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Spectrophotometric Assay of Drinking Water in Remote Areas of Chiniot City, Pakistan

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ABSTRACT: Almost 70% of earth's surface is covered with water. The importance of pure water lies in the fact that it is the basic need of every human. In one of the studies reported by WHO it has been mentioned that that almost 80% of diseases are water borne. One of the major reasons of water pollution is the wastes generated from industries, domestic waste discharge, extensive increase in population, Industrialization, domestic waste discharge, extensive use of fertilizers. In the present study an assay of quality of drinking water has been conducted to analyze the life standards and health of people dwelling in the low lying regions of Pakistan. From the results obtained it is found that various water parameters and quality of water reflects poor standards of living conditions in the nearby villages of Chiniot city.

Keywords: spectrophotometric assay, drinking water, remote areas, Chiniot, water pollution

INTRODUCTION

Water is the main component of an ecosystem and without water sustenance of life on earth is not possible. Approximately ~71% of Earth's surface is covered with water (Durack et al., 2012). Out of the total available water resources, ~96.5% is present in the form of seas and oceans, ~1.7% exists in the form of ground-water and glaciers, whereas only 0.001% of water circulates as fresh water in the form of vapors, clouds, and precipitates in the form of rain (Graham et al., 2010; Durack et al., 2012). Studies indicate that water keeps on circulating throughout the ecosystem in the form of vapor-transpiration, transmission, condensation, and precipitation and finally

reaches the sea (Critchley et al., 2013). Sea water is not fit for drinking purposes due to high salinity content. Fresh water is considered as one of the most important resources naturally available on earth. Out of all available fresh water resources only 1% of fresh water is available in the form of drinking water. Over the past few decades an increased urbanization has resulted in a scarcity of naturally occurring resources of drinking water. It is expected that till 2025 extra than half of the world-population is vulnerable to water scarcity(Cosgrove and Rijsberman, 2014). The importance of drinking waters lies in the reason it is calories-free and has no natural vitamins in it.

Being an underdeveloped country, Pakistan limited possess primary resources, municipal authorities and other limited utility services thus an haphazard congestion has led to urban the deterioration of primary natural sources of the country. During the last few decades, it has been observed that environmental problems of Pakistan are associated with social and economical imbalances. In many regions of Pakistan, limited access to pure drinking water is available and people are consuming contaminated hazardous water for drinking purposes. In one of the study it has been reported that only 25.61% of Pakistan's population i.e. 23.5% of rural and 30% of urban areas have access to safe and drinkable water (Durack et al., 2012).

One of the major threatening factors to fresh water ecosystems in Pakistan is industrial effluent. Most of the industries discharge their effluents into water bodies without treating them properly.Water pollution from heavy metals and minerals due to industrial loads is one of the major problems being faced by Pakistan, these days. The word "heavy metals" is given to those elements which have a density greater than 5 g/cm^3 . Due to their non degradable nature, they are persistent in nature. Some of the heavy metals are referred as xenobiotics i.e. they have no beneficial role in human body and can be harmful even present in very small amount. Zn, Hg, Cd, As, Cr and Pb are most commonly occurring toxic heavy metals in water bodies.

In the present study an attempt has been made to estimate the quality of water in one of the cities of Pakistan. Chiniot, located near Jhelum. It is one of the populated cities of Pakistan. The importance of this city lies due to its furniture industry which draws an important earning source. Chiniot located at the North-West of Chenab River is approximately 86 Km away from Jhang. District Jhang is divided into 3 TMAs, out of three Chiniot primary city of one TMA. Chiniot is the primary city of this TMA. The Tehsil is primarily rural with 8 urban and 32 rural union councils. In 1998, it was reported that the total population of Chiniot was 965,124. Chiniot city has 4

most important CO units, including (i) Chiniot, (ii) Chenab Nagar, (iii) Lalian, Bhawana and (iv) (uu.urbanunit.gov.pk/Documents/Publicati ons/0/106.pdf). To ascertain the quality of water available, sampling was done from various rural regions of Chiniot.In the present study eight samples of water were collected from Village 204 Jotianwala, Lagrana 237 JB, Basal Wali 206. Mehrukachak 236. AmeenPur Road.

AddaJamia Abad, Waggage, and mainChiniot city. All the samples were collected in neat and accurately labeled PVC bottles to avoid chances of water contamination. Obtained results can be useful in predicting the quality of life and scarcity of resources available to people dwellingin Chiniot and its nearby areas. Table 1 gives a brief labelling of water samples with respect to areas of collection.

Table. 1. Water sample Id's collected from various regions of Chiniot city

Sample	Location of Sample	Sample	Location of Sample
P ₁	Village 204 Jotianwala	P ₅	AmeenPur Road
P ₂	Lagrana 237 JB	P ₆	AddaJamia Abad
P ₃	Basal Wali 206	P ₇	Waggage
P ₄	Mehrukachak 236	P ₈	Chiniot City

Procedeure employed for testing hardness of water was same as reported by (Donnet et al., 2005).

MATERIALS AND METHODS

The chemicals used in the present study include HCIO₄ (72% Analytical grade, Merk), HCl (37%, Merck), and HNO₃ (65%, Fluka) used for extraction as well as acid digestion processes. Buffer solution (NH₄Cl-NH₄OH) was prepared by dissolving 33.8g of NH₄Cl (Merck, Germany) 286mL NH₄OH and total volume was diluted up to 500mL using distilledwater. All the chemicals were used as received without any further purification.

To test water hardness, 0.25g of Erichrome black-T and 50g of NaCl were mixed well. This mixture was used to prepare 0.01M Na₂-EDTA solution using distilled water as solvent.0.01M standard solution of CaCO₃ was prepared by dissolving about 0.5g of CaCO₃ in distilled water H_2O and made the volumeup to 500mL. The procedure employed for testing hardness of water was same as reported by (Donnet et al., 2005).

Standardization of 0.01M EDTA Solution

Standardization of EDTA solution was done by titrating 0.01M prepared EDTA solutionagainst standard solution of 0.01M CaCO₃ where Erichrome black tea (EBT) was used as indicator(Nomura et al., 1986). To 10 mL of collected water samples, added I mL of buffer solution to adjust its pH at 10. Using EBT indicator, this water sample was titrated with 0.01 M EDTA solution. Change in color from red to blue indicated the endpoint. Three concordant readings were taken to evaluate the accuracy of procedure and hardness was calculated using formula given below;

Physico-Chemical Analysis

Digital electric balance (Chyo-balance) was used for weighing purpose, digital pH meter (Germany Inolab720) for pH measurements. conductivity meter (Germany 7110) was employed for measuring conductivity of collected water samples. Detection of heavy metals was carried out using fast sequential atomic absorption spectrophotometer FAAS Varian AA240. The heavy metals estimated in the present study include Zinc (Zn), Cadmium (Cd), Lead (Pb), Manganese (Mn), Chromium (Cr), Copper (Cu), Magnesium (Mg), and Calcium(Ca).

Hardness of CaCO₃(mg/L) ₌[Titrant used (mL) for sample - Titrant used (mL) for blank] \times M_{×50000}

Samples (mL)

where:

M = Molarity of EDTA solution and

(50000 is Constant value)(Wojtowicz, 2001).

Blank readings were also run in the similar way to compare quality of collected water samples.

RESULTS AND DISCUSSION

Color Testing

As Platinum-Cobalt standard method is not handy to use therefore field method is preferred. In this method, tubes of metal were used which contained glass disks at one end and a set of glass tubes of sample and distilled water on other end. The color or shade of water samples was compared with reference tube containing clear water(Bates et al., 1973).

Temperature Measurement

The room temperature and temperature of samples were easily measured by the help of Mercury glass thermometer(Sloan and Keatinge, 1973).

pH Measurement

The readings of pH of water samples were estimated by dipping its electrode into samples. The pH meter (Germany Inolab720) should be precalibrated by using buffer standards with pH 10, 7 and 4(Parveen et al., 2012).

Conductivity of Samples

The readings of conductivity of water samples were estimated by dipping its electrode into samples. The conductivity meter (Germany 7110) should be pre-calibrated by using 0.01M KCl which will show the conductivity \sim 1372 µS/cm at 25°C(Jurak et al., 2015).

TDS value determination

The values of TDS for all samples of water were determined by filtration of samples through pre-weighed Whatman's 42). filter paper (No. Undissolved particles were accumulated on the surface of filter paper after several flushing with help of 20-30mL of DI water. Finally cool the filter paper to room temperature after drying the filter paper in oven (at 100-110°C). Then weighed the filter paper after drying and calculate the amount of suspended solids (in mg/L)(Renuka et al., 2013). Table 2 gives an elaborative description of various physico chemical properties of collected water samples.

From the data given in Table 2, it is seen that total hardness in samples collected from Village 204 Jotianwala (P₁=710 ppm), *Lagrana 237 JB* (P₂=642 ppm) and AmeenPur Road P₅=701 ppm) exceed the WHO permissible limit < 500ppm. Whereas the calculated values, chloride content and pH show that all the collected samples lie within permissible range of WHO standards, i.e. chlorides \leq 200ppm and pH equals to 6.5-8.5. From values the data for conductance measurements and Total dissolved solid (TDS), it is seen that the measured values for the water samples collected cross the WHO permissible limits 0.05-0.5 mS/cm and \leq 500 mg/L respectively.

Sr. No	Sample	*Total Hardness (ppm)	*Chlorides (ppm)	*Alkalinity (ppm)		**pH	**Conductivity (mS/cm)	**TDS (mg/L)
		<u><</u> 500ppm	<u><</u> 200ppm	CO3 ⁻²	HCO ₃ ⁻¹	6.5-8.5	0.05-0.5 mS/cm	≤ 500 mg/L
				<u><</u> 00	оррш			mg/L
1.	P ₁	710	143.633	420	512.4	7.136	3.2688	1623.8
2.	P ₂	642	71.568	460	561.2	7.1246	2.864	1432.2
3.	P ₃	431	75.54	280	341.6	6.818	1.589	804.6
4.	P ₄	231	119.28	660	805.2	7.526	2.506	1242.4
5.	P ₅	701	37.77	470	573.4	7.046	1.855	922.6
6.	P ₆	348	26.34	412	516.2	6.668	1.072	537.8
7.	P ₇	478	45.22	415	506.3	6.814	1.5942	797.2
8.	P ₈	468	115.80	305	572.1	7.426	1.73	867

Table 2. Physico-chemical characteristics of collected water samples

*Mean value of triplicate measurements

**Mean value of five replicate measurements

These higher values of conductance measurements can be attributed to higher concentration of ions present in collected water samples. The presence of these ionic species can be hazardous or toxic for health and related issues. In case of alkalinity (for both CO₃⁻ 2 and HCO_3^{-1}), only the water sample collected from *Mehrukachak* 236P₄ exceed the WHO permissible limit (< 600ppm)where as all other samples gave satisfactory results for alkalinity measurements. However. detailed a comparison of various physico - chemical

parameters of collected water samples with the reference values prescribed by WHO standards indicate poor quality of water available in these regions. High percentage of salinity, conductance and total measurements hardness measurements reveal that water available to the rural areas of Chiniot city is not fit for drinking and irrigation purposes. Prolonged use of such water without proper treatment may result is several oral diseases and stomach disorder reflecting poor standards of life.

Sample ID /WHO permissibl e limit	Zn (mg/L)	Cd (mg/L)	Pb (mg/L)	Mn (mg/L)	Cr (mg/L)	Cu (mg/L)	Mg (mg/L)	Ca (mg/L)
	5.0mg/ l	0.003mg/ l	0.01mg/ 1	50mg/l	0.05mg/ 1	1.0mg/ 1	0.05mg/ 1	75mg/l
P ₁		0.004				0.004	47	73
P ₂	0.36	0.004	0.001		0.001	0.003	55	72
P ₃		0.006				0.003	41	69
P4		0.004		0.002		0.004	48	60
P ₅		0.009	0.001		0.001	0.003	42	58
P ₆	0.002	0.004		0.001		0.003	52	70
P ₇	0.605	0.007	0.001	0.001	0.001	0.002	58	62
P ₈	0.26	0.009	0.001	0.002		0.003	49	68

Table 3. Heavy metal analysis of collected water samples



Fig. 1. Graphical illustration of occurrence of heavy metals in collected water samples

From the data collected, it is inferred that the concentration of almost all the studied heavy metals lies within WHO permissible limit of water standards. except for the magnesium(Tsade, 2016). It is evident that the concentration of magnesium is quite high and exceeds well above the permissible limit range of magnesium. Studies indicate that there is a tremendous protective influence of magnesium intake from drinking water against hypertension. Nonetheless, in the modern-day world, recommended intake of dietary magnesium is usually lower than the recommended dietary amount of 6 mg/kg/day (Rubenowitz et al., 1996)

From the knowledge of function of magnesium levels in drinking water we can develop an association between the mortality rate due to hypertension and concentration of magnesium ions found in drinking water. According to one of the proposed hypothesis recently it is suggested that an impairment of membrane of cell, transport of sodium ion is found responsible for the increased total peripheral resistance found in essential hypertension cases (de Wardener and MacGregor, 1980). Under such situation, magnesium acts as an enzyme (Na/K-ATPase) activator and facilitates to regulate the cellular energy, vascular tone, and cell membrane ion transport system. Lower concentrations of magnesium ions during lowering of blood pressure may lead to a decrease of intracellular potassium ions concentration thereby increasing the calcium content, as a result blood vessels contracts rapidly leading to an increased risk of death (Altura et al., 1984; Reinhart, 1991).

However, in addition to the positive effects of magnesium ions against hypertension, studies indicate laxative effects in human beings may be associated to the prolonged exposure to magnesium ions, which may lead to diarrhea or intestinal obstructions especially among children and old age people.

CONCLUSIONS

From the study conducted it can be concluded that the quality of water available for drinking in the nearby areas of Chniot city reflects poor standards of life. It was found that some water samples contain high concentration of cadmium heavy metal as well as high TDS level, total hardness and

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