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Heavy Metal Contents and Other Physical Quality Indices of Sewerage, Canal and Drinking Waters

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Analysis of Cd, Pb and Cu in canal, sewerage and drinking waters by potentiometric stripping analysis (PSA) is described. Other quality indices of waters such as temperature, pH, EC and total solid were also determined. The levels of heavy metal contents of sewerage, canal and drinking waters revealed marked differences and wide coefficient of variability (CV). Generally Cd and Pb contents were higher in sewerage than canal and drinking waters. However, Cu content of drinking waters was higher than other waters tested. The total solids were found to be generally higher in sewerage and canal waters than drinking waters. The variations in temperature, pH and EC were marginal to marked depending upon the source and the location.

Key words: Environmental pollution, Water pollution, Heavy metals and contamination.

Introduction

In view of the importance of heavy metals in the health and nutrition of human beings and animals, several studies have been carried out in Pakistan and other countries (Jalinek 1982; Wolnike *et al* 1985; Marletta *et al* 1986; Jaffar and Saleem 1987; Sattar *et al* 1989). Although it is difficult to classify trace metals into essential and toxic groups, it is well known that an essential metal becomes toxic at sufficiently high intakes (Khurshid and Qureshi 1984). Lead and cadmium are the non-essential trace elements extensively studied because of their various toxic effects in human at low doses (Sattar *et al* 1989; Haider 1997). The typical symptoms of lead poisoning are cholic, anaemia, headache, convulsions and chronic nephritis of the kidneys, brain damage and central nervous system disorders (Greenwood and Earnshaw1986). Cadmium is extremely toxic and accumulates in human and damages mainly kidneys and liver (Greenwood and Earnshaw 1986; Sattar *et al* 1989). A human adult contains around100 mg of Cu, mostly attached to protein and requires a daily intake of 3-5 mg. Copper deficiency results in anaemia and the congential inability to excrete Cu, resulting in its accumulation, is Wilson's disease (Greenwood and Earnshaw 1986). Several techniques such as neutron activation analysis (NAA), atomic absorption spectroscopy (AAS), anodic stripping voltametry, inductively complied plasma (ICP) and potentiometric stripping analysis are used to determine heavy metals (Jagner 1979; Qureshi *et al* 1984; Satzger *et al* 1984; Benzo *et al* 1986). Potentiometric stripping analysis (PSA) is widely used (Jagner, Granch 1976; Jagner, Westerlund 1980) and is particularly well suited for liquid samples since normally no pre-treatment of samples is necessary (Sattar *et al* 1989). Findings of a recent study show the pollutants in drinking and irrigation waters (Sattar *et al* 1990). Determination of some physical parameters is also important for the quality evaluation of fresh waters (Danishwar and Shah 1997). Various quality parameters like pH, EC and total solid contents and pollutants were determined earlier (Ahmed *et al* 1982; Ahmed *et al* 1983; Bangash 1995). The objective of this study was to determine the concentration of selected heavy metals and other quality parameters in some drinking, canal and sewerage waters.

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Materials and Methods

Samples of drinking, canal and sewerage waters were collected from different locations (Fig-1) in Peshawar areas (Table 1). All the samples were collected in one litre plastic bottles. After measurement of pH and electrical conductivity (EC), the samples were acidified by addition of 0.5 ml of HCl to a pH of about 2.0 to determine other physical and chemical parameters.

Physical parameters i.e. pH, Ec, Ts, colour and temperatures employing Hamdard methods. The selected having metals were determined using the potentiometric stripping system, available at NIFA, which can detect selected heavy metals, (Danielsson *et al* 1983) using the Tecator Striptec System (Model 1069-001). Keeping in view of the hazardous effects and limitations of the instrument, only Pb, Cd and Cu were determined. The stability of the instrument was checked each time, whenever analyses were carried out. The lower limit of detection (LOD) was found to be 0.005 ppm mg l^{-1}.

Calculations.

$$X = \frac{L_o \times C}{L_1 - L_o}$$

C= Concentration of standard solution added to the solution
X= Metal to be determined in µg 25 ml^{-1}
L_o = Length of plateau before addition
L_1 = Length of plateau after addition

Procedure. An accurate amount of 25 ml of water sample is taken in a sample-holder and 1-5 ml of 1000 ppm Hg is added to it for deposition of metal on glassy carbon electrode. The pH is adjusted in the range of 1-2 and the volume is made upto 40 ml with distilled water and the sample is analysed on potentiometric stripping analyser and a graph is plotted. After adding 10 ml (0.25 ppm) of standard to the sample, it is again run on the analyser.

Results and Discussion

An essential component of the human environment into which the toxic metals may easily be released from various sources of pollution is surrounding water. It was, therefore, desired to monitor the levels of heavy metals in various types of waters used for drinking and irrigation purposes and collected from different areas. The results obtained in the present study were compared with the recommended limits for drinking and municipal water given in Table 2 (WHO 1984).

Heavy metal concentrations of water obtained from irrigation canal (Sardar Garhi) are presented in Table 3. Three samples were taken from a distance of 200m apart and were analysed. The results showed wide variation for cadmium and lead as compared to copper. Concentration of Cu was highest followed by Pb and Cd in these waters. Heavy metal contents of sewerage water (Table 4) should high levels of cadmium (1.37 ppm) in the samples obtained from sewerage water near Faqirabad. However, lead (1.87 ppm) content was more in a sample of sewerage water obtained from Hajiabad. The mean concentration of copper was almost comparable at both places. Toxic and heavily loaded industrial effluents are produced daily in almost all the industrial concerns. In Peshawar the sewerage and industrial effluents are disposed into the canals or rivers, which are used for irrigation in the vicinity of Peshawar.

Oxygen in drinking water is the most important substance for human life (IDRC 1998). If water resources are not better managed and protected, shortage and contamination will present major dangers to health and environment (IAEA 1998). In Peshawar, the principal source of the drinking water is the ground water including hand pump, tube-well and tap water. Water pollution is the specific impairment of water quality by agriculture, domestic or industrial wastes. In water, smoke and wastes of vehicles are deposited on the soil surface and in

Table 1
Water used for heavy metal assays

Sample	Date of collection	Type of water	Location
1	15.7.1995	Canal water	Sardar Garhi Sheikh Wala
2	-do-	-do-	-do-
3	-do-	-do-	-do-
4	17.7.1995	Sewerage sludge water	Hajiabad Charsadda road Peshawar
5	-do-	-do-	-do-
6	-do-	-do-	Faqirabad road Peshawar
7	-do-	-do-	-do-
8	-do-	-do-	Main Nala
9	5.8.1995	Drinking water	Bara area
10	-do-	-do-	Hayatabad
11	6.8.1995	-do-	Gulbahar
12	-do-	-do-	Dalazak road
13	-do-	-do-	NIFA
14	-do-	-do-	Pabbi
15	8.8.1995	-do-	University town
16	-do-	-do-	University campus

rainy season it results in considerable rise in the contamination of water. In irrigated areas, the chemicals, fertilizers and pesticides used in the fields reach the ground water levels. The other possible sources of heavy metals pollution include leaching from pipes; Pb/Cd based solder pipe joints and use of sub-standard chemicals for water treatments cause the metal pollution. The factors affecting the quality of the ground water also include soil texture, elevation of water table, quality of waste water, extent of injection direction and velocity of ground water flow (SAIC 1998). The concentrations of heavy metals of drinking water collected from other locations are shown in Table 5. The results of the analyses of the drinking water samples were compared with the international standards of drinking water given in Table 2. It showed that highest amount of Cd (0.82 ppm) was in the water obtained from NIFA and the lowest in water from Dalazak road. pb levels was highest in the water obtained from University Campus (0.78 ppm) and the lowest 10.08 ppm in the sample obtained from Gulbahar.

Determination of means and CV of all the waters indicated wide variation in the heavy metal contents in each case. Elemental concentration of industrial effluents from few industries has been reported in few studies (Ahmad *et al* 1982). An early investigation of drinking and irrigation waters carried out at NIFA has shown quite significant variation in the heavy metal levels (Ahmad and Saleem 1983).

The results showed (Table 4) that the temperature, pH, EC and total solids of sewerage water differed widely dependently upon the location from where the samples were taken. Electrical

Table 2

Guidelines for the quality of drinking and municipal waters

Parameter	International recommended limits for drinking water*	NEQS for municipal water/ industrial effluents*
pH	6.5-8.5	6-10
Total solids	1000	3500
EC	4000 μ s cm^{-1}	-
Cd	0.005	0.1
Pb	0.05	0.5
Cu	0.05	1.0

*($mg l^{-1}$, unless otherwise defined); NEQS, National Environmental Quality Standards.

Table 3

Selected quality indices and heavy metal levels of canal/irrigation water

Locations	Distance (meter)	Concentration (ppm) Cd	Cu	Pb	Temp. (°C)	pH	EC (μ mhos)	TS (ppm)
Sardar Garhi	200	0.104	0.714	0.313	26.5	7.8	630	950
Canal water	400	0.122	0.046	0.488	26.5	7.8	620	875
-do-	600	0.042	1.154	0.878	26.5	7.8	640	1092
Mean		0.09	0.96	0.56	26.5	7.8	630	972
CV		46.9	23.4	51.7	-	-	1.58	11.3

Values are means of 3 independent determinations.

Table 4

Selected quality indices and heavy metal levels of sewerage water

S. No.	Location	Distance (meter)	Concentration (ppm) Cd	Cu	Pb	Temp. (°C)	pH	EC (μ mhos)	TS (ppm)
1	Hajiabad,	200	0.833	1.875	1.875	26.5	7.3	1400	1060
	Peshawar	400	0.412	0.521	0.638	-do-	7.3	1400	1042
	Mean		0.62	1.198	1.125	26.0	7.3	1400	1051
	CV		47.8	79.9	69.6	0	0	0	1.2
2	Faqirabad,	200	1.37	0.568	0.131	26.5	7.3	610	1730
	Peshawar	400	0.78	1.458	0.561	-do-	7.2	610	2157
		600	0.33	1.67	0.379	-do-	7.2	620	1886
	Mean		0.83	1.06	0.36	26.5	7.23	613	1924
	CV		63.1	42.6	60.5	0	0.06	1.0	11.2

Each sample 200m apart from Hajiabad and Faqirabad locations (downstream); Values are means of 2-3 independent determinations.

Table 5
Selected quality indices and heavy metal levels of drinking water

S. No.	Location	Concentration (ppm) Cd	Cu	Pb	Temp. (°C)	pH	EC (µ mhos)	TS (ppm)
1	Bara Area	0.08	2.50	0.08	26.5	7.6	630	663
2	Univ. Town	0.32	11.50	0.14	26.5	7.6	500	833
3	Gulbahar	0.52	8.33	0.08	26.5	7.6	1200	590
4	Dalazak road	0.03	1.39	0.08	26.5	8.0	1550	675
5	Hayatabad	0.44	0.91	0.65	26.5	7.8	1500	671
6	NIFA	0.82	0.94	0.08	26.5	7.5	500	480
7	Univ. Campus	0.53	1.38	0.78	26.0	7.9	710	864
8	Pabbi	0.14	3.75	0.12	26.5	7.7	610	609
	Mean	0.36	3.84	0.25	26.43	1.71	900	673
	CV	75.0	103.2	115.2	0.67	2.23	49.43	18.7

Values are means of 3 independent determinations.

conductivity (EC) of the samples obtained from Hajiabad (1400 µ mhos) was much greater than others. The total solids of water sample taken from Eidgah road varied from 1730-2157 ppm. The pH and temperature varied slightly among water samples of sewerage obtained from different locations of the main Nala.

Similarly the canal waters (Table-3) taken from three different locations of the same canal showed that the total solids, ranged from 875 to 1092 ppm, generally higher levels of total solids were found in sewerage water than in canal water. The data for quality indices of drinking water (Table5) revealed slight variation in pH and temperature and wide in EC values. Highest EC was observed in the drinking water taken from Dalazak road (1550 µmhos). The measured EC values are mostly well below the recommended limits (Table 2). The total solids ranged between 480 and 864 ppm while the recommended limit for TS is 1000 ppm. Hence, the levels of TS are lower in all samples. The measured data indicates that majority of samples are in the permissible pH (Table 2).

The studies conducted by Nasreen (1994) also showed considerable variations in pH, EC and total solids. The data obtained from the present study differed widely, however, these investigations indicate the need for continuous monitoring of the status regarding pollution of water supplies.

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