ISSN-1996-918X

Pak. J. Anal. Environ. Chem. Vol. 21, No. 1 (2020) 152 – 157

http://doi.org/10.21743/pjaec/2020.06.18

The Studies on Water Quality for Cobalt and Manganese Content in Drinking Water of Multan Area, Southern Punjab, Pakistan

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Received 08 October 2019, Revised 30 December 2019, Accepted 26 February 2020

Abstract

The trace elements, cobalt (Co) and manganese (Mn) were determined in the drinking water of Multan city and areas in its vicinity. For this purpose, ten water samples were collected from various points within a circle of one kilometer radius, each time around seven disposal units. Water samples were stored in sealed glass flasks at room temperature. The quality of these water samples was compared with reference samples collected from various far off places which were not affected by any disposal unit. Analysis for Co and Mn was carried out using Flame-Atomic Absorption Spectrophotometer. The highest concentration of Co (0.31 ppm) was found in New Multan disposal area, while highest concentration of Mn (0.45 ppm) was noted in Suraj Miani disposal area. The contents of Co and Mn metals in most of the points are found to be greater than permissible limits of WHO guide lines for drinking water.

Keywords: Water quality, Drinking water, Heavy metals, Concentration, Cobalt, Manganese, Multan area

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Introduction

Contamination of surface and ground water has become one of the major environmental issues in big cities. Clean drinking water is the basic obligation for all citizens [1]. There is a wide diversity of pollutants like heavy metals, textile dyes, pesticides, pathogens etc. affecting the water bodies [2]. Heavy metals gain a particular distress due to their strong toxicity and bio-accumulating nature even at lower concentrations [3]. Industrial processes like metal plating units, hydrometallurgical operations, mineral beneficiation and tanneries discharge waste containing multiple types of heavy metal ions [4]. Majority of heavy metals are persistent and toxic especially when accumulated above the level of permissible limit [5, 6].

Intake of heavy metals causes severe problems related to human health like gastro, dysentry, cholera, typhoid, hepatitus. According to the report published by UNESCO in 2003, almost 2.3 billion people all over the world are suffering from water borne diseases [7]. In developing countries more that 2.2 million people die each year by drinking contaminated water [8].

In Pakistan, condition of water quality is not satisfactory in most of the areas of the country and water pollution is becoming a serious threat due to mismanagement of resources [9]. Ground water contamination has been reported in several areas of Pakistan [9, 10]. Studies have shown that industrial effluents from major cities of Pakistan

have higher concentrations of heavy metals than NEQS limits [11-14].

The present study has been carried out purely to asses the quality of drinking water in Multan Area of Southern Punjab, Pakistan in order to meet the purpose of providing clean and standard quality water. This communication presents the results of contents of Co and Mn in drinking water samples collected from various points of the city for academic purpose. It is a fact that health of a community depends not only on the availability of health services but also on the better hygienic atmosphere. The provision of health services together with clean drinking water is the surest safeguard against communicable diseases. There is a dire need to provide full information to the population of areas under study using water especially in highly populated and polluted areas. In Pakistan people carry many diseases solely because of water as majority of the population in our country is not provided with standard water.

Materials and Methods

Sample collection

Drinking water samples were collected from various disposal unit areas and areas away from these units Fig. 1. For this purpose, seven sampling points of Multan city region were selected as New Multan disposal area (tube well), Vehari Road disposal area (motor pump), Kiri Jamandan disposal area (motor pump), Suraj Miani (motor pump), Chungi No. 9 (motor pump), Old Shuja Abad road (tube well) & BZU campus (tube well). These samples were kept in sealed glass flasks at room temperature.

Preparation of standard solutions

Standard Co stock solution (1000 ppm) was prepared by dissolving 4.9322 g of A.R. grade cobalt nitrate [$Co(NO_3)_2.6H_2O$] of Merck/ BDH in water with the help of 1% nitric acid. The volume in the flask was made up to 1000 mL Similarly, standard Mn stock solution (1000 ppm) was prepared by dissolving 3.6065 g of A.R. grade manganese chloride [$MnCl_2.4H_2O$] of Merck/ BDH per 1000 mL of water containing 1% hydrochloric acid. Working standards were prepared by appropriate dilutions form the stock solutions.

Determination of trace elements

The concentration of Co and Mn in water samples was determined by Atomic Absorption Spectrophotometer (Model: Z-8000 Hitachi, Japan) under optimized conditions. The results obtained were reported in Table-1. The concentration ranges of various samples were also found and presented in Table-1. Statistical analytical data of cobalt and manganese in drinking water samples around various disposal areas (n=10) was calculated by following relation and the data was given in Table-2.

$$S.D.= X-X/n-1$$

Analytical results were compared with reference to origin of water (municipal hand pumps and motor pumps) and disposal unit areas.

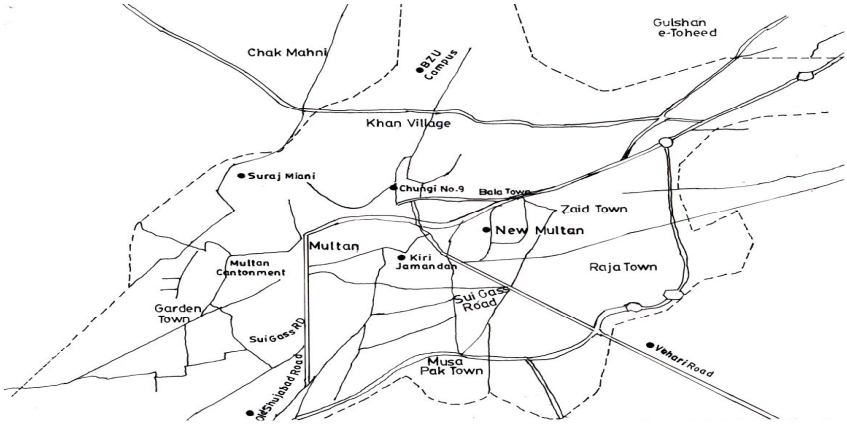

Figure 1. **Location map of main water collection points of Multan city area**

Table 1. **Concentrations (ppm+sd) and ranges (ppm) of cobalt & manganese in drinking water samples collected from various disposal areas of Multan city.**

Sampling Area or Station	Cobalt Concentration Mean (ppm+sd)	Concentration Range of Cobalt (ppm)	Manganese Concentration Mean (ppm+sd)	Concentration Range of Manganese (ppm)
B.Z.U. Campus (Tube Well)	0.14 ± 0.013	0.01-0.26	0.03 ± 0.006	0.00-0.17
Old Shuja Abad Road (Tube Well)	0.22 ± 0.016	0.16-0.29	0.02 ± 0.003	0.00-0.17
New Multan Area (Tube Well)	0.15 ± 0.014	0.07-0.31	0.03 ± 0.006	0.00-0.12
Chungi # 9 (Motor Pump)	0.12 ± 0.008	0.03-0.19	0.14 ± 0.012	0.08-0.26
Kiri Jamandan (Motor Pump)	0.07 ± 0.005	0.00-0.22	0.04 ± 0.011	0.00-0.24
Vehari Road (Motor Pump)	0.02 ± 0.01	0.00-0.12	0.08 ± 0.011	0.04-0.26
Suraj Miani (Motor Pump)	0.08 ± 0.01	0.00-0.13	0.14 ± 0.013	0.02-0.45

Table 2. **Statistical analytical data of cobalt and manganese in drinking water samples around various disposal areas (n=10).**

Sampling Area or Station	Cobalt Concentration (ppm)	Manganese Concentration (ppm)
B.Z.U. Campus (Tube Well)	0.15 ± 0.09	0.04 ± 0.04
Old Shuja Abad Road (Tube Well)	0.22 ± 0.03	0.03 ± 0.05
New Multan Area (Tube Well)	0.16 ± 0.07	0.04 ± 0.04
Chungi # 9 (Motor Pump)	0.12 ± 0.05	0.15 ± 0.06
Kiri Jamandan (Motor Pump)	0.08 ± 0.07	0.05 ± 0.07
Vehari Road (Motor Pump)	0.03 ± 0.04	0.09 ± 0.06
Suraj Miani (Motor Pump)	0.09 ± 0.04	0.14 ± 0.12

Results and Discussion

The observed range of Co concentration in all water samples collected from tube wells and motor pumps was 0.0-0.31 ppm as is evident from Table 1. However, higher level of Co was found in tube well water samples of New Multan disposal area 0.07-0.31 ppm, whereas low concentration range 0.0-0.12 ppm of Co was found in water samples of motor pumps obtained from Vehari road, disposal area.

Among the water samples obtained from motor pumps, higher concentration 0.0-0.22 ppm of Co was present in samples of Kiri-Jamandan disposal, while lower concentration 0.0-0.12 ppm was found in Vehari road area. Whereas, water samples of Suraj Miani and Chungi No. 9 disposal units contained 0.01-0.13 ppm and 0.03-0.19 ppm of Co respectively. In municipal water supply, highest concentration 0.07-0.31 ppm of Co was found in New Multan disposal area as mentioned earlier. The old Shuja Abad road disposal area samples contain Co concentration in the range of 0.16-0.29 ppm of Co level slightly lower than New Multan disposal area. From these results of Co analysis, it is obvious that its higher concentration is found in tube well water samples of three areas i.e. Bahauddin Zakaria University (BZU), New Multan area and old Shuja Abad road. The level of Co is slightly on the higher side than the standard value (Co = 0.07 ppm) [15]. It is suggested that the concentration of Co in water can be reduced to less than 0.07 ppm by using either ion exchange

resins [16] or low cost adsorbents [17] in order to provide quality water to local population.

The observed range of Mn level in various tube well water samples was 0.0-0.45 ppm (Table-1). Higher concentration (0.02-0.45 ppm) was present in motor pump samples of Suraj Miani disposal area, while lower concentration (0.00-0.12 ppm) was found in motor pump water of New Multan area. It was noted that New Multan area contains lower concentration (0.00-0.12 ppm) than those of municipal water supply (0.00-0.17 ppm).

Water samples obtained from tube well as source contain Mn concentration level of 0.00-0.17 ppm collected form BZU campus and old Shuja Abad road disposal area respectively, while New Multan areas samples contain 0.00-0.12 ppm of manganese. Water samples obtained from motor pumps, contain maximum Mn level of 0.02-0.45 ppm in Suraj Miani disposal area samples whiles other disposal areas contain comparable concentration 0-0-0.26 ppm of Mn. It is recommended that concentration of Mn in water can be reduced to less than 0.05 ppm by increasing chlorine doses or increasing pH to make it suitable for drinking purposes [15].

Samples of drinking water for comparison were collected from different sources (tube wells, motor pumps) away from these disposal areas. Trace elements Co and Mn were estimated in these samples. The concentration range values of these trace metals are comparable with the concentration ranges of drinking water samples collected from different places around disposal units. The comparison of the concentration ranges of the trace metals (Co and Mn) with reference to source of water (tube well and motor pump) shows that the upper level of these metals is generally higher in water samples obtained from motor pumps around various disposal unit areas. Among all disposal areas studied, the water samples obtained from Old Shuja Abad road and Vehari road areas contain relatively lower average concentrations of the both heavy metals (Table-1).

The British permitted concentration values for Co and Mn are 0.07 ppm and 0.05 ppm, respectively. A comparison of these levels with the observed concentrations of these metals in water samples reported reveals that Co and Mn concentration range in water samples from all disposal location are slightly higher than those reported by British Water Quality Act 1989 [15]. It is suggested that population using low quality water must be provided with standard quality water after carrying out complete analysis regarding macro and micro elements. This will lead us towards healthy generations.

Co and Mn occurs naturally in many soils that may erode into surface and ground water sources. However, human activities are also responsible for much of the Co and Mn contamination in water in some areas. Higher levels in drinking waters are usually associated with industrial pollution. The concentration of Co and Mn in ground water samples of the study area and other studies along with permissible limits are given in Table-3. The present study was compared with drinking water quality in the rural areas of the Bhongiri region, India. Chennaiah *et al.* [18] studied water quality of Ghatkesar, Pagidipalli, Bibinagar, Yamnampeta, Annampatla, Aushapur and Guduru towns. A total of 42 drinking water samples were collected from these areas to assess the status of drinking water. The concentration of Mn in the drinking water samples ranged from 0.0049 to 2.046 ppm, while the concentration of Co in the drinking water samples ranged from 0.0003 to 0.0028 ppm. The concentration of Mn exceeds the permissible limits of WHO 2004 [19] in the study area (0.100 ppm). Co and Mn are needed at low levels as catalysts for enzyme activities. Drinking water containing high levels of these essential metals may be hazardous to our health. High level of Mn in drinking water is associated with neurological damage. The accumulation of Mn may cause hepatic encephalopathy [20]. High level of Co in drinking water may cause lung cancer [21].

The removal of Co and Mn, the metallic toxic pollutants from drinking water is very important to safeguard the habitats of the particular area. Different processes are being used throughout the world for the removal of heavy and toxic metals from polluted water to make it drinkable. These processes include solvent extraction, membrane separation, micro & ultra-filtration, forward and reverse osmosis,

coagulation, electrolysis, precipitation, phytoremediation, ion exchange and adsorption [22, 23]. The adsorption of Co and Mn on low cost media such as alumina or bentonite seems to be an economically viable solution to make the polluted water of the Multan city areas as drinkable [24, 25].

Table 3. **The concentration ranges of trace elements (cobalt and manganese) in ground water samples of the study area along with permissible limits and its comparison with some other areas .**

Concentration Range of Elements (ppm)	Multan City area, Pakistan	Bhongiri Region, India	WHO (2004)	British Water Quality Act 1989
Cobalt	0.000-0.31	0.00032-0.0028	Not available	0.07
Manganese	0.000-0.45	0.0049-2.046	0.100	0.05

Conclusion

It is concluded that the concentration ranges of cobalt and manganese are higher in water samples obtained from motor pumps as compared to the tube well samples. The concentration levels of cobalt and manganese in water samples obtained from various disposal areas are comparable with the water samples obtained from areas away from disposal units. The concentration of both metals is slightly higher than those of permitted values. The concentration of these metals can be reduced to permissible limits by adsorption on suitable media.

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