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ORIGINAL RESEARCH ARTICLE

Determination of Trace Elements in the Drinking Water of Hassan Abdal (Punjab), Pakistan

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ABSTRACT

Water is life, as it constitutes about 70% of the human body. Nature has also enriched the earth's crust with about 75% of water so as to fulfil the most intense need of the human body at no cost. Access to safe drinking water is necessary for sustainable life and the environment. The present study aimed to investigate the concentration of heavy metals (Cr, Cd, Cu, Fe, Mn, Ni and Zn) and light metals (Na, K, Ca and Mg) in the drinking water (surface and groundwater) of Hasan Abdal Town, Punjab, Pakistan. The analysis of heavy metals (HM) and light metals (LM) in different water samples was done using atomic absorption spectroscopy. It was found that all the above elements are present under the permissible limits suggested by different national & international organizations. The water is free from any toxic pollutants and is safe for drinking purposes.

Keywords: Drinking water, Heavy metals, Light metals, Atomic Absorption Spectroscopy.

INTRODUCTION

Water is the elixir for all living things. Drinkable safe water is absolutely important and is the basic need for all human beings on earth. Water supports the life processes and with-out it life is impossible. Total quantity of water on this planet is about 1.4 trillion cubic meters. [1] Water also has many health benefits that extend to the skin. The drinking water quality is affected in many ways. When there is no pollution present, we give close attention to water quality by monitoring and testing. Drinking water quality monitoring is a scientifically planned system of long term, consistent measurement, systemic observation, evaluation and treatment of water quality in order to define status and trends.[2]

Trace elements are chemical elements that are required in a very minute amount for the proper

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growth, development and human physiology. They are called heavy metals because their densities greater than 5g/cm3. However these essential trace elements be-come poisonous when their concentration becomes extreme.[3] These elements have attracted particular consideration in the recent two decades and within the framework of environmental investigation. Pollution of the natural environment by trace elements is a worldwide problem. These metals are indestructible because of their resistance to decomposition in natural condition.[4] Therefore, monitoring these metals is utmost necessary for safety assessment of the environment and human health in particular. Biologically or chemically these metals cannot be degraded, and thus may either accumulate locally or be transported over long distance.[5]

In ground water heavy metals results from two independent aspects. The first involves the weathering of soils and rocks[6, 7] with its products are transported by air[8, 9] and water.[10] Second one involving a large number of anthropogenic activities that have a probable impact on human health. Pollution of the ground water mostly often goes unseen and remains hidden from the view of the public. Recently, this issue raised wide-spread concerns in different parts of the world and the results reported by various agencies have been alarming.[11]

Pollution of the environment by heavy metals is very prominent in areas of mining sites and reduces increasing distance away from these sites. Another contribution of anthropogenic metals of terrestrial origin is from industrial development and other activi-ties such as agriculture, metallurgy and transport.[12, 13] From mining activities, ground water is most vigorously polluted. The metals are transported as either dissolved species in water or as an integral part of suspended sediments. Then these metals may be stored in sediments or leach into the ground water mainly in springs and wells. The extent of contamination of these springs and wells by heavy metals depend on the nearness of the mining sites. Result of these factors metal concentrations in the natural environment (water) changes. In the last few decades, industrial development and urban activities have contributed a large extent in the increase of metal contamination in semi-arid environment. They have directly influenced the urban ecosystems causing toxic mutagenic effects to the human health depending on the substance's properties.[5] The present study aimed to determine the heavy metals concentration in Hassan Abdal (A historical town in Punjab Pakistan) drinking water. The metals considered of concern in the investigation are Chromium (Cr), Cadmium (Cd), Copper (Cu), Iron (Fe), Nickel (Ni) Manganese (Mn), Zinc (Zn), Sodium (Na), Potassium (K), Calcium (Ca) and Magnesium (Mg). The water was found to be safe

and drinkable regarding the WHO/Pak-EPA permissible limits of these elements.

MATERIALS AND METHOD

Sampling

2.25 Liter clean polythene screw capped bottles were used to collect the samples from the site. Each sample bottle was washed with a brush and phosphate free detergent, three times with tap water, soaked in 10% hydrochloric acid, again washed with tap water and finally rinsed three times with deionised water. Then these bottles were dried in sunlight and kept in the oven at 60oC for 12 hours, cooled to room temperature, recapped and labelled before collection of samples. Six drinking water samples were collected from different locations. Three samples (1, 2 and 3) were collected from tube wells within the houses and the remaining three samples (4, 5 and 6) from drinking water springs in different areas of the Hassan Abdal town. At the time of sampling bottles were rinsed with sample water. All necessary measures were taken during samples filling, transport and storage. Before starting the analysis all the glassware was washed on the same procedure as the sample bottles were washed.

Chemical analysis

Acidified water samples were analyzed for Heavy Metal (HM) (Cr, Cd, Cu, Fe, Ni, Mn, and Zn) and Light Metal (LM) (Na, K, Ca, Mg) with the help of atomic absorption spectrometer (Perkin-Elmer AAS-700). Standard working solutions of all concerned metals were prepared by appropriate dilution of 1000 mg/L certified standard solutions Fluka Chemica (Buchs, Switzer-land) in deionised water. All the chemicals used during analysis were of analytical grade.

RESULTS AND DISCUSSION

Chromium (Cr) is distributed in the earth's crust widely and always exists in +3 to +6 oxidation states. Cr (III) is usually present in very small amount in soils and rocks. The surface water contains chromium in the range of 0.001 to 0.010 mg/L.[5] The Cr concentration in surface water represents the industrial activity.[14] The concentration of Cr in dirking water samples that we analyzed ranges from 0.011 to 0.041 mg/L as shown in Table 1. It was found that Cr concentration is within the permissible limit in all these samples (Table 2) set by different organizations such as Pak-EPA, Canada, US and WHO.[15-17]

Table 1: Concentration of Heavy Metals in examining drinking water

Sample ID	Cr (mg/L)	Cd (mg/L)	Cu (mg/L)	Fe (mg/L)	Ni (mg/L)	Mn (mg/L)	Zn (mg/L)
1	0.016	0.005	0.01	0.018	0.030	0.031	0.058
2	0.019	0.003	0.09	0.020	0.020	0.027	0.041
3	0.011	0.005	0.19	0.015	0.021	0.043	0.049
4	0.031	0.001	0.07	0.019	0.012	0.021	0.034
5	0.025	0.001	0.03	0.011	0.017	0.037	0.055
6	0.041	0.004	0.1	0.090	0.015	0.051	0.067

Table 2: Drinking Water Quality Guidelines given by different Organizations

Contaminants	Pak-EPA Limits (mg/L)	Canadian Limits (mg/L)	US Limits (mg/L)	WHO Limits(mg/L)
Cr	0.05	0.05	0.01	0.05
Cd	0.05	0.005	0.005	0.003
Cu	2	1	1.3	2
Fe	-	0.300	0.300	0.300
Ni	0.02	-	-	0.020
Mn	0.5	-	-	0.5
Zn	5	5	5	5

Cadmium (Cd) is a rare earth element. It is homogeneously distributed in the earth crusts at an average concentration range from 0.15 to 0.2 mg/kg.[18] Its concentration in pure fresh water is generally less than 0.001 mg/L, while in sea water is about 0.00015 mg/L.[19, 22] The concentration of Cd in the present study was found to be in the range from 0.001 to 0.005 mg/L (Table 1) and was within the standard permissible limit (Table 2).

The concentration of iron (Fe) usually found in natural fresh water is at a level ranging from 0.5 to 50 mg/L. In drinking water it may also be present due to the use of iron coagulants or the corrosion of steel and cast iron pipes during water supply and from mineral industries.[20] In the present investigation, the concentrations of Fe in all drinking water samples were found between the range of 0.011 and 0.090 mg/L (Table 1). This range of Fe concentration is within the permissible

guidelines (Table 2) and was recommended by the local physicians to be well suited potable water.

Copper (Cu) usually presents in drinking water in the range from 0.005 to 30 mg/L. Standard permissible value of the WHO for Cu is 2 mg/L based on protective measures against acute gastrointestinal effects of this mortal.[23] The concentration of copper found in the present study was in the range of 0.01 to 0.19 mg/L (Table 1). This limit of Cu concentration in the drinking water of Hassan Abdal town is again within the permissible values (Table 2).

Manganese (Mn) in fresh water ranges from 1 to 2ooµg/L. Sometimes Mn green sand is used for potable water treatment.[23] The drinking water samples analyzed in the present study and the concentration of Mn was determined ranged from 0.021 to 0.051mg/L (Table 1) and do not exceed the permissible limits put by WHO And Pak-EPA (Table 2).

The natural sources of Nickel (Ni) in drinkable water are the ultramafic rocks and the soils derived from these rocks [20]. The concentration of Ni determined in all the drinking water samples ranged from 0.01 to 0.06 mg/L (Table 1). This contamination by Ni is within the standard permissible limit set by WHO and Pak-EPA (Table 2). Except in sample No 1 the concentration of Ni was 0.03mg/L, which exceed the standard permissible limit 0f WHO and Pak-EPA. But one should not worry about it because this excess is in a very small quantity. The highest concentration of Ni in these waters is assumed to be due to Ni-based minerals in the soils and rocks of this specific area of Punjab province.

Zinc (Zn) is present in a very minute amount almost in all igneous rocks. In Most surface water the concentration of Zn is below 0.010 mg/L and in groundwater it ranges from 0.010 to 0.040 mg/L. The concentration of Zn determined in potable water lay in the range of 0.041 to 0.067 mg/L (Table 1). The concentrations of Zn investigated in all drinking water samples were within the permissible limits (Table 2), set by various organizations.

Furthermore, the regional water also contains certain trace elements which are usually present in safe drinking water. These elements include Sodium (Na), Potassium (K), Calcium (Ca) and Magnesium (Mg). The concentration of these elements in the water was found to tally with that reported in literature (Table 3).[1, 22, 23]

Table 3: Concentration of Light Metals in the examined drinking water

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)
1	34.88	3.33	29.90	8.69
2	41.13	7.63	24.31	11.22
3	45.78	13.38	36.02	6.76
4	37.16	8.19	21.02	17.91
5	29.87	5.54	45.19	13.57
6	51.21	4.78	31.55	6.22

CONCLUSION

In the present study elemental analysis of various water samples taken from Hasan Abdal town was carried out. Heavy metals Cr, Cd, Cu, Ni, Mn, Fe, Zn and the light elements such as Na, K, Ca and Mg concentrations were found within the permissible limits set by WHO, Pka-EPA, US-EPA and Canada. All the water samples were found to be safe and drinkable.

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