PHYSICAL, AESTHETIC AND MICROBIOLOGICAL ANALYSIS OF DRINKING WATER FOR SCHOOL CHILDREN

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ABSTRACT: Samples of water were collected from different sources available at schools and analyzed for physical, aesthetic and bacteriological parameters. The physical analysis included pH, turbidity and electrical conductivity. Aesthetic examination involved colour, odour and taste. In bacteriological analysis total coliforms and feacal coliforms (E.coli) along with their relationship with residual chlorine were determined. An awareness study regarding water problems was conducted involving one hundred teachers and students in the schools using a questionnaire. Most of the water samples taken from schools were fit for drinking, as far as physical and aesthetic water quality parameters were concerned except ground water. Ground water available in some of schools was saltish and brackish and was unfit for human consumption. WASA water as direct supply contained sufficient amount of chlorine and did not have any bacteria. Most of the water samples that were taken from coolers and storage tanks of schools had no chlorine content and contained coliforms. Feacal coliforms (E. coli) were not present in any of the samples tested in the study.

INTRODUCTION

The quality of drinking water is a major public health concern (Best *et al*, 2007). Water pollution is considered as a major cause of deaths in developing countries (Witt, 1982). Almost 50 percent of all the people in the developing countries are suffering from water borne illness. Two million child deaths occur every year due to contaminated water. Almost 1.8 million children die from diarrhoea each year and 443 million school days are lost due to water related illness (UNDP, 2006). Simply in Faisalabad district during 1991, 292 cases were registered about water borne diseases in the public hospitals (Cheema, 1993).

The water is contaminated not because it is not treated, but because of leakage of old pipes which are laid parallel or beneath the sewerage pipes causing the mixing of waste effluents in to the fresh water. The pipes supplying to Ghulam Mohammad Abad passes through a sewer that carries effluents from some industrial units. There are areas where pipes have not been changed for the last 47 years although the old pipes were replaced in other parts of the city in 1982. The average age of the water supply pipes in Faisalabad is around 22 years. Faisalabad is among those cities that do not have a single water filtration plant and therefore clean water remains a dream. In May and June 2006, more than 25, ooo people complained of stomach pain and diarrhoea and had visited government and private hospitals in Faisalabad. 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 their immune system is weak and they are more susceptible to diseases rather then adults. 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 quality of drinking water available to children of different schools of Ghulam Mohammad Abad at Faisalabad.

MATERIALS AND METHODS

Samples of drinking water were collected from various water sources available at different schools in Ghulam Mohammad Abad, Faisalabad. Water samples for physical and aesthetic examination were collected in 1.5 liter plastic bottles. Before collecting the sample the bottles were washed properly and rinsed thoroughly several times first with water then with distilled water. For bacteriological analysis water samples were taken in screw capped glass bottles. All the bottles were wrapped with craft paper and sterilized at 170 °C. The bottles were kept un-opened until required for sampling. Before processing, each sample was kept at refrigeration temperature in order to minimize the chance of change in bacterial population. Forty water

samples were collected for physical and aesthetic examination and another 40 samples were collected from different water sources for bacteriological analysis. Four kinds of sources were selected for sampling i.e. WASA water as direct supply (W D), WASA water stored in school tanks (W T), Filtered water stored in school coolers (W C) and Ground water (W G). The water samples were analyzed for physical, aesthetic and bacteriological parameters and the analysis was done at research laboratory of Water and Sanitation Agency (WASA), Faisalabad. The methods used for analysis are given below.

a) Physical analysis

pH: pH was measured by pH meter (pH 600, Milwaukee). The pH meter was calibrated with the help of buffer solution. The sample of water was taken in a beaker and electrode was dipped in to it till the reading was stable. The measurement was repeated several times to get pH value.

Turbidity: The turbidity was measured by Turbidity meter (DRT-100). The equipment was calibrated with the help of standard solution of water which always have turbidity equal to 0.1 NTU (Nephelometric Turbidity Unit). The water sample was taken in a glass tube and was placed in the Nephelometer. Turbidity was recorded and presented as NTU.

Electrical Conductivity: Electrical conductivity was measured by EC meter (WM-22EP, TDA-DKK). The conductivity meter was calibrated. The sample of water was taken in a beaker and electrode was dipped in to it till the reading was stable. The measurement was repeated several times to get the EC values.

b) Aesthetic Examination

In aesthetic examination colour, odour and taste were determined by sensory method.

c) Bacteriological analysis

Total coliforms and feacal coliforms (E.coli) were determined by Membrane Filtration Technique. At first 100 ml of sample was passed through a membrane with a pore size of 0.45 microns. Filter was placed on an absorbent pad saturated with culture medium selective for coliforms. The Petri dish containing filter on Endo Agar was incubated at 35 °C for 24 hrs. Greenish metallic sheen colonies were observed (APHA, 1992). For faecal coliforms, the samples positive for total coliforms were inoculated on Macconkey's Agar for 18 hrs at 37 °C. E.coli appears as pink colour colonies due to fermentation of lactose and production of acid (Buxton and Fraser, 1977). For further confirmation of E.coli, Mug test was applied.

d) An Awareness Survey on Water Problems

Different schools were included in this survey. The examination was done using a questionnaire which was prepared and pre tested. The information was gathered on quality of drinking water, sources of drinking water in use and the diseases caused by drinking water. Schools were selected randomly and 10 schools were included in this study. Ten questionnaires were filled from each school, 5 from student and 5 from teachers.

STATISTICALANALYSIS

The data obtained from the study were 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. The data on awareness survey was also tabulated. Percentages of opinions by the respondents were worked out. Some of the factors were presented in bar diagrams (Steel *et al*, 1997).

RESULTS AND DISCUSSION

Physical and Aesthetic Analysis: Physical and aesthetic analysis of drinking water from different sources available at various schools in G.M.Abad, Faisalabad has been shown in Table 1.

The pH values of 40 water samples ranged between 7.4 to 9.3. According to WHO (1985) recommendations, the pH value of safe drinking water is 6.5 to 8.5. Most of the samples from all sources were found with in the safe limits. However, 3 samples of WASA water as direct supply, 1 sample of cooler water and 1 sample of ground water exceeded the limits. All the sources of water included in the study do not vary significantly. However, some samples showed higher pH values and that could be due to sampling error or error during estimation. Physico-chemical characteristics of some water samples used for drinking purpose were analyzed and the pH of water samples was above WHO permissible limits for safe drinking water. It was reported that such water might cause a serious threat to the health of

the users (Ikhifa *et al.*, 2007).

All the water samples collected from different sources had no turbidity. According to WHO guidelines the turbidity of drinking water should be less than 5 NTU. All the water samples therefore, were safe. Water from direct source is supplied by tube wells and is stored in tanks and coolers. All the water samples had passed through natural soil filter. The water was clear and its turbidity was zero. Jamal and Jamroz (2006) collected samples of ground water from Haripur city. The water samples were collected periodically and analyzed for turbidity. It was remarked that the ground water in Distt. Haripur had become turbid due to increased industrial as well as haphazard and unplanned urban expansion. The values of above referred work are being higher than our results. Locational changes might also have affected.

Electrical conductivity in WASA water as direct supply (WD) was the lowest (743 micro siemens/cm) as compared to other sources. However EC in ground water (WG) was the highest (4244.2 micro siemens/cm) than other sources. The EC of potable water in USA ranged from 50 to 1500 micro siemens/cm. All the water samples (WD, WC and WT) were found with in the safe limits. However the mean EC value of samples of WG exceeded the safe limits. It was observed that direct water score was the minimum but there were non-significant differences among WD, WT and WC. However, WG score was significantly higher than other sources. Sajjad and Rahim (1998) investigated chemical quality of ground water of Rawalpindi/Islamabad. It was observed that electrical conductivity showed increasing trend as water moves from adjoining recharge areas of Margalla and Murree hills towards centre of the basin, which acted as discharge area for ground water. The electrical conductivity increases from less than 400 micro siemens/ cm near the mountains to the maximum of 1200 micro siemens/ cm in the centre of the basin. It was observed that electrical conductivity in the water of hilly areas was low and it showed increasing trend as water moved from these areas towards centre of the basin. Present results showed higher levels of EC in ground water because of plane area and may be due to higher concentration of TDS.

All the samples were free of any colour and objectionable odour. Water seems to be free of coloured organic matters, primarily humid and fluvic acids. Iron and other metals from the natural impurities or with corrosion products were also not present. Water samples under observation were also tasteless except ground water. Whereas a number of samples of ground water had objectionable taste. Two samples of ground water had slight saltish taste and 5 samples were brackish that were highly saltish. According to WHO drinking water standards, water should be tasteless. So, all the samples of WASA water as direct supply, cooler water and tank water were found fit. However, ground water in schools was unfit for drinking purpose being salty or brackish. Hussain *et al.* (2001) conducted physico-chemical analysis of drinking water from Rawalakot and its surroundings. Objectionable gun powder and sulphur odours were observed in some water samples of District Rawalakot because of its location and may be due to difference in chemical quality.

Bacteriological analysis: The bacteriological analysis of drinking water has been shown in Table 2. According to WHO safe limits there should be no coliforms/E. coli in 100 ml of water. Fifteen samples of WD were free of E. coli out of sixteen examined. WASA water as direct supply was therefore with in the safe limits. Water stored in school tanks had only 4 samples that were fit, and 7 samples contained coliforms and were found exceeding the safe limits. Water stored in school coolers had 4 samples that were found fit and 2 samples were unfit. However, all the samples of ground water had coliforms and were unfit for drinking purpose. All the water samples collected from different sources had no feacal coliforms (*E. coli*). A total of 240 samples were collected out

Table 1 Physical and aesthetic analysis of different sources of water for drinking by children in various schools in G.M.Abad.

Sources of water	No of samples	pH	Turbidity (NTU)	Electrical conductivity (EC) (micro siemens/ cm)	Colour	Odour	Taste
WD	16	7.93 (7.4---8.4)	0	743[a] (711---784)	colourless	odourless	tasteless
WT	11	8.8) 7.7	0	770[a] (711---1063)	colourless	odourless	tasteless
WC	6	(7.4---8.4)	0	755[a] (742---783)	colourless	odourless	tasteless
WG	7	7.9 (7.4---8.7) 8.00 (7.5---9.3)	0	4244.2[b] (2100---6010)	colourless	odourless	Saltish/Brackish*

The values in parenthesis are ranges.
Same alphabets on means in columns show non-significant differences.
* Out of 7 samples tested, 5 were brackish and 2 saltish.

of which 17 samples had coliforms. They were further tested for *E. coli*. However, no *E. coli* was found in any of the samples. For further confirmation MUG test was applied and it confirmed that E. coli was not present. So, out of 40 samples 23 samples of drinking water were bacteriologically clear and 17 samples were unsuitable for drinking purpose. It was reported that the drinking water quality in the city of Karachi was not good. There was a presence of coliform bacteria in the main distribution lines. It indicated that water got contaminated from the surrounding leaky sewerage pipelines. Secondly, the presence of feacal coliform in the water of branch lines feeding to consumers and stand posts confirmed the mixing of sewage in to drinking water lines making it unfit for drinking (Malick *et al*, 1998). Hashmi and Shahab (1999) reported that ground water and surface water used by rural and urban areas were heavily polluted by both sewage and industrial wastes. Jahangir (2001) found 94 percent water samples collected from Islamabad/Rawalpindi as bacteriologically contaminated and 34 percent having feacal contamination. The present study indicated only total coliforms which are themselves harmless but there was no feacal contamination in drinking water. However, results of above referred work are different from the results of present study, due to mixing of sewage and industrial wastes and may be due to difference in source and location.

The relationship between the amount of residual chlorine and bacterial count was also observed. Water samples that had no residual chlorine had total coliforms in 17 out of 18. However, the water samples having residual chlorine as 0.1, 0.2 and 0.4 ppm did not contain any bacteria. According to WHO guideline values the recommended amount of residual chlorine is 0.2 to 0.4 ppm. The results however showed that 0.1 ppm residual chlorine was also sufficient to kill the bacteria in drinking water. It has been observed that isolated microorganisms were growing in drinking water reservoirs. The microorganisms of the flowing water as well as those growing in the reservoir were studied and it was found that bacteria were 84.5 and 91 percent of the total heterotrophic biomass in the reservoir and in the flowing water, respectively. By the increase of free chlorine concentration the biodegradable organic carbon dramatically reduced the biomass of bacteria (Amblard *et al*, 1996). This showed that increase of residual chlorine decreases the number of bacteria.

Table 2 Number of samples of water showing the presence of total coliforms and feacal coliforms (E. coli) from different sources available for drinking by children at various schools in G.M.Abad, Faisalabad.

Sources of water	Total no of samples examined	Total Coliforms (No of samples)			Feacal coliforms
		-ve samples	+ ve samples	Too numerous to count (TNTC)	(E. coli)
W D	16	15	1 (300)	Nil	Nil
W T	11	4	1 (55)	6	Nil
W C	6	4	2 (29,119)	Nil	Nil
W G	7	——	7 (2 ----38)	Nil	Nil

The values in parenthesis are number of total coliforms.

Awareness on Water Problems: Majority (82 %) of the respondents were females. Fifty percent of respondents were less than 30 years of age. Middle age and older people also participated in the study. Majority of the respondents were graduates. People having education up to middle and matric level were also among the respondents. Fig I represent the sources of drinking water used by the respondents. Majority of the respondents had water supplied by WASA (71%). Twenty percent of the respondents were using electric pump and only a small percentage (9 %) had other sources of water supply. The majority of the respondents (84%) informed sweet taste of drinking water in their house hold. Seven percent of the subjects complained that they had brackish water for drinking whereas 9 percent showed that their drinking water was tasteless. Seventy eight percent of the respondents were satisfied with the quality of their drinking water. About 95 percent of the respondents had a view that poor quality water was harmful for their health. The information obtained from the survey about the treatment given by the respondents to the water used for drinking is shown in figure II. About 41 percent of the respondents were using boiled water while about 38 percent of the respondents were using filtered water. Some of the respondents were chlorinating their house hold tanks. However, still 20 percent of the respondents did not use any type of treatment. All of the respondents agreed that poor quality water expands diseases. About 62 percent of the respondents knew that the diseases are caused by drinking water while the remaining had no knowledge. Majority of the respondents personally suffered from diarrhea caused by un - wholesome water, eleven percent had gastroenteritis while 7 percent were affected by

kidney problems. Only a few were affected by cholera and hepatitis. Twenty one percent of the respondents had to receive treatment of diseases but majority of the respondents did not get any treatment. Majority of the respondents (75%) were aware of water contamination but one fourth did not have awareness about it. In order to avoid contamination, 35 percent of the respondents cleaned their water tanks, 24 percent cleaned their pipelines where as only a few used other methods, while 34 percent did not adopt any treatment to avoid contamination. Majority of the respondents suggested that boiling the water can avoid contamination, while 13 percent suggested to use bottled water and a similar number suggested to adopt filtration. Ten percent were of the view that pipelines should be cleaned, 8 percent suggested that Government should give awareness to improve the water quality. However only a small number suggested water chlorination. Figure III shows the views of the respondents about government action. More than half of the total respondents (51%) expressed that government was taking action to improve water quality while remaining (49%) were not in agreement with this statement.

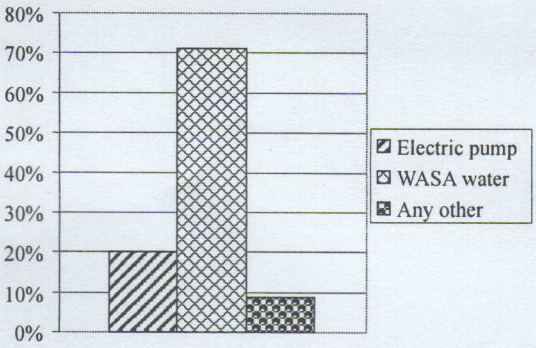

Figure I showing the sources of drinking water used by the respondents

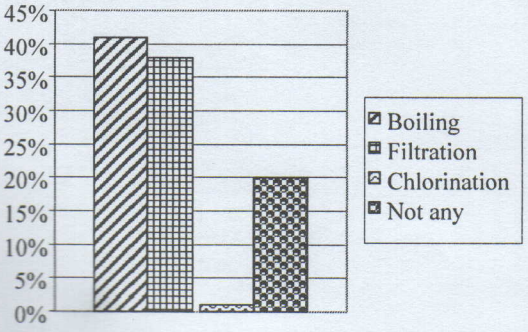

Figure II Showing the kind of water treatment used by the respondents

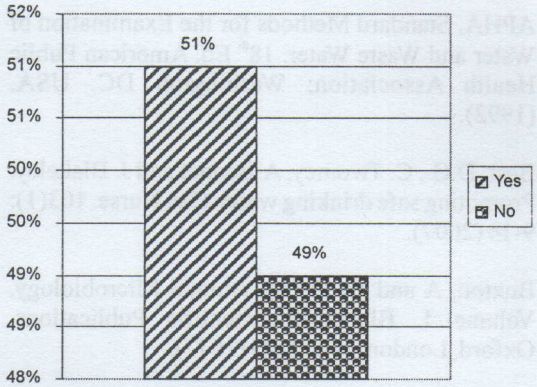

Figure III Showing the view of respondents about Government action

CONCLUSIONS

Most of the water samples taken from schools were fit for drinking, as for as physical analysis and aesthetic water quality parameters were concerned. Ground water available in some of schools was saltish and brackish and was unfit for human consumption. WASA water as direct supply contained sufficient amount of chlorine and did not have any bacteria. Most of the water samples that were taken from coolers and storage tanks of schools had no chlorine content and contained coliforms. Feacal coliforms (E. coli) were not present in any of the samples tested in the study. It is recommended that water should be taken from direct source at supply time. Drinking water should not be stored in un hygienic tanks without chlorination. Low cost house hold level water treatment of water tank should be done for providing clean and uncontaminated water.

ACKNOWLEDGEMENT

Authors are grateful for the research facilities provided by Research Laboratory of Water and Sanitation Agency, Faisalabad for this valuable research work. The technical assistance provided by Madam Tahira Ijaz and Madam Farhat is greatly acknowledged.

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