STUDY OF CHEMICAL QUALITY OF DRINKING WATER AVAILABLE TO THE CHILDREN OF DIFFERENT SCHOOLS OF GHULAM MOHAMMAD ABAD, FAISALABAD-PAKISTAN

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ABSTRACT: Forty samples of water collected from different sources available at schools were examined for chemical composition. The analysis included total hardness, total dissolved solids, chlorides, carbonates, bicarbonates, nitrates, calcium and magnesium. Results showed that WASA water as direct supply, water stored in school tanks and that available in school coolers had calcium less than the WHO permissible limits. Total hardness, total dissolved solids, chlorides, carbonates, bicarbonates, nitrates and magnesium were within the safe limits. However, analysis of ground water showed that chlorides, total dissolved solids, carbonates, bicarbonate, calcium and nitrates exceeded the WHO limits. Ground water of that area was extremely unfit for human consumption.

INTRODUCTION

Needs and necessity of water in human life can not be under estimated. Water is the basic constituent of all living beings. Without water living being can not survive. Being Universal solvent, water is highly prone to contamination. Such contaminated water may interfere with normal physiological functioning (Waheed *et al.,* 1987). Present days water sources are being polluted largely by agricultural and industrial chemical waste disposals (Sattar and Ramia, 1981).The water at the source is usually potable, fit and of good quality for human consumption but it gets contaminated and polluted by mixing of sewerage water through cracks and holes in old or rusted pipes. Usually fresh water pipes are laid parallel or beneath the sewerage pipes causing the mixing of waste effluent in fresh water (Hussain, 2002).

Exposure to contaminated water through ingestion as drinking water is a significant mode of transmission of gastrointestinal infections. World Health Organization recommends that water must be treated in order to make it free from disease producing organisms and toxic chemicals before human consumption (WHO, 1976).In Pakistan 72 percent population lives in rural areas. Most of them do not have excess to safe drinking water. So, due to polluted water the people of villages have many diseases like typhoid, cholera, gastroenteritis, kidney problem, food poisoning and skin problems (Iliyas, 1989).

Water supply in Faisalabad is constrained by the lack of growth in piped water supply system, which has not been able to cope with growing population. The supply network covers less than half of the total population and rest are depended on hand pumps and shallow wells (Randhawa and Hussain, 1993). As per UNDP study only 34 percents of the total households in the city has access to piped water, however in kachi abadis and slums the accessibility to the piped water is 39 percent and 10 percent respectively (FDA, 1993). Safe drinking water is achieved by maintaining quality from the initial supply point to final consumption (Hoque *et al.,* 2006).

In May and June 2006, more than 40 people most of them living in major urban areas of Hyderabad, Faisalabad, Dera Ghazi khan, Gujranwala and Sheikhupura died of dehydration and other complications resulting from contaminated water. Worst hit was Faisalabad, the third most populated city in Pakistan, where at least 16 people died due to gastroenteritis outbreak in about a week, especially in D-block of Ghulam Mohammad Abad a densely populated area. Children were mostly affected because there immune system is weak. Since, then no proper planned scientific work on water quality has been done. The published work is also scanty. A study was therefore conducted to examine the chemical quality of drinking water available to the children of different schools of Ghulam Mohammad Abad at Faisalabad.

MATERIALS AND METHODS

Drinking water samples were collected from various water sources available at different schools in Ghulam Mohammad Abad, Faisalabad. Water samples for chemical analysis were collected in plastic bottles of 1.5 liter capacities. Before collecting the sample the bottles were washed properly and rinsed thoroughly several times first with water then with distilled water. Samples were collected from forty sources. The following were the sources of water available at various schools.

1- WASA water as direct supply (W D): WASA water is directly supplied by 29 tube wells which have been installed in the old bed of Chenab River about 20 km away at Chiniot. Each tube well has a capacity of 4 #.Water is drawn from these wells through collector mains and transmission mains at in line booster station, where water is disinfected. At the terminal reservoir located at chak 7 (J.B) water is stored and with the help of pump supplied to the city through distribution mains and lines.

2- WASA water stored in school tanks (W T): WASA water is supplied and stored in tanks available at schools for drinking water.

3-Filtered water stored in coolers (W C): The water available for drinking in the schools, stored in coolers having filters.

4- Ground water (W G): Ground water obtained with the help of electric motor and used for drinking in the schools.

Chemical analysis for total hardness, total dissolved solids, chlorides, carbonates, bicarbonates, nitrates, calcium and magnesium of water samples was performed. All the samples were analyzed by the methods recommended by APHA (1992). The procedures for different analysis are briefly given as follows:

Total Hardness: A 25 ml of water sample was taken and diluted to 50 ml with distilled water in a conical flask. One ml of buffer solution and 1-2 drops of Erochrome Black T indicator was added, the solution became brick-red in colour. Then the solution was titrated with EDTA titrant which was added slowly with continuous stirring, until wine red colour disappeared and blue end point was attained. The duration of the titration was not extended beyond 5 minutes. Total hardness was calculated as under:

Hardness (mg/l) = ml of EDTA used x 40

Total Dissolved Solids: A 50 ml of water sample was filtered through filter paper in to a dried previously weighed flask. TDS passed down the filter paper in to the flask. The water was evaporated from the flask and weight of TDS was recorded. TDS was calculated as given below.

TDS (mg/l) = Wt of dried residue x 1000/ 50 ml

Chlorides: A 25 ml sample was taken in a conical flask. A few drops of potassium dichromate indicator solution were added and titrated against standard solution of $AgNO_3$ up to pinkish yellow end point and the amount of chloride was calculated as under:

Chloride (mg/l) = Vol of $AgNO_3$ used x 9.9 x 2

Carbonates: A 50 ml of sample was taken in a flask and one drop of phenolphthalein indicator was added. The carbonate was considered to be zero in case of no pink colour. If the sample turned in to pink, it was titrated against the standard 0.021 N HCl until it became colourless. The volume of acid used was noted and the concentration of carbonates was calculated by the following formula:

Carbonate (mg/l) = Vol of HCl used x 20 x 2.

Bicarbonates: A 50 ml of sample was taken in a flask and one drop of methyl orange indicator was added. It was then titrated against standard 0.02 N HCl until the colour changed from yellow to orange. The volume of acid was recorded and the concentration of bicarbonates was calculated by the following formula:

Bicarbonate (mg/l) = Vol of HCl used x 20 x 2

Nitrates: A water sample was taken in a cuvette and placed in the spectrophotometer. Then cell blank key was pressed and after 3 minutes sample used for cell blank was discharged and simultaneously measuring key F_4 was pressed. In the mean time second sample was prepared by taking 25 ml sample in a flask with plug. Then reagents R_1 and R_2 were added and sample shaken well (100 times/min), put in a cuvette and placed in the spectrophotometer. After the specified time, the concentration was displayed automatically and was expressed as mg/L.

Calcium: A 50 ml sample of water was used. Then 2 ml of NaOH solution was added. After stirring well, 0.1 to 0.2 gm of Murexide indicator was added. Then EDTA titrant was added slowly, with

continuous stirring until the proper end point was reached. The calculation was made by the following formula:
Calcium (mg/l) = Vol of EDTA used x 8

Magnesium: Magnesium was estimated by difference with the help of a formula as given below:
Mg = Total Hardness-Ca (2.5)/ 4

Statistical Analysis: The data obtained from the study was entered in the computer using a software SPSS version 15.0. Proper tabulation was made and means were worked out. Analysis of Variance technique was applied to see the significance of the effect of different types of waters. The comparison of means was made by Least Significance Difference test (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

The data on water analysis have been presented in Table 1. The table shows chemical analysis of 4 different sources of drinking water available at schools. The study indicated that overall means for total hardness, TDS, Cl^{-1}, HCO_3^{-1}, No_3^{-1} and Ca^{+2} of ground water (WG) were significantly higher than all other sources. However, there was a non-significant difference in contents of these components among WD, WT and WC. The contents of magnesium from all sources did not vary significantly.

The highest hardness score of 418.86 mg/l was observed in case of ground water as compared to other sources of water. According to the guidelines of water quality by WHO (1985), acceptable hardness for drinking water lies between 10 to 500 mg/l. All the water samples from different sources were therefore found with in the safe limits. The chemical analysis of water indicated that Ca and Mg contents were not above the acceptable limits that is why water had hardness score with in the limit. Khalid *et al.* (2005) collected 9 water samples from various areas of district Mirpur and found all the samples polluted with extraneous matter and had high hardness. Results of above referred work are higher than our results due to higher amount of $CaCO_3$. Public acceptability for the degree of hardness of water may vary considerably from one community to other depending on local conditions.

Taste, palatability and softness of water are related to the total dissolved solids (TDS) and it is recommended by WHO that these might be less than 1200 mg/l. However, with very low concentration of TDS may be totally unacceptable because of its flat insipid taste. It was observed that the average value of TDS for WASA water as direct supply (WD) was 465.88 being the lowest of all sources. But the value of TDS for ground water (WG) was the highest (2,529.14) of all the sources. All the samples collected from different sources except WG were within the safe limits. However, the TDS value of samples of WG exceeded the maximum WHO limits. The ground water was therefore unacceptable. Malick *et al.* (1998) reported drinking water quality in the city of Karachi. Forty samples were taken from supply lines of different locations of the city originating with water from the Indus River. It was reported that water from the treatment plants meets WHO guidelines. However, the samples taken from Kemari and Mirpur area showed significant increase in TDS from the original values of treated water, perhaps due to seepage of brackish water or saline water intrusion. The previous studies indicated the difference in TDS due to difference in sources and difference in location might also have affected. The average amount of chloride in WC was the lowest (47.19 mg/l) of all the sources. However there was minor difference between the amount of chloride in WC and in WD. The amount of chloride was higher in ground water i.e. 578.44 mg/l and was the highest of all other sources. According to WHO safe limits the permissible level of chloride in drinking water is up to 250 mg/l

Table1: Chemical analysis of different sources of water for drinking by children at various schools in G.M.Abad.

Sources of water	No of samples	Total Hardness mg/l	Total dissolved solids mg/l	Chlorides (Cl^{-1}) mg/l	Bicarbonate (HCO_3^{-1}) mg/l	Nitrates (No_3^{-1}) mg/l	Calcium (Ca^{+2}) mg/l	Magnesium (Mg^{+2}) mg/l
WD	16	295.56^a	465.88^a	49.43^a	170.63^a	0.34^a	57.25^a	38.75^a
		(176--344)	(376--586)	(43.56--61.38)	(120--250)	(0.04--0.93)	(40--92.8)	(17--52)
WT	11	304^a	512^a	54^a	163.64^a	0.47^a	54.26^a	43.09^a
		(268--352)	(374--704)	(21.78--74.25)	(140--200)	(0.04--0.86)	(28.8--76)	(19--70)
WC	6	330^a	500^a	47.19^a	196.67^a	0.30^a	54.93^a	50^a
		(296--412)	(404--584)	(43.56--55.44)	(160--240)	(0.04--0.79)	(46.40--65.60)	(41.00--67.00)
WG	7	418.86^b	$2,529.14^b$	578.44^b	580^b	3.19^b	105.26^b	42.50^a
		(260--532)	(704--3550.00)	(54.45--1,029.60)	(200--720)	(0.15--5.84)	(44.80--144.0)	(5--110)

The values in parenthesis are ranges.
Same alphabets on means in columns show non-significant differences.
Carbonates were determined but none of the sample had these ions.

All the water samples except WG therefore fell with in the safe limits. But in WG chloride content exceeded the limits. Fytianos and Christophoridis (2004) found that the majority of the tap water samples, collected from areas along the seashore contained increased concentrations of chloride ions. In the neighborhood of the sea, the salinity of water tends to be high. The chloride content of water varies from place to place. The present study also indicated the difference in chloride content of WG due to difference in source and location.

Carbonates were determined in all the water samples derived form different sources in schools. However, the carbonate test did not show the presence of these ions. The mean value for bicarbonate was lower in WT i.e. 163.64. WD had some what higher bicarbonates (170.63 mg/l) and water samples drawn from school coolers (WC) had further higher bicarbonates (196.67 mg/l). The mean value of bicarbonate content in WG was much higher than the other sources (580 mg/l).There should be no carbonates in good drinking water (WHO, 1985). The water samples under study were therefore, safe for drinking. It has been recommended that bicarbonates should range between 30 to 500 mg/l in good drinkable water. Water samples from different sources (WD, WT and WC) were within the safe limits. But majority of WG samples exceeded the safe limits. Kannan *et al.* (2005) observed the physico-chemical characteristics of water samples mixed with effluent discharged from textile industries and reported elevated level of carbonates. The concentration of the ion exceeded the permissible limits. Thus water was hard, brackish and unsuitable for drinking purpose.

Concentration of nitrates in WC was the lowest i.e. 0.30 mg/l and the nitrate content of WD was comparable to WC. The concentration of nitrate in WT was 0.47 mg/l. However, concentration of nitrate was higher in WG than other sources. According to WHO standard the permissible level of nitrates in drinking water is 0 to 45 mg/l. All the water samples drawn from schools were found to have nitrates with in safe limits. Tahir *et al.* (1998) analyzed the drinking water quality in the rural areas of Rawalpindi. district. Their results showed higher levels of nitrates in many water samples. Generally the higher levels of nitrates are found in ground water. The findings of present study indicated that water of the study area was found to have nitrates with in the safe limits because the pipelines of the area were recently changed and there was no sewerage contamination in drinking water.

The amount of calcium in WC and WT were 54.26 and 54.93 mg/l, respectively. The average amount of calcium in WD was 57.25 mg/l being slightly higher than afore mentioned two sources. But the amount of calcium was the highest in WG i.e. 105.26 mg/l. According to WHO guidelines the recommended amount of calcium in drinking water is 75 to 200 mg/l. The water samples (WC, WT and WD) contained amount of calcium below the WHO limits. But the amount of calcium in WG was with in the permissible limits. The results showed that the calcium content in all water samples was low except WG. In order to fulfill the requirement, high calcium diet like milk, dairy products, canned fish and leafy vegetables are recommended. Tahir (1989) studied pollution problems in water supply systems of Rawalpindi and Islamabad city. The supply system of both cities was found fit with respect to calcium. The previous studies also indicated the difference in calcium content due to difference in sources and location. The average value of magnesium in WD was the lowest (38.75 mg/l) of all types of water samples. The value of magnesium in WC was higher than other values (50mg/l). According to WHO, the recommended amount in drinking water is 30 to 100 mg/l. Water samples from all the sources in this study were found with in the WHO limits. Kannan *et al.* (2005) observed elevated level of magnesium. The concentrations of the ion exceeded the safe limits. The increase in the concentrations of Mg ion could be responsible for higher values of electrical conductivity (EC). The present study is some what different from the above referred work. The difference in previous study is due to higher levels of EC in the water of that area and may be due to leakage of pipelines.

CONCLUSIONS

Most of the water samples taken from different sources (WD, WC and WT) were fit for drinking, as far as chemical quality parameters were concerned. Only the amount of calcium was lower than the WHO permissible limits in water supplied by WASA. But ground water available in schools was of poor quality and extremely unfit for human consumption.

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