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Drinking Water Quality in Capital City of Pakistan

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Abstract

This study was designed to evaluate the quality of drinking water in selected areas of capital of Pakistan and its adjacent city Rawalpindi. Drinking water samples collected from selected localities of Rawalpindi and Islamabad are analyzed for different water quality parameters such as pH, alkalinity, hardness, total dissolved solids, chloride, bicarbonates, sodium, potassium, calcium, magnesium, sulphates, phosphates, nitrates lead, copper, cadmium, cobalt, iron and zinc. Total viable count, coliforms, fecal coliforms and *Escherichia coli* were also part of the study. Analyzed samples provide information that the level of pH, alkalinity, lead, copper, nitrates, phosphates, cadmium, cobalt, iron, zinc, potassium, magnesium, sulfate, bicarbonates and chloride are under the limit specified by WHO and PSQCA. While some water quality parameters such as calcium, sodium, total dissolved solids, and hardness were found to be above the WHO and PSQCA specified limit in some regions of Rawalpindi and Islamabad. Total viable count test performed to analyze the microbial quality of water samples revealed that all the samples were heavily loaded by microbial growth and considered unsafe for drinking purposes. Presence of coliforms, fecal coliforms and *Escherichia coli* clearly revealed that water is not fit for drinking purpose in the twin cities of Pakistan.

Keywords: Drinking water; Water quality; Chemical contaminant; Microbial quality; Pakistan

Introduction

Water is essential for biochemical processes taking place in every living organism and is basic requirement for human being but unfortunately, it is largely contaminated by physical, chemical and biological impurities that may include trace elements, pesticides, and detergents [1]. The presence of these contaminants in drinking water is a great threat to the public health causing number of diseases such as diarrhea, trachoma, nausea, abdominal pain and vomiting. The severe toxicity of these contaminants may also cause death [2]. Ground water, the source of drinking water for human beings around the World, is contributing about one-third in total water resources of Pakistan and is a major source of water supplies in major municipalities [3].

In Pakistan access to safe drinking water falls below satisfactory levels with only 25% of the population has sustainable access to quality drinking water [4-7]. Like many other countries in the world, Pakistan is also under great threat regarding availability of safe and clean drinking water. Polluted water is becoming the major cause in deteriorating the health related issues to the public in the country. Further the quality of ground water in the country is also no longer safe due to the manipulation of many external factors. The quantity of water available to public sector for drinking is of inferior quality. The old and rusty pipelines carrying drinking water are becoming more dangerous to the natural composition of the water. Insufficient water treatment measures and lack of any monitoring plan made this problem more severe [8].

Prevalence of waterborne diseases in Pakistan is mainly due to contamination of drinking water mostly with municipal sewage and industrial waste [7]. According to the Pakistan National Conservation Strategy report of 1992, about 40% of communicable diseases are waterborne [7]. Major diseases mostly connected with drinking water in Pakistan are diarrhea, gastroenteritis, typhoid, cryptosporidium infections, giardiasis intestinal worms, and some strains of hepatitis. According to International Union on Conservation of Nature (IUCN), 60% of infant deaths are caused by waterborne diarrhea in Pakistan, which is the highest in Asia. It is estimated that water related diseases cause annual national income losses of USD 380–883 million or approximately 0.6-1.44% of the GDP [7,9].

Pakistan ranked 80th in the world on availability of safe and clean drinking water to its people [10]. It has been estimated that if no improvements are made to ensure the availability of safe drinking water, only1000 m3 per capita will be available from onward to 2010 in the country [11]. Water samples collected from major cities of the country like Karachi, Faisalabad, Kasur, Gujrat and Rawalpindi revealed that the analyzed samples from these cities are unfit to drink [12]. In a study conducted by Sun et al. [13] related to Islamabad showed that, out of 271 samples collected, 77% were unsafe bacteriologically while 10.3% contained both bacteriological and physicochemical contamination. Amongst 196 of CDA (Capital Development Authority) samples, 5.1% were polluted bacteriologically while 3.6% contained both physicochemical and bacteriological contamination. The quality of water in the twin cities of Islamabad and Rawalpindi is no better than the rest of the country. 94% of the total samples were found heavily polluted with biological contamination and considered unfit to safe [14] while 34% have fecal contamination. Similarly a survey conducted by NIH Pakistan [15] confirmed that 75% of water in Islamabad and 87% of water in Rawalpindi are unsafe for human consumption [16]. Hashmi et al. [7] analyzed the drinking quality of highly populous area in Rawalpindi (Westridge and Tench) concluded that water is unfit for drinking. In Pakistan, the drinking water is getting contaminating and there are very few studies conducted in some areas concerning this issue. So there is dire need to analyze the drinking water to identify the potential harmful contaminants in these localities.

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Water supplies of Islamabad and Rawalpindi are mostly supplemented by ground water through more than 200 wells installed by the Capital Development Authority. The twin cities are facing water quality problem due to contamination through untreated sewage and industrial waste. This aims of present study were to access the quality of drinking water in twin cities, to access the level of contaminants in the drinking water samples of Rawalpindi and Islamabad and to compare quality of drinking water with World health standards (WHO) and Pakistan national standards (PSQCA).

Material and Methods

Study area and sample collection

Water samples were collected in polyethylene bottles from different localities of Rawalpindi and Islamabad region (Twin cities) of Pakistan (Table 1). These two cities are highly populous and broad socio-economical features. Sampling was done in all major areas. Before taking the samples from each location the bottles were thoroughly washed with sample water and filled in such a way that no air bubbles entrapped in the bottle and according to the standard method described by Arnold et al. [17].

Instruments and reagents

The pH was analyzed using pH meter (Hanna instrument, H18418). Flame photometer (Model no. JENWAY PFP7), Atomic absorption spectrophotometer (GBC 932 plus), TDS meter were used as main instruments. Standard solutions were prepared with chemicals of analytical grade and distilled water is used for dilution of solutions.

Analytical procedures

Sodium and potassium in samples were determined by Flame photometer. Nitrate and phosphate were also determined by spectrophotometry. Calcium, magnesium, copper, lead, cadmium, cobalt, iron and zinc in water samples were analyzed using atomic absorption spectrophotometer. This method was also used in determination of alkalinity and carbonate in water samples. Chloride in samples was determined using mercuric nitrate method. Total dissolved solids were analyzed using TDS meter. All analysis was carried out in quadruplet (n=4).

Microbial analysis

Total viable count was determined on Potato Dextrose Agar (PDA) at 25°C and possible colonies were calculated on colony counter. Total coliforms were detected on Chromogenic Agar (CA). 10 mL of water treated in buffer peptone (BP) was filtered through 0.42 µm filter and incubated on CA for 24 hrs. Presence of pinkish colonies indicates the presence of coliforms, while a purple colony indicates presence of *Escherichia coli*. Total fecal coliforms were detected on slanetz and burtz media (S&B) and presence of blackish colonies indicates fecal contamination [18].

City	*Sampling Area*	*Sampling Code*
Islamabad	F-10	**A1**
	G-6	**A2**
	G-10	**A3**
	H-9	**A4**
	I-9	**A5**
Rawalpindi	Dhok Kala Khan	**B1**
	Commerical Market	**B2**
	New Milpur	**B3**
	Pindora	**B4**
	Dhoke Rattah	**B5**

Table 1: Sampling area of Twin cities of Pakistan.

Results

Physico-chemical analysis

Results of physic-chemical parameter determined in Twin cities were presented in tables 2 and 3. The results showed mean pH of 7.34, total dissolve solids 911 mg/L, total hardness 436.8 mg/L and alkalinity 6.74 mg/L from water samples of twin cities (Figure 1). The mean concentrations of cations are in order of sodium (Na) 102.7 mg/L, calcium (Ca) 92.8 mg/L, and magnesium (Mg) 13.6 mg/L, while anions are in order of bicarbonates (HCO_3) 274.4 mg/L, sulphates (SO_4^{-2}) 46.23 mg/L chlorides (Cl^-) 23.3 mg/L, nitrates (NO_3-) 0.34 mg/L and phosphates (PO_4^{-3}) 0.02 mg/L.

Trace metal analysis

Results of trace metal analysis from twin cities were presented in Table 4. The mean concentration of trace metals were copper (Cu) 0.04 mg/L, lead (Pb) 0.166 mg/L, cadmium (Cd) 0 mg/L, cobalt (Co) 0.01 mg/L, iron (Fe) 0.02 mg/L and zinc (Zn) 0.01 mg/L. It was noticed that concentration of trace metals were more in Rawalpindi areas as compare to Islamabad, while in Islamabad sample A5(I-9) showed higher concentration.

Microbial analysis

The results of microbial analysis were presented in Table 5. The mean value of total viable count was 3.613 cfu/mL, while coliforms and fecal coliforms were seen on all samples. *E.coli* was detected on samples A5, B1, B3 and B5, respectively.

Discussion

Physico-chemical parameter on quality

The study assesses the drinking water quality in Twin cities of Pakistan. The pH values detected in water samples ranged between 7.1-7.5. Significantly highest pH (7.5) was found in samples collected from New Milpur, whereas lowest pH value (7.1) was recorded in Dhoke Kala Khan which was statistically significant from all other samples collected from Rawalpindi and Islamabad. The maximum permissible limit described by WHO for pH in drinking water ranged between 6.5-8.5. The pH values in all samples met the WHO requirements and considered safe for drinking purposes. Non-significant variation in tested samples in Islamabad locations was attributed to either better water supply system or it may be due to better purification facility available to Capital Development Authority. The small but non-significant variation in pH of drinking water is affected by the composition of all the constituents available in ionic forms, notably hydrogen and hydroxyl ions present in it. Similarity in pH values of samples taken from the selected locations indicated that water has almost same ionic composition in studied areas. These results are also in accordance with the earlier study conducted by Farooq et al. [6] in which the pH values varied from 7.02 to 7.30 and also with Hashmi et al. [7] in which pH values ranges from 7.03 to 7.73 in Westridge and Tench Bata in Rawalpindi.

The alkalinity in water samples ranged between 5.0-7.9 mg/L. Statistically, highest alkalinity (7.9 mg/L) was found in samples collected from I-9 sector Islamabad, whereas lowest alkalinity (5.0 mg/L) was recorded in samples collected from Dhoke Kala Khan. The safe limit proposed by Canadian Water Rules on alkalinity is 250 mg/L. All water samples were below the alkalinity limits for drinking purposes. The

						Drinking water Criteria	
Parameters	**Units**	**Mean**	**SD**	**Minimum**	**Maximum**	**Pakistan**	**WHO**
pH		7.34	0.24	6.9	7.8	6.5-9.2	6.5–8.5
Alkalinity	mg/L	6.74	1.12	3.5	8.2	-	-
Calcium	mg/L	92.80	21	58	124	75-200	-
Magnesium	mg/L	13.60	1.12	11	14.9	50	-
Hardness	mg/L	436.80	113.1	264	587	500	500
TDS	mg/L	911.00	191.4	674	1227	1000	-
Sodium	mg/L	102.70	49.8	29	202	-	200
Potassium	mg/L	7.26	2.99	2	14	12	-
Sulfates	mg/L	46.23	17	25	82	200	250
Chlorides	mg/L	23.30	11.1	10	45	200	250
Bicarbonates	mg/L	274.40	61.9	184	383	-	-
Nitrates	mg/L	0.34	0.21	0.02	0.6	< 50	50
Phosphates	mg/L	0.02	0.01	0.01	0.03	-	-

Table 2: Physiochemical results of water samples collected from different localities of Pakistan.

						Drinking water Criteria	
Parameters	**Units**	**Mean**	**SD**	**Minimum**	**Maximum**	**Pakistan**	**WHO**
Calcium	mg/L	92.8	21	58	124	75-200	-
Hardness	mg/L	436.8	113.1	264	587	500	500
Sodium	mg/L	102.7	49.8	29	202	-	200
TDS	mg/L	911	191.4	674	1227	1000	-

Table 3: Water quality parameters exceeding the limits set by WHO and PSQCA for drinking water.

						Drinking water Criteria	
Parameters	**Units**	**Mean**	**SD**	**Minimum**	**Maximum**	**Pakistan**	**WHO**
Lead	mg/L	0.166	0.04	0.10	0.26	0.01	0.01
Copper	mg/L	0.040	0.01	0.09	0.01	1	2
Cadmium	mg/L	0.000	0.00	0.00	0.00	0.01	0.003
Cobalt	mg/L	0.010	0.01	0.00	0.02	-	-
Iron	mg/L	0.020	0.01	0.00	0.03	-	0.3
Zinc	mg/L	0.010	0.01	0.00	0.02	5.0	3.0

Table 4: Trace metal analysis of water samples collected from different localities of Twin cities of Pakistan.

Parameters	*Units*	*Mean*	*SD*	*Minimum*	*Maximum*
Total Viable Count	CFU/mL	3.163	1.33	2.26	6.86
Total Coliforms	Presence/Absence	Present	Present	Present	Present
Fecal Coliforms	Presence/Absence	Present	Present	Present	Present
E.coli	Presence/Absence	Present	Present	Present	Present

Table 5: Microbial analysis of water samples collected from different localities of Twin cities of Pakistan.

variation regarding alkalinity in tested samples taken from selected locations suggested that there were no industries releasing wastewater without proper treatment near studied locations. However, there are some human activities which were found to slightly modify alkalinity in drinking water such as practices involved in water treatment process and operations involved in dry cleaning processes.

Statistically highest hardness value (584 mg/L) was found in water samples collected from I-9 sector Islamabad. The lowest value of hardness of 265 mg/L was recorded in samples taken from Dhoke Kala Khan. Water samples taken from New Milpur, Dhoke Rattah, G-10 and I-9 sector of Islamabad did not confirm the PSQCA standards. All other samples were within the recommended levels of 500 mg/L by PSQCA. Due to the presence of high amount of calcium in I-9 and G-10 sector Islamabad; it gives significant reason in optimizing the level of hardness in I-9 and G-10 sector. High amounts of limestone and magnesium carbonate may also be attributed to higher level of hardness in these areas. The problem of hardness becomes more serious due to the presence of rocky materials and marble industries in these areas. Another possible source to increased hardness is the presence of inorganic materials in the water. Persistent flowing of hard water in water distributing pipelines is the major reason to impart scaling on the surface of these pipelines. Another important problem related to hard water is the incrustation of utensils used in kitchens. Previous study conducted by Aziz [19] confirmed hardness of 150-540 mg/L in different samples of water from Rawalpindi region. Similar results were also provided by Hashmi and Shahab [20].

Total dissolved solids detected in water samples ranged between 675.3-1224 mg/L. Statistically highest total dissolved solid (1224 mg/L) were found in I-9 sector Islamabad. Whereas lowest total dissolved solids (675.3 mg/L) were recorded in samples of Dhoke Kala Khan. Samples taken from New Milpur, Dhoke Rattah, I-9 and G-10 did not confirm the standards set by PSQCA, while all other samples are under safe limits. The maximum permissible limit regarding total dissolved solids according to PSQCA is 1000 mg/L. Total dissolved solids in water distribution pipelines originate from many sources such as sewage, urban and agricultural runoff and industrial wastewater. The

highest value of total dissolved solids detected in Islamabad regions may be due to the higher levels of inorganic compounds present in the water. Cemented storage tanks used to store the drinking water may also attribute to increase the level of total dissolved solids in these areas. There are no such evidences that by consuming water having total dissolved solids more than 1000 mg/L cause deleterious physiological reactions. However, excessive amount of total dissolved solids in drinking water may impart undesirable flavor and also scaling on water distribution pipelines .Higher level of TDS was also detected by Farooq et al. [6]. Similarly in Rawalpindi higher TDS of 209 to 1042 mg/L in different samples were identified by Aziz [19] (Figure 2).

Statistically, highest Na (199.6 mg/L) was found in Dhoke Rattah, while lowest Na (46.6 mg/L) was recorded in G-6 sector Islamabad which was statistically non-significant with Pindora. According to PSQCA, the maximum permissible limit for Na in drinking water is 200 mg/L. All tested water samples were under the safe limits. The research results of studied area revealed that presence of Na in water samples may also give indication of rock salts deposited nearby the selected localities. Improper sewage treatments also contributed to raise levels of Na during mixing into fresh water streams. Moreover industries discharging wastewater without any treatment also contributed to raise the level of Na as well as other mineral contents. Salts intrusion to the fresh water streams may become the reason to deviate the research results regarding Na in selected localities.

Statistically highest Ca concentration of 121 mg/L was found in water samples collected from I-9 sector Islamabad, whereas lowest value of Ca (63.6 mg/L) was recorded in samples collected from Dhoke Kala Khan. According to PSQCA the maximum permissible limit for Ca in drinking water is 100 mg/L. Water samples taken from New Milpur, Dhoke Rattah, G-10 and I-9 did not confirm the PSQCA standards for Ca. All other samples were within limits of PSQCA. The highest Ca concentration detected in I-9 sector may be due to the presence of calcareous rocks found in underground and significant amount of which is being added into ground water used for drinking purposes. The presence or absence of limestone near selected locations may also be a detrimental factor in variable Ca values. Calcium is well known to cause hardness of water by the combined effect of other compounds.

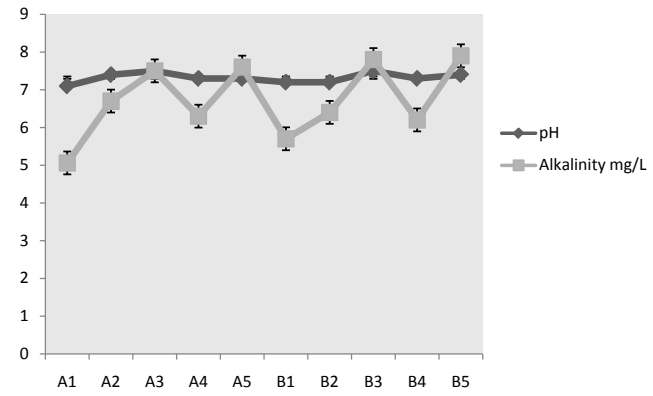

Figure 1: Variation of pH and Alkalinity in water samples from twin cities.

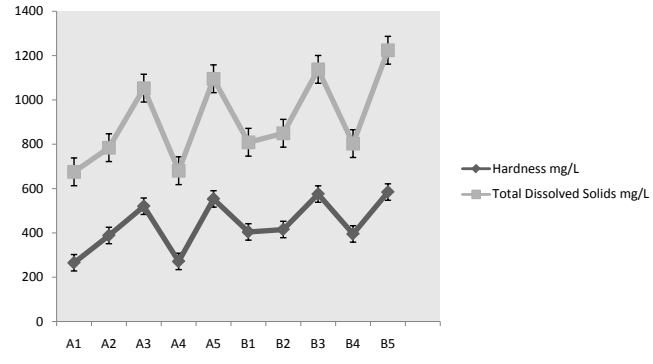

Figure 2: Variation of TDS and hardness in water samples of Twin cities.

The Mg detected in water samples ranged between 12.3-14.8 mg/L. Statistically highest level of Mg (14.8 mg/L) was found in water samples taken from I-9 sector of Islamabad whereas, lowest level of Mg (12.3 mg/L) was detected in G-6 sector Islamabad. The maximum permissible limit for Mg in drinking water is 250 mg/L according to the standards set by the PSQCA. All samples are considered in safe limits for drinking purposes. The amount of Mg detected in water samples did not confirm the any other external contamination. However, there are chances that highest amount of Mg detected in I-9 may due to the external factors such as presence of some rocky material contributing Mg to underground water. No health base guideline value regarding magnesium is set by WHO. However, according to PSQCA the maximum permissible limit for magnesium in drinking water is 150 mg/L.

Highest value (12.33 mg/L) of K was found in I-9 sector Islamabad, whereas the lowest value (5.1 mg/L) was detected in Commercial Market Rawalpindi. The PSQCA standard value for potassium in drinking water is 12 mg/L. all tested samples have lower value as prescribed by PSQCA, therefore water is fit for drinking purposes. The most important source of potassium in drinking water is the waste materials discharged by the industries located nearby the studied areas. K is important chemical used in manufacturing and processing industries and is continuously added to natural sources of drinking water. Ionic forms and salts are highly soluble in water, and it is very easy for potassium to become a drinking water pollutant. Moreover there may be other sources responsible for K excess in drinking water such as fertilizers. In ionic forms are soluble, therefore from the soils potassium can leach to the ground water.

The highest value (80.3 mg/L) of SO_4^{-2} was observed in samples of I-9 sector of Islamabad, while lowest value (26.3 mg/L) was recorded in samples collected from Pindora, Rawalpindi. The maximum permissible limit of sulfate according to the standards set by PSQCA is 250 mg/L. the range of sulfate in tested water samples was under acceptable limits. Research results showed that it was detected in high amounts in samples taken from I-9 sector of Islamabad. It may be due the leaching of gypsum to the ground water in that area. Sodium sulfate is another compound involved to release the sulfate in fresh streams of drinking water. Like many other compounds its amount in drinking water is also influenced by waste materials discharge by the industries. Sulfur compounds used in industries and being discharge through waste materials without any proper treatment is important factor in raising levels of sulfate in drinking water (Figure 3).

Statistically, highest value of 43.6 mg/L for Cl^- in water samples were from Dhoke Rattah, while lowest value of 11 mg/L for Cl^- was detected in samples taken from G-6 sector Islamabad. The maximum permissible limit for chloride in drinking water set by WHO is 250 mg/L. The chloride level detected in all samples was below the guidelines provided by the WHO, therefore all the samples are considered safe to drink with respect to chloride. The research results are in agreement with the

findings of Jahangir [14] who also found normal level of chloride in drinking water samples taken from Rawalpindi and Islamabad regions.

Statistically, highest value (382 mg/L) of HCO3-1 was found in samples taken from I-9 sector of Islamabad, while lowest value (185.3 mg/L) was recorded in samples taken from Dhoke Kala Khan. There are no guidelines related to the HCO_3^{-1} in drinking water. But in general safe limit considered in drinking water is 500 mg/L. All the samples were found to be within safe limits. Research results revealed that alkalinity values detected in high amount in I-9 sector of Islamabad give reason to higher level of bicarbonates. Moreover bicarbonates values in drinking water are also deviated by weathering of rocks. Rocky materials are well known to have many minerals having calcium compounds which ultimately lead to increase the level of bicarbonates in drinking water. The variation in values of bicarbonates in studied locations may also due to the harness of water. No significant health effects are associated with consumption of drinking water containing high amount of bicarbonates.

Highest value (0.6 mg/L) of NO_3^{-1} was found in water samples of A5 (I-9) Islamabad and B5 (Dhoke Rhatta). Similarly, highest (0.03 mg/L) of PO_4^{-3} was found in sample taken from Dhoke Rhatta (B5). The likely reasons for these higher values could be runoff from agricultural fields where ammonium nitrate, nitrophosphate and diamonium phosphate fertilizers were applied. In addition, applied sewage and industrial wastewater also contained higher concentrations of NO_3^- and PO_4^{-3} [21,22] (Figure 4).

Trace metals on quality

Statistically, highest value (0.025 mg/L) was found in samples taken from I-9 sector of Islamabad, while lowest value (0.010 mg/L) was recorded in Dhoke Kala Khan (B1). The maximum permissible limit for lead concentration in drinking water according to WHO is 0.05 mg/L and all values were below the WHO recommendations. The values detected were small because of the lead pipelines that are used to deliver the drinking water on domestic scale. Besides studied areas is located near the main roads containing high amounts of lead. The vehicle discharge containing lead compounds is directly or indirectly involved to pollute the drinking water sources. Lead is harmful for normal functioning of many organs of human body. No previous study on lead contamination in Twin cities has been reported so far.

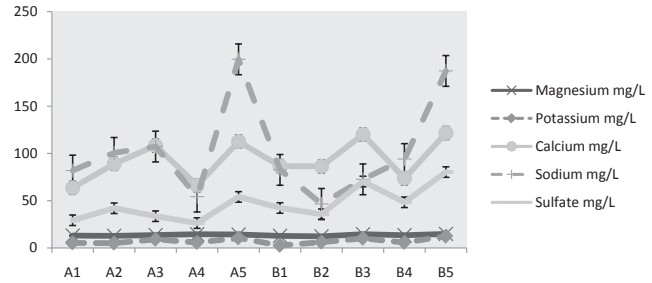

Figure 3: Variation of different cations in water samples from Twin cities.

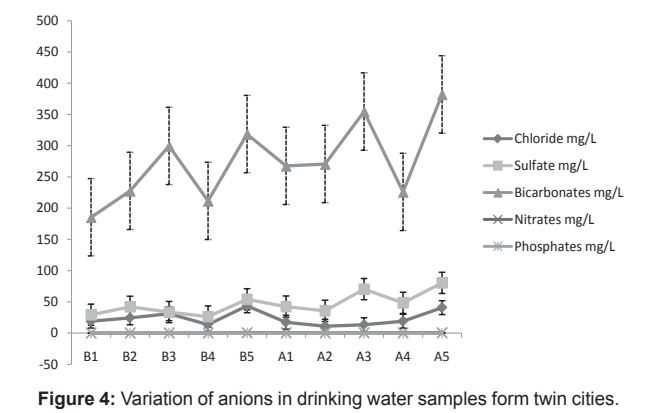

Figure 4: Variation of anions in drinking water samples form twin cities.

The values of Cu detected in the water samples ranged between 0.02-0.08 mg/L. statistically, highest value (0.08 mg/L) of copper was observed in water samples taken from I-9 (A5) sector Islamabad, while lowest value (0.02 mg/L) of copper was detected in water samples taken from Commercial Market (B2) which was statistically non-significant from G-6 sector of Islamabad. The maximum permissible limit for copper in drinking water is 3 mg/L according to WHO. As in all tested samples the copper concentration was below the WHO guidelines. Cu concentration in the treated water often increases during distribution, particularly in the systems where an acidic pH exists or in the presence of high-carbonate waters with an alkaline pH. The guidelines are derived on the basis to be protective against the gastrointestinal effects of copper [23].

Cd was not detected in any samples from twin cities. The possible reason for this lies in fact that there was no tanning industries located in surrounding vicinity. Smoking is a significant additional source of cadmium exposure [23]. Cadmium accumulates primarily in the kidneys and has a long biological half-life of 10-35 years, in humans. For Pakistan a value of 0.01 would be appropriate, which is in accordance with the standards for most developing nations in Asia [23].

Higher value (0.02 mg/L) of Co, (0.03 mg/L) Fe and (0.02 mg/L) Zn were seen in water sample from A5 (I-9) from Islamabad and B5 (Dhoke Rhatta) from Rawalpindi. These values are well below then standards of both WHO and PSCQA. The results are well matched with previous study of Aziz [19] and Hashmi and Shahab [20]. They reported iron concentration in drinking samples from 0.03 to 1.53 mg/L in Islamabad and 0.03 to 0.07 mg/L in Rawalpindi, respectively (Figure 5).

Microbial quality

Statistically, highest value (6.86 cfu/ml) of total viable count in water samples taken from Dhoke Rattah, while lowest value (2.26 cfu/ml) of total viable count was detected in samples taken from Dhoke Kala Khan. According to WHO recommendations there should not be a single microbial growth per m/L of drinking water. The total

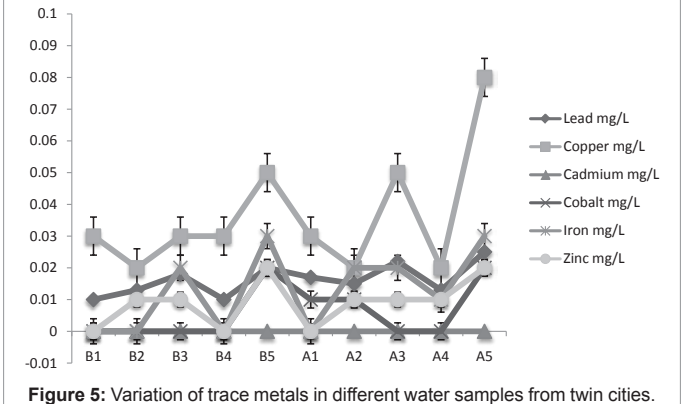

Figure 5: Variation of trace metals in different water samples from twin cities.

viable count detected in all samples is above the guide lines provided by the WHO, therefore all the samples are considered unsafe to drink. The most important factor used for determination of water quality is dependent on microbial load present in the water. There are many reasons that are attributed to increase the level of total viable count in drinking water. Old and rusty sewage pipelines are good source for the growth of microbes. Moreover the organic material present in water provide food to these microbes. The highest value of total viable count detected in samples taken from Dhoke Rattah may be due to the mixing of fresh supply water with sewage water. The leakage of water supply pipelines also attributed to contaminate the drinking water with external pollutants. Further inadequate water treatment also gives reason for the survival of microbes.

Coliforms and fecal coliforms were seen on all samples. *E.coli* was detected on samples A5, B1, B3 and B5. The presence of *E.coli* clearly indicated that water was unfit for human consumption and the presence of these microbes led to different diseases that are easily seen in different communities in twin cities. The Total viable count was much lower than previously reported by Hashmi et al. [7]. They reported 4 CFU/mL to 108 CFU/mL from water samples of Westridge and Tech Bata of Rawalpindi. Ali and Ahmed [24] reported water quality from hand pumps and open wells in Punjab and concluded that these are highly contaminated with coliforms and E.coli. The infestation ranged up to 4000 coliforms/100mL and 166 *E.coli* colonies/100mL.

Conclusion

The research revealed that some samples collected from Rawalpindi and Islamabad were not suitable for drinking purposes. Chemical parameters such as hardness, total dissolved solids and calcium were higher than the standards set by WHO and PSQCA for drinking water quality. Total viable count test performed to analyze the microbial quality of water samples revealed that all the samples were heavily loaded with microbial contaminants such as, coliforms, fecal coliforms and *E.coli* and the water was unfit of drinking. Therefore it is concluded that contamination in drinking water from some regions of Rawalpindi and Islamabad necessitates the need for efficient water treatment for chemical and microbial quality before it reaches the consumer.

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