mehkar.

- - absence of metal.

S.NO	Metals	WHO Guidelines (2011) mg/l	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	Cd	0.03	0.002	0.004	0.002	0.001	0.006	0.007	0.008	0.001	0.002	--
2	Pb	0.01	0.082	0.075	0.003	0.003	--	--	0.021	0.041	0.034	0.006
3	Zn	5.00	0.412	0.011	0.012	0.041	0.180	0.170	0.782	0.416	0.041	0.024
4	Cr	0.05	0.010	0.058	0.070	0.043	0.059	0.004	0.012	0.069	0.057	0.054
5	Cu	0.05	0.187	0.219	0.042	0.032	0.004	0.031	0.230	0.004	0.007	0.030
6	Fe	0.30	0.072	0.410	2.806	2.770	0.450	0.300	0.560	3.401	--	0.934

3.0 CONCLUSION

The borehole water samples were collected from various locations of Mehkar, Buldana District, Maharashtra, India in November 2015 for determination of Cd, Pb, Cr, Zn, Cu and Fe by using AAS. Concentration of metals Cadmium and Zinc for all samples are found within permissible limit given by WHO. Concentration of Fe found much higher for almost all samples. Similarly samples S1, S2 and S7 show Pb in higher concentration than WHO limit. Chromium is found in higher concentration in sample S3, S5, S8 and S10. Out of ten studied samples only S6 and S9 were of good quality, six samples of fair quality and the samples S2 and S9 are of poor quality for drinking purpose. This suggests significant risk to this population given the toxicity of these metals and fact that for many, boreholes are the only source of their water supply in this environment. From the result of present study, we can suggest that the Government should be adopted some treatment technologies in the following study areas to minimize this heavy metals in groundwater for safe drinking water to the public.

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