Physical and Bacteriological Analyses of Drinking Water of Korangi, Landhi and Malir Towns of Karachi, Pakistan

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Summary: The present study has been conducted for the investigation of the status of drinking water of various towns of Karachi city of Pakistan from various sources including municipal water supply. Currently Karachi city has been divided in eighteen towns and samples of three towns were collected at the consumer end. Ninety-seven water samples were collected from three towns of Karachi city and quality of drinking water was examined by Most Probable Number (MPN) techniques. The results were compared with WHO, EU, Canada, USA and Russia guidelines. It was found that municipal water is almost contaminated in every town with the hazardous organisms of public health importance in higher than any permitted standards. This is an acute problem of Karachi city, where free style of disposal of toxic industrial waste water/ effluents into the natural water contaminates the surface and ground water.

Introduction

Since water is the most essential for all living things and their sustainability. Nevertheless, water is also carrier of a number of microorganisms, causing different infections. Microbiological status is commonly employed for determining the quality of the water. Drinking water must be free from turbidity, color, odor and objectionable taste as well as from disease causing organisms and organic and inorganic chemicals which may produce adverse physiological effect. Contamination of water with the responsible pathogens occurs primarily through human or animal feces. The diseases which are caused by contaminated fecal material transmitted by the fecal-oral route. All types of infectious agents may be transmitted by the fecal-oral route *via* water, including viruses (such as infectious hepatitis, rotavirus and Norwalk agent) bacteria (such as cholera, typhoid and dysentery) and parasites (such as Giardia, *Cryptosporidium* and *Entaamobea histolitica*).

Higher incidences of typhoid, gastroenteritis and dysentery have become common problems of public health in Karachi city. Diarrhea is water born which affects 40 % children under five years of age and it has been estimated that only in 1995 more than 1.5 billion episodes of diarrhea occurred in children in the developing countries (excluding China) and that 4 million resulted in death [1].

Pakistan is also facing the impact of water born diseases due to bad sanitary conditions and poor drinking water quality. Lack of infrastructure facilities for providing clean drinking water and sanitation has caused widespread drinking water pollution problems in rural as well as urban areas in Pakistan [2].

Karachi is one of the twenty-mega cities of the world having population of about fourteen million and covers an area of more than 800 square kilometers, faces the problems of unhygienic drinking water which causes a number of stomach diseases [3]. As population and industries of Karachi are growing rapidly therefore municipal water has becoming insufficient. Due to imbalance supply and demand, ground water is being used to fulfill the requirement and it is a known fact that the ground water of Karachi is highly polluted.

In case of municipal water, some time mixing of sanitary water with municipal water occurs this contaminated it as well.

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The present study deals with the physical and bacteriological examination of drinking water from various locations of the Karachi city.

Results and Discussion

Drinking water quality varies from place to place, depending on the water sources and the treatment it receives. An under ground network of pipes typically delivers drinking water to the homes and business served by the water system. Drinking water must meet required health standard when it leaves the treatment plant. After treatment water leaves plant it is monitored within the distribution system to identify and remedy any problems such as water main beaks, pressure variations or growth of microorganisms. Water supplies use a variety of treatment process to remove contamination from drinking water. The most commonly used process including coagulation (flocculation and sediment-tation), filtration and disinfections.

During this study total ninety-seven (97) samples were collected from various locations of the three towns of Karachi city are given in the table-1. Out of which were 41, 25 and 31 samples were collected from Landhi, Korangi and Malir towns, respectively. Results of bacteriological and physical parameters of drinking water of these towns are collected in Tables 2-7.

Table-1: Main Sources of Drinking Water Supply by Karachi Water and Sewerage Board (KWSB).

S. No	Location	Quantity	Sources
1.	COD Filter Plant	115 MGD	Kalri Lake
2.	Gharo	20 MGD	Kalri Lake
3.	Pipri	50 MGD	Kalri Lake
4.	North Super Highway	50 MGD	Kalri Lake
5.	Scheme 33 (Sadi Town)	100 MGD	Kalri Lake
6.	Hub River	100 MGD	Hub Dam
7.	Flowing from Thatta to Arabian Sea	8.7 MGD	Dimloti wells
	Total	435 MGD	

The quality of drinking water of Landhi town showed very worst conditions, 40 % of samples demonstrated MPN values, greater than 1100, 6 % exhibited greater than 240, 50 % showed 230 MPN/ dl value. The range of dissolved oxygen were found 3 mg/ l in most of the samples and the turbidity value were found more than 5 NTU in the majority of the samples the maximum total dissolved solids (TDS) value in this town were found 2174 mg/ l.

Table-2: Morbidity and Mortality Rates of Some Important Water-related Diseases (After WHO, 1995).

S. No.	Disease	Cases per Annum in thousands	Deaths per Annum in thousands
1.	Cholera	384	11
2.	Typhoid	500	25
3.	Giardiasis	500	Low
4.	Amoebiasis	48,000	110
5.	Diarrhoeal disease	1,500,000	4,000
6.	Ascariasis	1,000	20
7.	Trichuriasis	100	Low
8.	Ancylostoma	1,500	60
9.	Dracunculiasis (Guinea Worm)	>5,000	-
10.	Schistosomiasis	200,000	800
11.	Trachoma	360,000 (active)	9,000 (blind)

Out of 25 samples from Korangi town, 95 % showed MPN/ dl values greater than 1100 and reaming shows 240 to 230 MPN/ dl values. The range of dissolve oxygen was found 3 mg/ l in most of the samples and the turbidity value was found more than 5 NTU in the majority of the samples. The maximum TDS value in this town was found 1593 mg/ l.

Out of 31 samples from Malir town, 98 % showed MPN/ dl values greater than 1100 and reaming exhibited 240 to 230 MPN/ dl values. The ranges of dissolved oxygen were found 3 mg/ l in most of the samples and the turbidity value was found more than 5 NTU in the majority of the samples. The maximum TDS value in this town was found 3485 mg/ l in union council no.1.

It is a fact that microbial contaminant are normally associated with acute and widespread effect on human being and places them in high priority category than chemical contaminants according to World Health Organization. Indeed, it can be argued that chemical standards for drinking water are of secondary consideration in a supply subject to serve bacterial contamination. Water constituents may affect the appearance, odor, or taste of the water and the consumer will evaluate the quality and acceptability of the water on the bases of these criteria. Water that is highly turbid, highly colored, or has an objectionable taste or odor may be regarded by consumer as unsafe and may be rejected for drinking purpose. It is therefore, essential to maintain a quality of water that is acceptable to the consumer, although

Table-3: Landhi Town Physical Parameters Analyses.

S. No.	Sample ID No.	Union Council	Location	pH	Temperature °C	Dissolved Oxygen	Turbidity NTU	Conductivity	TDS mg/l
1	1001	1	New Muzzafar abad Colony	7.60	35.0	3.1	<5	430.0	266.6
2	1002	1	Old Muzzafar abad Colony	7.50	36.0	2.9	<5	446.2	272.2
3	1003	1	Majeed Colony	7.66	34.0	2.9	<5	2443.0	1539.1
4	1004	2	Muslim abad	7.65	34.0	3.2	<5	401.1	252.7
5	1005	2	Bilal Colony	7.57	33.5	2.9	<5	416.6	262.5
6	1006*	3	Sher Pao Colony	7.11	34.0	3.1	<5	1224.8	783.9
7	1007	3	Sher Pao Colony	7.51	36.0	3.1	<5	450.8	279.5
8	1008*	3	Labour Colony	6.86	32.0	2.9	<5	1830.0	1134.7
9	1009	3	Tuheedabad	7.44	34.5	3.2	<5	446.2	272.2
10	1010	3	Firdous Colony	7.76	32.2	2.9	<5	3391.38	21704.8
11	1011*	3	Dawoud chorangi	7.01	33.0	3.0	<5	307.5	370.6
12	1012	3	Dawoud Challi	7.62	34.0	3.1	<5	273.1	302.8
13	1013	4	Moinabad	7.33	33.0	2.9	<5	457.9	293.1
14	1014	4	Mansehra Colony	7.36	35.9	3.1	<5	440.0	277.7
15	1015	4	Mansehra Colony	7.29	36.0	2.9	<5	456.7	283.2
16	1016	5	Peer Bakhash Goth	7.73	34.0	3.1	<5	422.5	266.2
17	1017	5	Sharafi Goth	7.65	35.0	3.1	<5	441.7	278.3
18	1018	5	Naik Muhammad Goth	7.62	34.0	3.1	<5	457.0	283.4
19	1019	5	Awami Colony	7.19	35.0	3.1	<5	1176.2	752.8
20	1020	5	Bhutto Nagar	7.85	34.5	3.0	<5	533.6	325.2
21	1021	6	Sector No. 37-B	7.41	34.8	3.1	<5	397.4	250.4
22	1022	6	Sector No. 37-D	7.16	34.0	2.9	<5	381.6	236.6
23	1023	7	Sector No. 37-A	7.40	33.9	2.9	<5	398.4	251
24	1024	7	K-Area	7.63	33.0	3.0	<5	386.2	252.9
25	1025	7	Shah Khalid Colony	7.30	34.0	2.8	<5	366.3	241.8
26	1026	7	Peer bukhari Colony	7.29	33.5	3.1	<5	414.3	265.2
27	1027	11	Sector No. 37-C	7.68	34.0	2.9	<5	363.0	228.7
28	1028	7	Khawaja Ajmeer Colony	7.66	36.0	3.1	<5	402.0	257.4
29	1029	8	Sector No. 36-B	7.50	35.0	3.1	<5	452.3	271.4
30	1030	8	Sector No. 36-E	7.50	35.8	2.8	<5	371.6	245.3
31	1031	9	Awami Colony	7.84	34.3	3.1	<5	491.6	299.9
32	1032	9	Future Colony	7.63	34.0	2.9	<5	486.7	301.8
33	1033	9	Future Colony	7.23	36.0	3.1	<5	462.7	282.3
34	1034*	10	Sector No. 36-C	7.25	33.5	3.1	<5	502.9	311.8
35	1035	10	Sector No. 36-G	7.56	35.4	3.0	<5	401.2	252.8
36	1036*	11	Sector No. 44-A	7.50	36.0	2.9	<5	584.8	374.3
37	1037	11	Sector No. J-1	7.08	36.2	3.1	<5	399.3	251.6
38	1038	11	Sector No. 43-F	7.38	35.0	3.1	<5	826.8	520.9
39	1039	12	Sheerabad	7.20	34.5	3.2	<5	1145.1	732.9
40	1040	12	Sweeper Colony	7.00	34.8	2.9	<5	487.9	307.4
41	1041	12	Sector No. 35-D	7.60	32.7	2.9	<5	453.9	286

* Bore water

the absence of any adverse sensory effect does not guarantee the safety of water. International standard methods were used to evaluate the quality of water under local circumstances before adopted in the surveillance programs [4]. All quality impacting processes were carried out in water testing. Planning and control of these processes was executed according to quality plans. Appropriate equipments were used and suitable working environment was regularly maintained. The standards for drinking water quality for Pakistan are being adopted from the guidelines provided by WHO [5]. Since, these standards directly affect the human health and lot of research and health considerations have been given in framing [5]. These guidelines have been accepted internationally and no relaxation can be acceptable in view of its direct impact on human health. Samples of water were collected from three main sources of water supply in Karachi namely, Indus river water through Kinjhar Lake, Hub dam water and Dimloti well water. Chemical and microbiological analysis of this raw water is presented in Table-3.

Administratively Karachi is divided into 18 towns. In the present study three towns were chosen where the above three different water supply sources are being utilized for drinking purposes. Ninety-seven samples of drinking water were collected from

Table-4: Korangi Town Physical Parameters Analyses.

S. No.	Sample ID No.	Union Council	Location	pH	Temperature °C	Dissolved Oxygen	Turbidity NTU	Conductivity	TDS mg/l
1	1101	1	Bilala Colony	7.51	28.6	3.1	<5	442.8	279
2	1102	1	Nusrat Colony	7.55	28.7	3.1	<5	490.5	299.2
3	1103	1	Nasir Colony	7.72	31.3	2.9	<5	491.0	314.3
4	1104	1	Sector-T	7.69	32.5	2.9	<5	579.7	365.2
5	1105	2	Allah Walla Town	7.81	33.2	2.8	<5	530.3	339.4
6	1106	2	Allah Walla Town	7.75	32.9	3.2	<5	560.6	342
7	1107	2	Sector No. 31-D	7.62	33.1	3.2	<5	553.9	349
8	1108	3	Karimabad	7.49	26.9	3.0	<5	589.2	383
9	1109	3	Norani Basti	7.52	28.3	2.9	<5	571.9	366
10	1110	3	Norani Basti	7.7	28.6	3.1	<5	592.0	373
11	1111	3	Charka Goth	7.69	33.1	2.8	<5	612.7	386
12	1112	3	Mustafa Taj Colony	7.33	29.3	2.9	<5	2450.8	1593
13	1113	3	Silver Town	7.93	32.1	3.0	<5	437.2	271.0
14	1114	4	Zaman Town	7.68	30.1	3.1	<5	590.3	366.0
15	1115	4	Zaman Town	7.81	30.9	2.9	<5	595.0	374.8
16	1116	4	100 Quarters	7.75	31.3	2.8	<5	550.0	346.5
17	1117	4	Sector No.50-A	7.81	32.3	3.2	<5	527.2	348.0
18	1118	5	Zia Colony	7.94	32.2	2.9	<5	1552.0	977.8
19	1119	5	Gulzar Colony	7.66	32.3	3.2	<5	542.0	341.4
20	1120	5	Gulzar Colony	7.76	30.4	3.1	<5	477.3	315.0
21	1121	5	Sector No. 34	7.8	30.6	3.1	<5	591.6	355.0
22	1122	6	Sector No. 23-B	7.93	32.1	3.1	<5	606.6	370.0
23	1123	6	Data Nagger	7.714	29.9	3.1	<5	586.9	358.0
24	1124	7	Sector No. 34 –A	7.65	31.3	2.9	<5	549.2	346.0
25	1125	7	Sector No. 51-B	7.76	29.8	2.9	<5	557.1	351.0

Table-5: Malir Town Physical Parameters Analyses.

S. No.	Sample ID No.	Union Council	location	pH	Temperature °C	Dissolved Oxygen	Turbidity NTU	Conductivity	TDS mg/l
1	1601	1	Malir Halt	7.5	33.0	3.0	<5	1317.1	843.0
2	1602	1	Gulshane Amna	7.52	34.0	3.0	<5	408.4	261.4
3	1603	1	Security Print Press	7.17	33.0	3.1	<5	521.9	328.8
4	1604	1	Rahim Jokhyo Goth	7.6	32.5	2.9	<5	468.0	290.2
5	1605*	1	Jokhyo Goth	7.05	37.0	2.9	<5	3337.2	1969.0
6	1606	1	Moeen Abad	7.5	35.3	3.1	<5	415.0	261.5
7	1607*	1	Modle Colony	7.26	32.9	3.0	<5	1416.8	906.8
8	1608*	1	Jaffer Bagh	7.15	36.6	3.1	<5	5531.7	3485.0
9	1609	2	Kala Board	7.34	33.2	2.9	<5	387.0	251.6
10	1610	2	Darkhshan Society	7.65	33.0	2.9	<5	338.7	213.4
11	1611*	2	Malir A-area	7.6	33.5	2.9	<5	422.5	266.2
12	1612	2	Malir ColonyB-Area	7.58	34.4	3.1	<5	412.8	243.6
13	1613	2	Christhen Colony	7.68	32.8	2.9	<5	409.1	253.7
14	1614*	2	Malir Colony G-Area	7.34	34.7	2.9	<5	436.3	274.9
15	1615	2	Sadat Goth	7.41	35.4	3.0	<5	398.2	266.8
16	1616*	2	Street 11 Malir Colony	7.25	33.4	3.1	<5	1561.0	1014.7
17	1617	2	Liaqat Markeet Malir	7.15	32.3	3.1	<5	1414.0	905.0
18	1618*	3	S-2 Area	6.96	33.4	3.1	<5	1593.6	1004.0
19	1619*	3	Malir colony H Area	7.22	32.1	3.1	<5	425.7	268.2
20	1620	3	Saoudabad	7.16	31.5	3.1	<5	1162.2	709.0
21	1621*	3	S-1 Area	7.5	26.2	2.9	<5	457.5	292.8
22	1622	4	Kouser Town	7.54	36.5	3.1	<5	419.2	264.1
23	1623	4	Pak Kouser Town	7.45	34.6	3.0	<5	405.3	271.6
24	1624	4	Indus Mehran Town	7.4	33.2	2.9	<5	435.6	274.4
25	1625	4	Khokhra par	7.73	31.5	3.2	<5	427.8	273.8
26	1626*	4	E-1Khokhra par	6.8	32.2	3.1	<5	1704.6	1108.0
27	1627*	5	Madina Colony	7.06	32.0	3.1	<5	3484.3	2230.0
28	1628	6	Adam Hingorja Goth	7.92	32.2	3.1	<5	397.8	254.6
29	1629*	6	Chaman Colony	7.39	33.0	3.0	<5	2263.0	1493.6
30	1630	6	Garibabad	7.7	34.3	2.9	<5	436.0	274.7
31	1631	7	Gazi Brohi	7.98	33.8	3.1	<5	440.0	277.2

* Bore water

Table- 6: Landhi Town Microbiological Analyses.

S. No	Sample ID No	Union council	Location	MPN/DL	Fecal Colifon
1	1001	1	New Muzzafar abad Colony	1100+	522.0
2	1002	1	Old Muzzafar abad Colony	1100+	420.0
3	1003	1	Majeed Colony	1100+	442.0
4	1004	2	Muslim abad	1100+	640.0
5	1005	2	Bilal Colony	1100+	640.0
6	1006*	3	Sher Pao Colony	1100+	354.0
7	1007	3	Sher Pao Colony	1100+	265.0
8	1008*	3	Labour Colony	1100+	548.0
9	1009	3	Tuheedabad	1100+	863.0
10	1010	3	Firdous Colony	1100+	530.0
11	1011*	3	Dawoud Chorangi	1100+	712.0
12	1012	3	Dawoud Challi	1100+	735.0
13	1013	4	Moinabad	230	123.0
14	1014	4	Mansehra Colony	1100+	520.0
15	1015	4	Mansehra Colony	1100+	522.0
16	1016	5	Peer Bakhash Goth	230	130.0
17	1017	5	Sharafi Goth	240	150.0
18	1018	5	Naik Muhammad Goth	230	110.0
19	1019	5	Awami Colony	230	120.0
20	1020	5	Bhutto Nagar	230	152.0
21	1021	6	Sector No. 37-B	230	120.0
22	1022	6	Sector No. 37-D	240	150.0
23	1023	7	Sector No. 37-A	230	110.0
24	1024	7	K-Area	230	120.0
25	1025	7	Shah Khalid Colony	230	110.0
26	1026	7	Peer bukhari Colony	230	95.0
27	1027	11	Sector No. 37-c	230	63.0
28	1028	7	Khawajw Ajmeer colony	230	120.0
29	1029	8	Sector No. 36-B	230	120.0
30	1030	8	Sector No. 36-E	230	110.0
31	1031	9	Awami Colony	230	110.0
32	1032	9	Future Colony	230	68.0
33	1033	9	Future Colony S.S	240	50.0
34	1034*	10	Sector No. 36-C	240	63.0
35	1035	10	Sector No. 36-G	230	110.0
36	1036*	11	Sector No. 44-A	240	120.0
37	1037	11	Sector No. J-1	230	120.0
38	1038	11	Sector No. 43-F	240	210.0
39	1039	12	Sheerabad	1100+	410.0
40	1040	12	Sweeper Colony	230	110.0
41	1041	12	Sector No. 35-D	1100+	640.0

* Bore water

the consumers end from these towns and analyzed in Sindh environmental protection monitoring laboratory. The data gene-rated for physical parameters are presented in Tables 3-5, whereas microbiological data are presented in Tables 6-8.

From the tables 6-8, it is obvious that most of the samples are contaminated with the fecal material; therefore, the water is potentially dangerous for human health. The conditions in Landhi, Korangi and Malir towns are worst, it was found that out of 97 samples none of the samples was fit for human consumption. The quality of water in these towns is unfortunately very poor and no residual chlorine was detected in any sample. Interestingly the quality of water in Malir town was not found satisfactory, however, this area is very close to Gharo treatment plant.

Table-7: Bacteriological Analyses of Drinking Water Collected from Korangi Town.

S. No	Sample ID No	Union council	Location	MPN/DI	Fecal Coliform
1	1101	1	Bilal Colony	1100+	630.0
2	1102	1	Nusrat Colony	1100+	522.0
3	1103	1	Nasir Colony	230	140.0
4	1104	1	Sector-T	1100+	530.0
5	1105	2	Allah Walla Town	1100+	622.0
6	1106	2	Allah Walla Town	1100+	630.0
7	1107	2	Sector No. 31-D	1100+	520.0
8	1108	3	Karimabad	1100+	420.0
9	1109	3	Norani Basti	1100+	511.0
10	1110	3	Norani Basti	1100+	422.0
11	1111	3	Charka Goth	1100+	630.0
12	1112	3	Mustafa Taj Colony	1100+	510.0
13	1113	3	Silver Town	1100+	522.0
14	1114	4	Zaman Town	1100+	620.0
15	1115	4	Zaman Town	1100+	410.0
16	1116	4	100 Quarters	1100+	320.0
17	1117	4	Sector No. 50-A	1100+	362.0
18	1118	5	Zia Colony	1100+	441.0
19	1119	5	Gulzar Colony	1100+	365.0
20	1120	5	Gulzar Colony	240	120.0
21	1121	5	Sector No. 34	1100+	563.0
22	1122	6	Sector No. 23-B	1100+	540.0
23	1123	6	Data Nagger	1100+	520.0
24	1124	7	Sector No. 34 –A	1100+	640.0
25	1125	7	Sector No. 51-B	1100+	422.0

Most of the bore water samples contain high number of total dissolved solids (TDS) *e.g.* in Firdous colony which is very close to the industrial area where most of the tanneries are located and the results showed that the ground water of this area is severely contaminated with industrial effluent. In Malir, bore water sample were collected from the Rahim Jokhio Village and found presence of high TDS because Malir river is passing near to this village, however, all the industrial and domestic waste water due to lack of awareness discharging into the Malir river without any treatment. This may be one of the possible reasons of contamination Tables (3-5). Results demonstrated that 99 % of these three towns have no residual chlorine in all samples which means these water samples are unsafe for drinking purposes and continuous threat to human health which may create unnecessary burden on health budget of City district Government. The treatment plants operate on "flocculation-sand filtration chlorination principle" from these only the sand filtration seems to be the major treatment process as there are serious inadequacies with coagulation and chlorination perhaps due to economic factors [4]. In the distribution network bacterial contamination previously present in pipelines reached to masses when sucked through

Table-8: Malir Town Microbiology Analyses.

S. No	Sample ID No	Union Council	Location	MPN/DL	Fecal Coliform	P/A Test (9221.D	E. coli (conform test) Kovacks Reagent
1	1601	1	Malir Halt	1100^{+}	420.0	P	+ve
2	1602	1	Gulshane Amna	1100^{+}	640.0	P	+ve
3	1603	1	Security Print Press	1100^{+}	522.0	P	+ve
4	1604	1	Rahim Jokhyo Goth	1100^{+}	366.0	P	+ve
5	1605*	1	Jokhyo Goth	1100^{+}	560.0	P	+ve
6	1606	1	Moeen Abad	1100^{+}	286.0	P	+ve
7	1607*	1	Modle Colony	1100^{+}	233.0	P	+ve
8	1608*	1	Jaffer Bagh	1100^{+}	468.0	P	+ve
9	1609	2	Kala Board	1100^{+}	352.0	P	+ve
10	1610	2	Darkhshan Society	1100^{+}	556.0	P	+ve
11	1611*	2	Malir A-area	1100^{+}	633.0	P	+ve
12	1612	2	Malir ColonyB-Area	1100^{+}	420.0	P	+ve
13	1613	2	Christhen Colony	1100^{+}	522.0	P	+ve
14	1614*	2	Malir Colony G-Area	1100^{+}	250.0	P	+ve
15	1615	2	Sadat Goth	1100^{+}	420.0	P	+ve
16	1616*	2	Sheet# II Malir colony	1100^{+}	412.0	P	+ve
17	1617	2	Liaqat Markeet Malir	1100^{+}	360.0	P	+ve
18	1618*	3	S-2 Area	1100^{+}	270.0	P	+ve
19	1619*	3	Malir Colony H Area	1100^{+}	622.0	P	+ve
20	1620	3	Saoudabad	1100^{+}	640.0	P	+ve
21	1621*	3	S-1 Area	1100^{+}	420.0	P	+ve
22	1622	4	Kouser Town	1100^{+}	320.0	P	+ve
23	1623	4	Pak Kouser Town	1100^{+}	420.0	P	+ve
24	1624	4	Indus Mehran Town	1100^{+}	240.0	P	+ve
25	1625	4	Khokhra par	1100^{+}	622.0	P	+ve
26	1626*	4	E-1 Khokhra par	1100^{+}	281.0	P	+ve
27	1627*	5	Madina Colony	1100^{+}	335.0	P	+ve
28	1628	6	Adam Hingorja Goth	240	126.0	P	+ve
29	1629*	6	Chaman Colony	1100^{+}	222.0	P	+ve
30	1630	6	Garibabad	1100^{+}	385.0	P	+ve
31	1631	7	Gazi Brohi	1100^{+}	420.0	P	+ve

* Bore water

pump or by gravity flow. The close proximity of sewerage and water lines, in most of the areas of the Karachi city water supplies pipelines and sewerage lines are passing crisscrossed, since either of the two networks defective or completed their planned physical lives, therefore there is continuous mixing of sewerage water with fresh waters. Another reason of mixing of this sewerage water with fresh waters may be due extensive careless civil work in the city legally or illegally. Estimation for unaccounted water from the treatment plants to the consumers vary from 40 to 70 %, with a substantial portion making up the leakage [5]. Leakage from the sewerage lines seemingly greater than drinking water flowing in the supply lines. Consequently when drinking water supply is interrupted, the water from the sewerage lines or from the surrounding subsurface area may enter into the water supply lines. Since the pressure from main supply source in most of the cases is insufficient so majority of the consumers compelled to use suction pump (donkey pump) to withdraw water from the lines which may be one of the causes for further mixing sewerage water with fresh water. The under ground water tanks also receive contamination through seepage from the surrounding areas. Moreover, consumers never take care about the regular and proper cleaning of underground and overhead water tanks of their residences due to lack of awareness [6]. According to a survey report by KDA, 70 % of the underground water tanks in old city areas of Karachi have been found to be contaminated by fecal organisms [6].

Experimental

To achieve the objectives of the current study, we have conducted our study according to the devaluation plan of City District Government Karachi, total ninety-seven water samples were collected from eighteen towns. There are three major sources of water supply to Karachi as depicted in Table 1. This study based on Korangi, Landhi and

Malir towns and samples collected from the consumer's ends of these towns. All samples were analyzed in the Environmental Protection Agency, Monitoring Laboratory Karachi and HEJ Research Institute of Chemistry, International Center for Chemical and Biological Sciences, Karachi.

Water samples for the bacteriological analysis were collected in sterilized water sampling bags containing sodium thiosulfate in Nasco WHIRL PARK-B 1040, in a way to neutral 8 ze, the effect of residual chlorine, if any and to avoid any possible contamination from out side environment.

Sample bags were labeled properly assigning a sample ID number and placed in icebox, maintaining temperature at 4-8 °C and transport to the laboratories and analysis were completed within 12 h. Free and combined chlorine residuals were determined with a (HACH) DR-2010 Spectrophotometer (model No. 8021), using the *N,N*-diethyl-*p*-phenylene diamine colori-metric technique [7]. Temperature of all water samples was determined upon collection with YSI-Telethermometer 400 series. All bacteriological techniques, time and temperature of incubation confirmed [8]. Standard multiple tube fermentation techniques were used for bacteriological analysis of total coliforms and fecal Coliform [9].

In the multiple tube method a series of tubes containing the volume of 10, 1.0 and 0.1 ml inoculated into two sets of 9 or 15 tubes, containing the suitable broth culture media with test portion of water sample.

Presence/ Absence Test

Presence/ absence test was carried out according to literature protocol [9]. The ColiQik MPN test used a specified number of tubes to statistically predict the number of organisms present. ColiQuilk features the 5-in-1 test tube unit, which consisted of five tubes method together into one, easy to handle unit. Each tube contained a specified amount of ONPG-MUG medium. Sample was added to the prescored fill-line one each of the tubes then the tubes were incubated and examined for a positive response indicative of organism growth. A yellow color after incubation indicates total coliforms and fluorescence under long-wave ultraviolet light indicated *E. coli*. Based on the number of tubes that gave a positive result, the most probable number of organisms present was determined using a table of statistically determined number.

Fecal Coliform detection method

Fecal Coliform Method No. 8001 (Hach) was used to distinguish between total Coliform organisms and fecal Coliforms. EC Medium was used for rapid test identification of fecal Coliform according to literature procedure [10]. This method was based on the normal MPN procedure in which lactose broth was used as a presumptive medium, however, the tubes were incubated directly in a water bath at 44 ± 0.5 °C without prior testing for total Coliforms at 35 - 37 °C for 24 h [11]. Ten-tubes test was required for USEPA reporting. Add 10 ml of sample into each of the tubes with a sterile pipette without touching the open end of the tube or the inside of the caps.

Immediately after addition of sample, shake well the tubes for thorough mixing of the sample with the nutrient medium and make sure the tube was upright position and the Durham tube (inner tube) was full of liquid with no air bubbles. The tubes must be kept upright (caps up with the Durham tubes inverted) for the rest of the operation. Place the presumptive tubes in dry atmosphere or other incubator at a temperature of 35 ± 0.5 °C.

After 1 h, Durham tubes were examined for trapped air and then continue incubation. At the end of 24 ± 2 h, each tube was opened gently and examine for gas. The cloudy broth appeared and the Durham tubes contained gas bubbles then coliform bacteria were presumed to be present. During this period, if no gas was present, the tubes were further incubated and again monitored after a total of 48 ± 3 h. Formation of gas in any amount led to a positive test and absence showed a negative test.

The confirmation test was carried out to eliminate a false positive result that sometimes occurs when the presumptive test is used alone. Each test was carried out in triplicate.

Conclusion

The present study showed that the drinking water quality in Karachi region is far away from the WHO guidelines. In the interest of public health, supplies should be examined regularly to confirm that they are free from the organisms, which are

hazardous for public health. Regular monitoring of the chlorine level in water supplies either from filtration plants or reservoirs should be ensured to maintain up to its threshold limits. Masses should be educated about the importance of the quality of drinking water and its impacts on human health.

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