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Chemical Analysis of Under Ground Water of Faisalabad City Sector-I (Areas Along Canal Rakh Branch From Manawala-Abdullahwala Bridge)

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Abstract

The present project was envisaged to provide guidelines for safe human consumption of underground water and to assess the presence of natural and anthropogenic throw out of pollutants into the hydro-environment. Water from all the localities had high concentration of chemical oxygen demand (COD), sodium and potassium. Most of the other parameters were within the permissible limit with a few exceptions. The situation therefore call for immediate corrective measures to save the citizens from impending health hazards. Piped and treated water supply, proper sewage disposal and strict sanitation measures are the immediate remedies required.

Introduction

Quality and quantum of the potable water are the most inescapable essentials of human sustenance. In fact water quality is a prerequisite to all life. Agro-development, industrial growth and economic expansion have provided irrefutable support to human life but they have also been discovered as exterminators and have to be taken cautiously (Katyal and Satake, 1990). Industrial effluent, city waste, agro-pesticides, chemical fertilizers, waste gases, untreated sewage and excessive salinization are now widely recognized health hazards. Water being an excellent solvent and carrier becomes the first hand source of disease and pestilence (Tyagi and Mehra, 1990). This type of health hazard becomes all the more acute in thickly populated industrial cities like Faisalabad. The city of Faisalabad has grown ten fold in the last five decades and now has a population of over three million presenting a typical scenario of highly industrialized and commercialized society of Pakistan. The resource management is thus not in step with the population expansion. The demand for potable water, for instance, is far more than can be met through municipal setup. Nearly half of the population is thus denied of piped in water supplies, privately managed water points are suspected health hazards and have never been precisely monitored for ill effects. The present study was, therefore, envisaged to sample locations for physico-chemical analysis of potable underground water to assess its suitability for domestic use.

Materials and Methods

Twenty different localities (Table 1) were selected and three samples were collected from each locality of Faisalabad city sector I (Areas along canal Rakh branch from Manawala to Abdullahwala bridge). The samples were analyzed for various physical and chemical parameters like pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), chemical oxygen demand (COD), hardness, some anions (Cl^- , NO_3^- , HCO_3^- , CO_3^{2-} , SO_4^{2-}) and some cations (Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Fe^{2+} , Mn^{2+} , Zn^{2+}).

Table 1: Sample Locations sample

Sample	Name of Location	Replication
1.	Faisal Gardens	3
2.	Manawala	3
3.	Amin Town	3
4.	Mansoorabad	3
5.	Abdullahpur	3
6.	Railway colony	3
7.	Canal colony	3
8.	Iron market	3
9.	Samanabad	3
10.	Nawaban Wale	3
11.	Green View colony	3
12.	Canal park	3
13.	Khyaban colony	3
14.	Medina Town	3
15.	Khalsa college	3
16.	Peoples colony #1	3
17.	Jhal Khanuwana	3
18.	Daar-ul-Ahsan	3
19.	Dee type colony	3
20.	Mundi quarters	3

pH was determined by using pH meter while conductivity was determined by conductivity meter. Evaporation method was employed for TDS (Greenberg *et al.*, 1992). Dissolved oxygen (DO) and chemical oxygen demand (COD) were analyzed by using DO meter and COD apparatus respectively (Greenberg *et al.*, 1992). EDTA titrimetric method was used to analyze hardness of water (Greenberg *et al.*, 1992). Chloride, carbonate and bicarbonate were analyzed by titration method using AgNO_3 and H_2SO_4 respectively. Turbidimetric method was used to estimate sulphate in water (Rump and Krist, 1992) while calorimetric method was used to estimate nitrate (Greenberg *et al.*, 1992). Flame photometer was proved useful to estimate Na^+ and K^+ while Ca^{2+} and Mg^{2+} were determined by EDTA titrimetric method (Greenberg *et al.*, 1992). A sophisticated technique of flame atomic absorption

spectrophotometry was employed for the estimation of Fe^{2+} , Mn^{2+} and Zn^{2+} in the samples of water (Greenberg *et al.*, 1992).

Results and Discussion

The present study was undertaken to determine the suitability of water for domestic consumption. The

samples collected from selected sample locations were analyzed for different water quality parameters. The precise estimation and analysis of these parameters was obtained and statistically analyzed to visualize it for continuous human use.

pH of the (Table 2) samples was found to range between 7.1 B 8.1 which is well within the permissible limits. pH

Table 2: Analytical results of physico-chemical parameters

Sample No.	pH	EC	TDS	DO	COD	Hardness
Standard value	6-8.5	500-1500 $\mu\text{Mho/cm}$	500 ppm	6 ppm	4ppm	250 ppm
1.	7.14	630	346	6.54	39.89	170
2.	7.2	1450	847	6.32	39.86	246
3.	7.1	3400	1870	5.97	39.35	252
4.	7.1	3160	1738	5.06	40.132	303
5.	7.1	1280	704	6.13	40.914	223
6.	8.1	4541	2486	6.79	39.60	209
7.	7.4	1170	643	6.25	37.45	258
8.	8.0	740	407	7.21	39.92	206
9.	7.6	1670	918	6.60	40.26	175
10.	7.5	1890	1039	6.02	40.979	290
11.	7.4	910	500	6.37	45.102	159
12.	8.1	583	1060	6.12	48.009	184
13.	7.2	1610	885	6.10	33.248	258
14.	7.6	1620	891	5.60	40.379	216
15.	7.7	1460	803	6.96	36.947	218
16.	7.73	3240	1780	5.87	38.735	220
17.	7.5	1020	561	5.31	37.790	184
18.	7.56	1210	665	5.66	37.840	223
19.	7.7	710	390	6.67	38.239	166
20.	7.6	810	445	6.25	37.673	210

Table 2a: Statistical analysis (t-test) of physico-chemical parameters

Sample No.	pH	EC	TDS	DO	COD	Hardness
1.	-253.56 ^{NS}	-1506.88 ^{NS}	-278.70 ^{NS}	61.99**	3108.09**	-69.28 ^{NS}
2.	-147.03 ^{NS}	-41.33 ^{NS}	400.68**	8.24**	324.87**	-4.00 ^{NS}
3.	-41 8.99 ^{NS}	1645.45**	1187.97**	-5.20 ^{NS}	2003.87**	2.31*
4.	-156.85 ^{NS}	2490. 50**	2035.29**	-45.16 ^{NS}	446.99**	45.90**
5.	-139.00 ^{NS}	-19.53 ^{NS}	267.10**	11.09*	532.75**	-23.30 ^{NS}
6.	-8.66 ^{NS}	151.99**	3870.18**	45.61**	777.30**	-45.73 ^{NS}
7.	-19.05 ^{NS}	-330.00 ^{NS}	165.70**	2.01*	990.02**	6.93**
8.	-8.66 ^{NS}	-658.18 ^{NS}	-161.08 ^{NS}	79.21**	652.20**	-28.80 ^{NS}
9.	-17.32 ^{NS}	63.94**	589.87**	39.28**	658.37**	-84.66 ^{NS}
10.	-31.34 ^{NS}	255.31**	760.42**	0.96*	624.03**	27.99**
11.	-18.96 ^{NS}	-590.00 ^{NS}	0.87 ^{NS}	0.04*	27.17**	-102.81 ^{NS}
12.	-3.78 ^{NS}	-630.66 ^{NS}	364.23**	8.06*	28.28**	-74.46 ^{NS}
13.	-36.16 ^{NS}	381.05**	530.18**	11.72*	919.76**	9.83**
14.	-1.20 ^{NS}	692.71**	776.84**	-27.07 ^{NS}	1031.19**	-37.80 ^{NS}
15.	-13.14 ^{NS}	-100.94 ^{NS}	641.14**	80.43**	661.81**	-17.95 ^{NS}
16.	-23.00 ^{NS}	1139.10**	1678.53**	-1.38 ^{NS}	1312.68**	-16.82 ^{NS}
17.	-17.23 ^{NS}	-474.20 ^{NS}	55.66**	-33.87 ^{NS}	467.99**	-43.21 ^{NS}
18.	-28.00 ^{NS}	-206.97 ^{NS}	202.19**	-11.25 ^{NS}	417.15**	-23.38 ^{NS}
19.	-13.86 ^{NS}	-517.80 ^{NS}	-181.94 ^{NS}	30.80**	726.22**	-41.10 ^{NS}
20.	-77.94 ^{NS}	-690.00 ^{NS}	-48.49 ^{NS}	21.36*	1291.89**	-34.64 ^{NS}

ND = Note Detected NS = Non Significant * = Significant ** = Highly Significant

Table 3: Analytical results of Anions

Sample No.	Cl ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₃ ²⁻	HCO ₃ ⁻
Standard value	250 ppm	45 ppm	200 ppm	250 ppm	250 ppm
1.	14.5	N.D.	15	N.D.	400
2.	92.0	11.99	73	N.D.	510
3.	650.0	N.D.	74	N.D.	650
4.	415.9	12.41	75	N.D.	610
5.	111.3	12.39	40	N.D.	419
6.	650.0	9.283	72	N.D.	710
7.	82.6	N.D.	37	N.D.	450
8.	21.6	N.D.	21	N.D.	430
9.	122.3	10.63	71	N.D.	430
10.	179.0	12.44	78	N.D.	400
11.	35.0	N.D.	68	N.D.	350
12.	70.3	N.D.	36	N.D.	500
13.	91.6	12.66	69	N.D.	500
14.	86.3	N.D.	78	N.D.	569
15.	149.6	10.26	44	N.D.	479
16.	249.0	12.45	73	N.D.	569
17.	70.6	10.62	39	N.D.	390
18.	108.3	11.24	43	N.D.	448
19.	48.3	N.D.	31	N.D.	389
20.	96.3	N.D.	17	N.D.	310

Table 3a: Statistical analysis (t-test) of Anions

Sample No.	Cl ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₃ ²⁻	HCO ₃ ⁻
1.	-271.93N.S.	-	-733.13N.S	-	150**
2.	-273.66N.S.	-3301.03N.S.	-1 17.75N.S	-	179.23**
3.	692.82**	-	-148.15N.S	-	153.94**
4.	66.63**	-2133.51N.S	-103 .33N.S	-	219.21**
5.	-95.44N.S.	-5648.36N.S	-134.11N.S	-	116.77**
6.	261.86**	-807. 5N.S	-204.96N.S	-	301.14**
7.	-139.23N.S.	-	-146.18N.S	-	138.11**
8.	-342.50N.5.	-	-337.33N.S	-	204.86**
9.	-145.89N.S.	-2365.77N.5	-84.45N.S	-	86.47**
10.	-61.49N.S.	-2708.50N.S	-82.38N.S	-	98.26**
11.	-124.13N.S.	-	-101.43N.5	-	86.60**
12.	-203.72N.S.	-	-325.84N.S	-	284.23**
13.	-131.74N.S.	-3.00N.S	-64.13N.S	-	123.63**
14.	-136.18N.S.	-	-461.12N.S	-	276.26**
15.	-113.77N.N	-2005.70N.S	-203.94N.S	-	113.11**
16.	-1.73N.S.	-2130.89	-181.43N.S	-	552.25**
17.	-96.63N. S.	-5954.65N.S	-348.54N.S	-	79.56**
18.	-116.63N.S.	216.50**	-142.56N.5	-	165.30**
19.	-167.80N.S.	-	-181.89N.3	-	68.88**
20.	-127.86N.5.	-	-168.72N.S	-	5.48**

provides the information about acidity or alkalinity of water (Greenberg *et al.*, 1992). It provides a mean of classifying and for collecting other characteristics or behaviour such as corrosive activity (Ghandour *et al.*, 1985). The conductivity analysis however, revealed a wide range of 630 B 4520 $\mu\text{mho/cm}$ and 35% of the samples were above the permissible limit (Table 2a). High value of conductivity means the presence of excess of minerals and dissolved matter in the water (Greenberg *et al.*, 1992). Water with EC

higher than 1500 $\mu\text{mho/cm}$ is harmful for human health (Tyagi and Mehra, 1990). The values recorded for TDS has shown as 75 per cent of the samples transgressed the permissible limit having reading above 500 ppm. Total dissolved solids are very important for the assessment of water for domestic use (Sawyer *et al.*, 1994).

The level of DO in the samples under study ranged from 5.07 B 7.21 ppm (Table 2) in which only 30 percent of the samples were within the standard limit while the bulk was

Table 4: Analytical results of Cations

Sample No.	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺	Fe ²⁺	Mn ²⁺	Zn ²⁺
Standard values	12 ppm	8 ppm	100 ppm	50 ppm	0.3 ppm	0.05 ppm	5.0 ppm
1.	60.0	12.0	56.6	6.72	N.D.	N.D.	0.190
2.	210.0	22.3	84.2	8.06	0.18	N.D.	0.02
3.	660.0	27.6	100.6	0.45	0.08	N.D.	0.05
4.	580.3	30.0	59.4	34.28	0.08	N.D.	0.05
5.	160.6	19.0	56.9	17.88	N.D.	N.D.	0.06
6.	120.6	15.7	64.3	11.33	0.08	N.D.	0.01
7.	350.0	18.6	96.7	4.87	N.D.	N.D.	0.30
8.	120.0	15.0	49.5	18.53	0.03	N.D.	0.17
9.	350.0	24.0	65.7	2.69	0.03	N.D.	0.10
10.	299.6	17.3	58.5	32.14	0.02	N.D.	0.30
11.	220.3	7.3	66.4	7.61	0.01	N.D.	0.02
12.	289.3	13.0	66.2	4.48	N.D.	N.D.	-
13.	509.3	19.3	76.9	14.74	0.03	N.D.	0.19
14.	339.6	25.0	68.0	10.83	N.D.	N.D.	0.03
15.	280.0	26.3	101.6	1.59	N.D.	N.D.	0.33
16.	777.3	23.0	76.1	6.65	0.13	N.D.	0.01
17.	149.3	29.0	72.8	3.14	0.05	N.D.	0.11
18.	160.0	17.6	82.5	4.05	0.03	N.D.	0.01
19.	80.6	4.0	58.6	4.73	N.D.	N.D.	0.20
20.	89.3	11.3	79.3	2.69	0.03	N.D.	0.07

Table 4a: statistical analysis (t-test) of Cations

Sample No.	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺	Fe ²⁺	Mn ²⁺	Zn ²⁺
1.	48.00**	6.93**	-146.26N.S	-2833.35N.S	-	-	-14428.97N.S
2.	342.95**	11.93**	-11.64N.S	-1023.74N.S	-11.92N.S	-	-826.56N.S
3.	311.29**	22.30**	2.03*	-3243.81N.S	-144.02N.S	-	-428.68N.S
4.	322.21**	38.11**	-126.21N.S	-21.96N.S	-220.00N.S	-	-2377.90N.S
5.	102.32**	9.53**	42.25N.S	-43.44N.S	-	-	-4940.00N.S
6.	123.22**	23.56**	-50.32N.S	-126.68N.S	-144.02N.S	-	-864.29N.S
7.	3.38**	12.09**	-3.15N.S	-96.34N.S	-	-	-307.69N.S
8.	70.70**	6.06 ⁴ *	-171.5N.S	-84.25N.S	-129.70N.S	-	-667.66N.S
9.	221.27**	10.47**	-21.70N.S	-3097.17N.S	-176.76N.S	-	-490.00N.S
10.	326.18**	326.18**	-110.03N.S	-150.14N.S	-242.49N.S	-	-307.69N.S
11.	312.50**	-2.0N.S	-26.89N.S	-54.44N.S	-50.23N.S	-	-3260.17N.S
12.	191.10**	8.66**	-17.83N.S	-5160.7N.S	-	-	N.D.
13.	413.18**	12.86**	-33.90N.S	-142.31N.S	-176.76N.S	-	-416.56N.S
14.	371.54**	14.72**	-47.93N.S	-90.75N.S	-	-	-860.83N.S
15.	268.00**	65.00**	5.01*	-183.85N.S	-	-	-808.87N.S
16.	280.50**	12.99**	-46.89N.S	-214.26N.S	-33.78N.S	-	-864.29N.S
17.	114.27**	36.37**	-18.96N.S	-3867.69N.S	-85.29N.S	-	-887.87N.S
18.	256.34**	10.96**	-85.99N.S	-1320.17N.S	-270.00N.S	-	-499.00N.S
19.	47.26**	-6.93N.S	-79.58N.S	-174.72N.S	-	-	-480.00N.S
20.	87.69**	10.00**	-113.33N.S	-5363.79N.S	-176.76N.S	-	-1613.72N.S

exceeding this limit. However, excess of DO might not be harmful for health. Usually underground water lacks dissolved oxygen (Campbell and Bower, 1996). Very low concentration of DO supports the growth of anaerobic micro-organisms and limits the purification capacity of the water (Sawyer *et al.*, 1994). Values computed of COD (Table 2) stood between 33.2 B 48.17 ppm presenting a sure sign of organic contamination in water making it harmful for human consumption. Hardness determination

revealed that 20 percent of the samples had concentration above the standar range, i.e., 250 ppm. A wider range of chloride concentration was however, observed in the samples under study. Values being 14 B 652 ppm (Table 3) chloride can be used as a pollution indicator when considered together other parameters (Rump and Krist, 1992). Excess of chloride ions causes hypertension (Katyal and Satake, 1990). Nitrates, the cause of various health hazards were within

the permissible limit (45 ppm) with maximum concentration of 12.66 ppm. In fact nitrate contents were not in detectable in 45 percent samples (Dey, 1989). Carbonate ions were absent while all the samples excelled the permissible limit of bicarbonates having a range of 310 B 710 ppm (Table 3a). Bicarbonates represent the major form of alkalinity. They are corrosive to metal pipe, boiler, heaters and other house hold and industrial equipment (Greenberg *et al.*, 1992). The sulphate concentration varied from 15.5 B 78 ppm (Table 3) and was within the permissible limit of 250 ppm. Excess of sulphate causes cathartic effect upon humans (Sawyer *et al.*, 1994). The analysis of sodium was also suggestive of alarmingly high concentration range of 60 to 780 ppm (Table 4) whereas the permissible limit for it is only 12 ppm. Sodium in excess produces a state of alkalosis, high blood pressure and certain other diseases are also stimulated by it (Greenberg *et al.*, 1992). Immediate corrective measures are needed for sodium treatment. Same is true for potassium where only 15 percent of samples were observed to fit the safe limits of below 8 ppm. Excess of potassium causes cardiac arrest, small bowel ulcers and dehydration (Tyagi and Mehra, 1990).

Calcium concentrations of only 10 percent samples were above the permissible limit of 100 ppm (Table 4a). Magnesium, an important contributor of hardness has a permissible limit (Table 4) of 50 ppm and all the samples had concentration well within this limit as it is varied only between 0.45-34.94 ppm. Magnesium was not detected in any sample while concentration of iron and zinc was within the safe limits of 0.3 ppm and 5 ppm respectively. These results show that no damage either to health or economy can occur due to these metals, as they were present only in traces.

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