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Determination of Some Heavy Metals in Water Collected From River Chublat (Hassan Abdal) Pakistan

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Abstract: ***Rivers are contaminated constantly by heavy metals from the atmosphere. Considering this fact, the World Health Organization and Environmental Protection Agency recommended qualitative and quantitative assay of heavy metals in drinking water. Although many studies on heavy metals in water have been conducted in other countries, little has been done in Pakistan in this regard. The perspective of this study was to determine Chromium, Copper, Lead, Cadmium, Zinc, Manganese, Iron, Nickel and some light metals, Sodium, Potassium, Calcium and Magnesium levels in the water of Chublat River Hassan Abdal (Pakistan). For this purpose six water samples were collected from the river. Batch mode of studies was performed to evaluate the indigenous properties of the collected samples. Then the concentrations of the metals in water samples were determined by using Atomic Absorption Spectroscopy. The concentration of some heavy metals such as Chromium, Cadmium, Iron and Nickel in the waters samples were above the permissible levels established by the WHO, Pak-EPA, US-EPA and Canadian limits for drinking water.***

Keywords: River Chublat; Heavy metals; Atomic Absorption Spectrometer; WHO;

1. Introduction

Water pollution has become a very critical area of study worldwide because of their direct implications on the aquatic life and the human beings (Ezemonye and Enuneku, 2005). The pollution of surface water by heavy metals is a serious environmental problem. They are non-degradable and can bio-accumulate through food chain. Though some metals like Fe, Cu and Zn are essential micronutrients, they can be harmful to the physiology of the living organisms at higher concentrations (Kar *et al*., 2008, Nair *et al*., 2010).

A large number of these toxic substances are rapidly introduced into the aquatic environment mainly due to anthropogenic activities such as increased industrialization, technological development, growing human population, oil exploration and exploitation, agricultural and domestic wastes run-off and naturally as a result of geological processes like weathering and leaching (Lima *et al*., 2008). Among these toxic substances, heavy metals are the most dangerous group because of their persistent nature, toxicity, tendency to accumulate in organisms and undergo food chain amplification and non-degradability (Enuneku *et al*., 2013, Fufeyin and Egborge, 1998).

The presence of some toxic metals in rivers is a serious challenge to our society. For this reason, there is a need for careful assessment, monitoring, and control of their release into the environment. Through various socio-economic and industrial activities, man causes severe pollution in the water bodies that leads to serious environmental problems which result in diseases, sudden deaths, and disabilities. Polluted water related diseases such as dysentery, diarrhea, bilharzias, typhoid fever, cholera, guinea worm and so on are very common among communities that live close to polluted river sources. In the world today, the rapid increase in population, urbanization and industrialization has brought about increase in demand for water and equitably a drastic rise in water pollution. "Population pressures will increase demand for food, this implies that more fertilizers, herbicides, and pesticides have to be applied on to the soil and crops, out of which some percentage of such chemical constituents would be leached or drained directly into surface waters and to make the water highly polluted. This implies that more the population more will be the pollution (Ajura, 1996).

Heavy metals have been investigated on a large scale in different river (Wakida., *et al*., 2008, Feng *et al*., 2008, Carolina *et al*., 2008). The toxicity of heavy metals has long been concerned since it is very important to the health of people and ecology. Heavy metals can also accumulate in the soil at toxic levels as a result of long-term application of untreated wastewaters. Soils irrigated by wastewater accumulate heavy metals such as Cr, Zn, Pb, Cd, Ni, etc in surface soil (Sanayei *et al*., 2009). When the capacity of the soil to retain heavy metals is reduced due to repeated application of wastewater, heavy metals leach into the ground water or soil solution available for plant uptake (Charya et al., 2008).

The aim of this study is to determine the concentration of heavy metals in the River Chublat (Hassan Abdal) Pakistan. The metals considered of concern in the investigation were Chromium (Cr), Cadmium (Cd), Copper (Cu), Iron (Fe), Nickel (Ni) Manganese (Mn), Zinc (Zn), Sodium (Na), Potassium (K), Calcium (Ca) and Magnesium (Mg).

2. Materials and Method

2.1 Sampling

2.25 Liter clean polythene screw capped plastic bottles were used to collect the samples from the River Chublat. Each sample bottle was washed with a brush and phosphate free detergent three times using tap water. Then the bottles were soaked in 10% hydrochloric acid for about 30 minutes and

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after that these were washed again with tap water. Finally these bottles were rinsed three times with deionized water. The bottles were then dried in sun light as well as were kept in oven at 60 ^{o}C for 12 hours. The dried bottles were recapped and labeled before collection of samples**.**

At the time of sampling bottles were rinsed with samples water. All necessary measures were taken during samples filling, transport and storage. Before starting the analysis all the glassware were washed on the same procedure as adopted for samples bottles**.** Analytical grade reagents were used in this study without further purification. All the solutions were prepared in doubly distilled water using Pyrex glass vessels.

2.2 Elemental Analysis

Acidified water samples were analyzed for heavy metals (HM) (Cr, Cd, Cu, Fe, Ni, Mn, Zn) and light metals (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, Switzerland) in deionized water.

3. Results and Discussion

Chromium (Cr): Cr is carcinogenic and distributed in the earth crust widely. It is always exists in +3 to +6 oxidation states. Cr (III) is usually present in very small amount in soils and rocks. Its +6 oxidation state is more toxic as compared to others. The surface water contains chromium in the range of 0.004 to 0.007 mg/L (Batayneh, 2012). The concentration of Cr in surface water represents the industrial activity (Shiller and Boyle, 1987). In this study the concentration of Cr ranges from 0.004 to 0.007 mg/L (Table 1). This concentration of Cr in the water shows that it is Cr polluted, because in most samples this level is above from the permissible limit (Table 3) set by different organizations such as Pak-EPA, Canada, US and WHO **(**Bala *et al*., 2008, Khan *et al*., 2012, Khan *et al*., 2011, Asweisi *et al*., 2013).

Cadmium (Cd): Cd is rare earth element. It is extremely toxic metal which has no necessary function in the body. It is homogeneously distributed in the earth crust's at an average concentration ranges from 0.15 to 0.2 mg/kg (Hiatt and Huff, 1975). Its concentration in pure fresh water is generally less than 0.001 mg/L, while in sea water is about 0.00015 mg/L (Fleischer *et al*., 1974, WHO, 2006). The concentration of Cd determined in this study ranges from 0.007 to 0.013 mg/L (Table 1) and mostly above from the standard permissible limits for drinking water (Table 3).

Iron (Fe): Fe is also essential micronutrient and play very important role in human physiology. Along with other elements especially Mn and Cu, Fe is very necessary for blood chemistry and essential for recovery from diseases but in higher concentration it is harmful. The concentration of iron (Fe) usually present in natural fresh waters at a level ranging from 0.5 to 50 mg/L. In water Fe present due to the use of iron coagulants or the corrosion of steel and cast iron pipes during water supply and from mineral industries (WHO, 2006). In the present research, the concentrations of Fe in all water samples were found between the range of 0.577 and 0.663 mg/L (Table 1). This range of Fe concentration is above the permissible guidelines for drinking water given by various national and international organizations (Table 3) and thus the River water is polluted with this element.

Copper (Cu): Cu is essential micronutrient but harmful in higher concentration and cause severe conditions in human physiology. It usually present in drinking water in the range from 0.005 to 30 mg/L. Standard permissible value of WHO for Cu is 2 mg/L based on protective measures against acute gastrointestinal effects of this metal (WHO, 2006). The concentration of copper found in the present study was in the range of 0.011 to 0.022 mg/L (Table 1). This concentration of Cu in the Chublat River Hassan Abdal is within the permissible values (Table 2), and thus free from the contamination of this metal.

Manganese (Mn): Mn is the essential component of those biochemical reactions that affects bone, cartilage, brain and energy supply but toxic in higher concentration. Mn in fresh water ranges from 1 to 2ooμg/L. Sometimes Mn green sand is used for potable water treatment (WHO, 2006). In the present study the concentration of Mn was determined ranged from 0.219 to 0.228 mg/L (Table 1) and do not exceed the permissible limits for drinking water set by various organizations (Table 3), so the water is not polluted with metal.

Nickel (Ni): Ni is carcinogenic and harmful to the physiology of all living organisms if present in higher concentration. The natural sources of Ni in water are the ultramafic rocks and the soils derived from these rocks (Khan *et al*., 2011). The concentration of Ni determined in all water samples ranged from 0.01 to 0.05 mg/L (Table 1). This contamination by Ni in most samples is above the standard permissible limits set by WHO, Pak-EPA, US-EPA and Canadian limits (Table 3). It means that water is also polluted with this metal.

Zinc (Zn): Zn is essential micronutrients. It is always present in all igneous rocks. The concentration of Zn in surface water is below 0.010 mg/L and in groundwater it ranges from 0.010 to 0.040 mg/L (Elinder, 1986). The concentration of Zn determined in the river water was in the range of 0.046 to 0.06 mg/L (Table 1). The concentrations of Zn investigated in all water samples of the river were within the permissible limits (Table 3), set by various organizations.

Furthermore, we also analyzed the River water for trace light metals. These metals include sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) (Table 2). The concentration of these elements in all water samples of the River Chublat was found to tally with that reported in literature (Javed *et al*., 2012, Shakeri *et al*., 2009, Sharifi *et al*., 2012, Heydari and Bidgoli *et al*., 2012).

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4. Conclusion

The study shows that the River Chublat water is relatively polluted with some toxic metals as compared to the benchmarks recommended by the WHO, Pak-EPA, US-EPA and Canadian limits for the drinking water. This occurrence of some toxic metals from above in Chublat water is due to the agriculture, use of synthetic chemical products in houses, rapid population growth, urbanization and commercial establishments that generate waste pollutants which flows in to the river water. Safe disposal of these domestic sewage, agricultural and industrial effluents should be made to reduce the concentrations of these toxic metals in the aquatic environment.

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Table Captions:

Table 1: Concentration (mg/L) of Zn, Cr, Fe, Mn, Cd, Cu and Ni in the River Chublat
Water Samples
Table 2: Concentration (mg/L) of Ca, Mg, Na and K in the River Chublat water samples
Table 3: Drinking Water Quality Guidelines given by different organizations

Table 1

S. No	Zn	Cr	Fe	Mn	Cd	Cu	Ni
1	0.06	0.007	0.663	0.228	0.013	0.022	0.05
2	0.049	0.004	0.598	0.220	0.007	0.011	0.03
3	0.053	0.007	0.674	0.225	0.013	0.020	0.05
4	0.059	0.006	0.633	0.227	0.010	0.017	0.05
5	0.046	0.005	0.687	0.222	0.013	0.019	0.01
6	0.055	0.007	0.577	0.219	0.012	0.021	0.04

Table 2

S. No	Ca	Mg	Na	K
1	42.15	15.56	24.38	9.01
2	35.71	13.42	33.08	5.87
3	39.37	15.19	23.71	8.66
4	29.05	15.68	30.37	6.03
5	41.66	10.11	27.66	8.27
6	42.08	12.52	30.76	7.49

Table 3

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

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