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EVALUATION OF DRINKING WATER QUALITY SUPPLIED IN THE CITY OF KARACHI

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ABSTRACT

The objective of this study was to assess the quality of water as it is transported from treatment plant to the consumers of Karachi city. The water samples collected from various supply lines were analyzed chemically and microbiologically. The results indicated that at treatment plant all the water quality meet WHO standard. However, the samples from distribution lines showed the presence of coliform bacteria and fecal coliform in the water samples of branched lines supplying water to the consumers. The residual chlorine was absent in almost all the samples. In contrast, the chemical quality of the water with respect to tested parameters (pH, turbidity, EC and TDS) did not alter significantly during the distribution. From the findings it may be concluded that the quality of water supplied to the city is not fit for drinking as per WHO standard. The measures to rectify the problems of water contamination need to be undertaken.

Key words: Water quality, treatment plant, distribution lines, fecal coliform, residual chlorine.

INTRODUCTION

There are several potential sources to contaminate drinking water. Bacteriological contamination of drinking water has been reported to be one of the most serious problems throughout Pakistan in rural as well as urban areas (Abid & Jamil, 2005; Kahlown, *et al*., 2004; Jehangir, 2002(personnel communication); Sun-OK, *et al*., 2001). Such contamination is attributed to leakage of pipes, pollution from sewerage pipes due to problem within the distribution system, intermittent water supply, and shallow water tables due to human activities. A second strong source of surface and ground water contamination is runoff from agricultural soil, untreated industrial effluent discharge (Tahir,1989; Tahir & Bhatti,1994; Din, *et al*., 1997; Tahir, *et al*., 1998; Sajjad & Rahim,1998; Hussain & Mateen, 1998; Sial & Mehmood,1999; Latif, *et al*., 1999; Chandio,1999 and Tahir, 2000). In addition, excessive monsoon rains, floods, untreated municipal waste, sewage breakdowns, and coastal water pollution due to waste discharges and oil spills are extremely hazardous. According to Pakistan National Conservation Strategy (1992) about 40 percent of communicable diseases in the country are water borne and 30 to 40 percent of the population (served through piped water) is deprived of safety measures.

In Karachi city, current water supply is 665 MGD. With 15 per cent wasted due to technical leakages, the available supply comes to 565.25 MGD, mainly from the Indus River, 150km away, and the remaining 75-100MGD from the Hub Dam, some 40km distant. At present, the supply from the River Indus comes via canals from Kinjhar, Haleji, Gharo, and through conduits to the Dhabeji pumping station. The water is then distributed via conduits, and distribution mains of diameters 66 inches and below. The routes are divided into, a) Northern - via Pipri to parts of the Malir cantonment areas, Gulshan COD reservoir, Gulshan Town then parts of Gadap, North Karachi, NEK, N.Nazimabad, Gulberg, Liaquatabad and parts of Lyari; and b) Southern, i.e Bin Qasim town, Landhi, Korangi, along the National Highway to Shah Faisal, Jamshed town, Saddar town (including Defence/Clifton), Lyari and Kaemari. The water mains at places are interconnected. The Hub source supply is mainly for Orangi, Site and Baldia towns. The Hub and Indus supplies at the level of the distribution mains are interconnected. The supply is therefore shared, as needed (KWSB, 2007).

Earlier in 1997-98 (during the time of study), the water supply from two sources, Indus (280 MGD) and Hub reservoir (100 MGD) was 380 MGD. Four treatment plants, Gharo Filter Plant, Pipri Filter Plant, North East Karachi (N.E.K) Filter Plant and COD Filter Plant for Indus raw water and one treatment plant in Hub Filter Plant for Hub raw water located in different parts of the city was used to treat the raw water. The treated water was distributed to the city via main distribution lines and passed on to the consumers through the branched lines, traveling a distance of about 3000 km of pipe lines (KWSB, 1998). The purpose of this study was to investigate whether the distribution system is capable to maintain high water quality from treatment plant to consumers end.

METHODOLOGY

During the study period, forty samples were taken from supply lines of different locations of the city originated from Indus River and Hub sources. Physical, chemical and microbiological parameters such as pH, Turbidity, Electrical Conductivity, Total Dissolved Salts, Total Coliform and Fecal Coliform tests (Multiple tube method) were performed according to standard methods (APHA, 1989). Residual Chlorine was analyzed using LaMotte test kit. All the results were interpreted according to WHO guidelines for the drinking water quality.

To evaluate drinking water quality in the city, water samples were collected with following objectives:

- Raw water quality before treatment
- Quality of the treated water
- Water quality as it is supplied from treatment plants to consumer sites at different locations.

All the samples were grab samples taken at different times. For residual chlorine, Coliform and fecal coliform test, samples were collected in sterilized glass bottle and immediately taken to the laboratory for analysis. The details of the study appears elsewhere (Malick, 1997).

Table 1. Values of water quality obtained from water supply lines of Indus Source via Gharo, Pipri and N.E.K. filter plant.

Parameters and Results										
S.No	Area	Type of sample Location	Distance Water Treatment Plant (Km)	pH	Turbidity (NTU)	E.C (micromhos/cm)	TDS (mg/L)	Residual Chlorine (mg/L)	Coliform Count (MPN/ml)	Fecal Coliform Count (MPN/ml)
	WHO Standard			**6.5- 8.5**	**<5**	**2000**	**<1000**	**0.2-0.5**	**0**	**0**
1.	Raw Water Dhabeji P.S.	Plant	5	7.1	5.2	290	186	0.2	0	0
2.	After Gharo Filter	Plant	0	7.2	3.5	310	198	0.6	0	0
3.	Raw Water Pipri T.P	Plant	5	7.1	5.8	280	243	0	4	4
4.	Pipri Treatment Plant (50 MGD)	Plant	0	7.2	2.0	310	198	0.5	0	0
5.	Pipri Treatment Plant(25 MGD)	Plant	0	7.2	2.2	310	198	0.5	0	0
6.	Grain Godown	Branched line	25	6.9	2.6	340	218	0	1100	450
7.	Landhi	Branched line	32	7.5	5.8	320	205	0	1100	240
8.	Korangi	Branched line	40	7.6	1.8	320	205	0	460	240
9.	Korangi (End)	Branched line	45	7.5	4.6	330	211	0	460	460
10	Raw Water (NEK Filter Plant)	Plant	5	7.4	5.2	320	205	0	15	4
11	After NEK Filter Plant	Plant	0	7.4	0.9	320	205	0.5	0	0

RESULTS AND DISCUSSION

The results of the analysis of water samples collected from the distribution lines originating from Indus and Hub sources are presented in Table 1, 2 and 3. Four samples of raw water from Indus water sources located at Dhabeji, Pipri, North East Karachi (N.E.K), and COD filter plant and one sample from Hub canal pumping station were taken. Six samples were also collected from the corresponding filter plants after the treatment. Result of the analysis showed that treated water samples from treatment plants meets WHO standard (WHO, 1993), in terms of pH, turbidity, TDS, residual chlorine, coliform counts and fecal coliform counts although the raw water samples from all the sources were contaminated with pathogens.

Table 2. Values of water quality obtained from water supply lines of Indus Source via COD filter plant.

Parameters and Results										
S.No	Area	Type of sample Location	Distance Water Treatment Plant (Km)	pH	Turbidity (NTU)	E.C (micromhos/cm)	TDS (mg/L)	Residual Chlorine (mg/L)	Coliform Count (MPN/ml)	Fecal Coliform Count (MPN/ml)
	WHO Standard			**6.5- 8.5**	**<5**	**2000**	**<1000**	**0.2-0.5**	**0**	**0**
1.	COD Hill (Raw Water)	Plant	5	7.4	5.5	380	243	0	43	0
2.	COD Hill (Treated Water)	Plant	0	7.4	3.5	320	205	0.5	0	0
	Branch A									
3.	Dawood College Hydrant	Hydrant	10	7.3	4.5	400	256	0	14	0
4.	Sadar	Branched line	15	7.0	1.0	520	333	0	93	43
5.	Kemari	Branched line	25	7.1	9.5	2500	1600	0	240	9
6.	Shireen Jinnah Clony	Pump Station	25	7.1	1.6	250	224	0	4	0
	Branch B									
7.	Golimar	Branched line	17	7.3	1.5	340	218	0	7	3
8.	Mauripur	Branched line	40	7.3	5.5	680	435	0	2400	120
9.	Agra Taj	Branched line	45	7.3	6.0	340	218	0	460	9
10	Manora	Hydrant	50	7.3	4.8	480	307	0	23	0
11	Gulshan-e- Iqbal	Branched line	8	7.4	0.92	320	205	0	4	4
12	Liaquatabad	Hydrant	15	7.4	0.92	320	205	0.2	0	0
13	Nazimabad	Branched line	20	7.3	3.0	320	205	0.2	0	0
14	Federal-B-Area	Branched line	30	7.4	1.0	330	211	0	93	0

Overall, twenty nine water samples were collected from different location of water distribution net work originating from Indus (16 samples) and Hub (13 samples) sources. This net work covers the entire area of Karachi. Out of twenty nine samples, nine samples, taken from "hydrants", representing water quality in the main distribution lines whereas the remaining twenty samples were taken from supply lines branched from the main distribution lines feeding directly to individual consumers. Results of the analysis indicated that almost all the samples were contaminated with coliform bacteria, samples from hydrants were free from fecal coliform but the samples from branched lines had fecal coliform with varying concentration. As expected, the residual chlorine in almost all samples were absent.

Table 3. Values of water quality obtained from water supply lines of Hub water source.

Parameters and Results										
S.No	Area	Type of sample Location	Distance Water Treatment Plant (Km)	pH	Turbidity (NTU)	E.C (micro mhos/ cm)	TDS (mg/L)	Residual Chlorine (mg/L)	Coliform Count (MPN/ml)	Fecal Coliform Count (MPN/ ml)
	WHO Standard			**6.5-8.5**	**<5**	**2000**	**<1000**	**0.2-0.5**	**0**	**0**
1.	Hub Canal before P.S. (Raw Water)	Canal	5	7.6	2.5	730	469	0	460	11
2.	Hub Main after P.S	Reservoir	0	7.1	3.8	740	474	0.5	0	0
3.	66 inch dia Line	Branched line	8	7.6	0.98	740	474	0	9	9
4.	48 inch dia line	Branched line	10	7.6	2.5	740	474	0	43	4
5.	Manghopir Graveyard	Hydrant	15	7.6	2.0	740	474	0	150	0
6.	Orangi End Sector	Branched	18	7.6	3.0	730	467	0	15	15
7.	Qasba Township	Branched line	20	7.5	1.8	750	480	0	28	11
8.	North Nazimabad (Sakhi Hussan Hydrant)	Hydrant	25	7.4	0.98	750	480	0	7	0
9.	F. B. Area (Water Pump Hydrant)	Hydrant	30	7.8	0.42	750	467	0	15	0
10	Orangi Central	Branched line	33	7.4	0.52	740	474	0	2400	93
11	Orangi Sector 1	Branched line	35	7.3	1.6	740	474	0	<2400	<2400
12	Banaras Chowk P.S.	Pumping Station	40	7.4	4.0	730	467	0	20	0
13	Site (33 inch dia)	Branched	45	7.4	2.3	720	461	0	1100	150
14	Baldia Township (Start)	Branched	48	7.4	0.9	740	474	0	>2400	28
15	Baldia Township (End)	Hydrant	50	7.4	0.95	740	474	0	28	0

* Data was produced during authors association with NED University & presented in 24th WEDC Conference

The presence of coliform in the water samples of hydrants indicates that the principle source of contaminants in the main distribution lines may be due to inclusion of soil through leaks/cracks. However, in the samples of the

branched lines, the presence of fecal coliform confirms the seepage of sewage water into the supply lines because of the poor sanitation conditions prevailing in the city. It should be noted that samples taken from low income areas, mainly Katchi abadies, such as Landhi, Korangi, Kemari, Mauripur, Agra Taj, Orangi, Baldia Town ship were found to be highly contaminated with sewage as the samples had high concentration of feacal coliform. This was expected because those areas are known to have poor sanitation conditions.

Recently the water quality from diverse areas of Karachi examined by the Department of Geography (Kazmi & Ihsanullah, 2009) reported similar results of bacteriological contamination in all the water samples. The study also reported that of the 2000 water samples collected over a period of 20 years from different part of the city, none have been found fit for human consumption according to WHO recommended standard. It seems that no intervention has been done for the improvement of water quality.

Regarding chemical quality, chromium and lead contamination has been reported in several drinking water sources in Karachi, particularly alarming level found in ground water sources (Haq *et al*., 2009,). In this study, the chemical quality of the water supply with respect to the tested parameters (pH, turbidity, TDS) did not seem to be deteriorated when distributed in the city. Except in two places, in Kemari and Mauripur, where the TDS concentration in the water samples was found to be significantly high from the original values of treated water, perhaps due to seepage of brackish water of sea or ground water. Whereas the in other samples, the TDS concentration were not altered significantly during distribution when compared with the original values of treated water samples collected from treatment plants.

It is worth mentioning here that the interviews and discussion with the number of residents from where the samples were collected reveal that the residents have very much concern of the quality and quantity of the water supplied. Majority of the consumers try to improve the quality of the supplied water by boiling or adding sulphur, potassium permagnate or alum in the storage tank.

CONCLUSIONS

Following conclusions can be drawn from the present and earlier studies carried out recently (Kazmi & Ihsanullah, 2009; Haq., *et al*., 2009; Rehman *et al*., 1997).

- The water quality at treatment plant meets WHO standard.
- The presence of coliform in the distribution lines indicate that as the supplied water is transported in the main lines, it gets contamination from surrounding soil through leaks/cracks.
- The presence of fecal coliform in the water of branched lines feeding to consumers and standposts, confirm the seepage of sewage into the lines making water unfit for drinking.

Overall conclusion of the earlier study is still valid and no significant improvement in the water quality has been observed as per comparison with the current data reported in literature. Unfortunately, the quality of water supplied to the city is still unfit for drinking as per WHO guidelines. However, this conclusion is based on the very limited samples (only forty) taken during the study period at one time basis. All year around periodic monitoring of the water quality in different part of the city would certainly reveal a better picture of the fate of the water quality as it is distributed around the city.

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