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Microbial Contamination in Drinking Water of Saggiyan-Lahore, Pakistan

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Abstract: The present study was carried to evaluate the physico-chemical parameters and microbial contamination of drinking water in the area of Saggiyan, Lahore. The tested water samples (S1-S30) were found to contain 199.6-402 mg/L TDS, 196-260 ppm EC, 196-260 ppm Hardness, 0.8-17 NTU turbidity, 169-290 mg/L alkalinity, 0-0.1 ppb arsenic and 0-0.1 ppm fluoride contents. 95% of the water samples were found contaminated with fecal coliforms while 27% of the samples had shown the presence of *E. coli*. Though the physico-chemical parameters of most water samples were found in the safe limits of WHO, however, the presence of microbial contamination rendered it non-suitable for drinking purposes.

Keywords: Microbial contamination, drinking water, most probable number (mpn), coliforms.

Introduction

Water is an essential and life-sustaining drink for all living beings (Ahmed et al., 2013; Sudarsan et al., 2018). Water resources are greatly degrading due to many anthropogenic activities like urbanization, excessive use of fertilizers, industrialization, mining and improper disposal of waste (Ali et al., 2012; Daud et al., 2017; Singare et al., 2014). Microbial contamination of drinking water is commonly observed in various parts of the world (Pu et al., 2016; Ashbolt, 2015) and is considered one of the most serious threats to human health (Nabeela et al., 2014). It may cause severe health issues like dysentery, hepatitis, gastroenteritis, cryptosporidium infections, diarrhea, intestinal worms, giardiasis, typhoid etc. (Butt et al., 2007; Daud et al., 2017).

Water contamination has been considered as a leading cause of morbidity and mortality in children of low- and middle-income countries (Nketiah-Amponsah et al., 2017). In the developing countries, the people mostly have no access to the safe drinking water (Ali et al., 2012). In Pakistan, about 70% of rural population is deprived of safe and clean drinking water. The surface and ground waters are mostly contaminated with microbial agents, metals and dangerous chemicals (Ali et al., 2012). Pakistan ranks at 80th number among 122 nations regarding the drinking water quality (Raza et al., 2017). The contaminated water from streams, rivers, lakes or ground water may contains variable quantities of *E.coli*, Total coliform, Fecal coliforms *etc*. (Azizullah et al., 2011; Sudarsan et al., 2018). Presence of these organisms is usually checked by the "Coliform test" and this method is accepted globally to check the microbial contamination (Farooq et al., 2008). The evaluation of pathogenic bacteria in water is of great importance with regard to human health (Antiochia et al., 2015).

This study was carried out to evaluate the physico-chemical parameters and bacteriological/ Microbial contamination owing to total coliforms, fecal coliforms and *E. coli* in drinking water of Saggiyan, Lahore.

Materials and Methods

This Research work was conducted from November 2017 to March 2018. Thirty ground water samples (S1 to S30) were collected from different sites of Saggiyan (Lahore, Pakistan) and were subjected to tests for microbial contamination. The sites of collection along with their respective locations are displayed in Table 1.

A GPS (Global positioning system) was used to find the longitude and latitude of sample locations. Necessary precautions (washing and sterilization of hands) were considered before collecting the water samples. The tap from where water samples were collected, was left open for about five minutes to exit all the previous standing water. The tap was cleaned and closed with tissue paper and also blazed with fire lighter to kill any germs; it was then allowed it to cool. Tap was opened again after cooling and kept on for one more minute. The bottle without touching with water tap, was placed under the tap for filling water samples. After filling the water sample, the bottle was closed with cap tightly. Before every experiment, the glassware was carefully rinsed with deionized water. The pH was calculated and noted by a pH meter at the time of sample collection. The instruments used for the determination of physico-chemical analyses include pH meter (HI 83141) for pH, conductometer (Hanna 2300) for electrical conductivity, turbidity meter (HI83414) for turbidity and atomic absorption

Table 1 Sample collection locations, Saggiyan, Lahore.

Sample code	Site of collection	Location (GPS)	Sample code	Site of collection	Location (GPS)
S1	Bore	N 31̊ 31.074'; E 073̊ 21.279'	S16	Bore	N 31°34.289'; E 074°15.395'
S2	Well	N 31̊34.346'; E 074̊16.391'	S17	Bore	N 31°35.559'; E 074°16.789'
S3	Bore	N 31̊34.297'; E 074̊16.342'	S18	Bore	N 31°34.867'; E 074°16.876'
S4	Bore	N 31̊34.462'; E 074̊16.563'	S19	Bore	N 31°345.778'; E 074°15. 898'
S5	H. pump*	N 31̊34.552'; E 074̊16.580'	S20	Bore	N 31°34.879'; E 074°15.687'
S6	Bore	N 31̊34.768'; E 074̊15.778'	S21	Bore	N 31̊ 34.076'; E 073̊ 21.299'
S7	Well	N 31̊34.741'; E 074̊15.762'	S22	Bore	N 31̊35.385'; E 074̊15.389'
S8	Bore	N 31̊34.842'; E 074̊15.658'	S23	Bore	N 31̊35.399'; E 074̊16.386'
S9	Tap	N 31̊35.925'; E 074̊15.925'	S24	Bore	N 31̊35.497'; E 074̊16.598'
S10	Bore	N 31̊35.94'; E 074̊16.030'	S25	Bore	N 31̊35.762'; E 074̊15.823'
S11	Bore	N 31°35.786'; E 074°15.785'	S26	Well	N 31̊34.985'; E 074̊16.785'
S12	H. pump*	N 31°35.741'; E 074 16.681'	S27	H. pump*	N 31̊35.942'; E 074̊16.758'
S13	Bore	N 31°35.468'; E 074°16. 581'	S28	Bore	N 31̊34.946'; E 074̊15.830'
S14	Bore	N 31° 34. 552'; E 074°16. 342'	S29	H. pump*	N 31̊36.825'; E 074̊16.525'
S15	H. pump*	N 31°35.769'; E 074°16.382'	S30	Well	N 31̊36.845'; E 074̊15.968'

H. pump* = Hand Pump

spectrometer (210VGP AAS, USA) for arsenic and fluoride contents.

The Most Probable Number (MPN) method was used to identify the total coliform, fecal coliform and *E. coli* in the potable water samples. In the MPN method, the measured volume of water sample is tested in differential prepared liquid media for counting bacteria. After incubation, those tubes which receive one or more organisms viable in the incubated inoculum are considered to have some growth and then the most probable number samples are counted. Brilliant Green lactose bile (BGLB) growth media was used for total coliform detection. The EC broth was used for the fecal coliform detection and determination. Levine Eosin-Methylene Blue (L-EMB) agar was used for confirmation of *E.coli*.

Results and Discussion

30 water samples (S1-S30) were collected from various regions of Saggiyan, Lahore (Pakistan) and subjected to physico-chemical and microbiological tests. The obtained results for pH, TDS, EC, hardness, turbidity, alkalinity, arsenic and fluoride contents are summarized in Table 2.

The pH values of the investigated samples were found

Table 2 Physical and chemical parameters of tested water samples (S1-S30).

Sample Code	pH	TDS (mg/L)	EC (mS/cm)	Hardness (ppm)	Turbidity (NTU)	Alkalinity (mg/L)	Arsenic (ppb)	Fluoride (ppm)
S1	7	255.94	382	200	0.80	248	BDL*	0.1
S2	7.26	308.2	468	216	2.8	290	0.05	0.05
S3	7.6	199.6	298	228	1.5	252	0.1	0.08
S4	7.92	254.6	380	244	1.2	280	0.05	BDL*
S5	8	266.6	398	200	1.5	260	0.06	0.06
S6	7.69	244.5	362	196	2.5	189	0.06	0.07
S7	7.58	293.4	438	240	17	236	0.1	0.1
S8	7.64	268	400	260	1.5	278	0.5	0.08
S9	7.9	247.9	370	240	2.5	268	0.1	BDL*
S10	7.92	258.6	386	236	3	276	0.06	0.05
S11	7	260	385	200	2.8	250	0.05	0.1
S12	7.27	402	470	216	0.80	290	0.1	0.05
S13	7.60	209	298	228	1.5	252	0.05	0.08
S14	7.92	254.6	380	244	1.2	280	0.06	BDL*
S15	8.0	268.6	398	200	1.5	260	BDL*	0.06
S16	7.69	245.6	362	196	2.5	188	0.06	0.07
S17	8	293.46	438	240	7	236	0	0.1
S18	7.64	268	400	200	1.5	278	0.05	0.09
S19	8	247.9	370	236	2.5	268	0.1	BDL*
S20	7.92	260.5	386	238	4	276	0.05	0.05
S21	8	258.6	382	200	3.5	280	0.1	0.05
S22	7.92	255	460	240	5	268	0.1	0..05
S23	7.64	308.2	298	196	2.5	278	0.05	BDL*
S24	8	199.6	380	200	2.8	236	0.06	0.09
S25	7.69	266.6	398	244	0.80	188	0.06	0.1
S2	8.0	254.6	362	228	7	260	0.05	0.07
S27	7.92	242.54	438	216	4	280	0.1	0.06
S28	7.60	293.46	400	200	2.5	252	0.05	BDL*
S29	7	268	370	196	4	290	0.1	0.05
S30	7.27	258.2	386	240	3.6	168	BDL*	0.1

*BDL = Below detection limit

Table 3 Total Coliforms in tested water samples (S1-S30).

Sample No.	BGLB tubes Confirmed Coliforms			MPN index/ 100ml of sample	Sample No.	BGLB tubes Confirmed Coliforms			MPN index/ 100ml of sample
	o.1 ml	1 ml	10 ml			o.1 ml	1 ml	10 ml	
S1	2	0	3	49	**S16**	3	3	2	44
S2	3	2	3	137.9	**S17**	2	2	3	116.7
S3	3	3	2	44	**S18**	1	2	3	95
S4	2	2	3	116.7	**S19**	3	1	3	85
S5	2	3	3	444.4	**S20**	3	3	2	44
S6	3	3	2	44	**S21**	3	3	2	44
S7	2	2	2	116.7	**S22**	3	1	3	85
S8	1	2	3	95	**S23**	1	2	3	95
S9	3	1	3	85	**S24**	2	2	3	116.7
S10	3	3	2	44	**S25**	3	3	2	44
S11	2	0	3	49	**S26**	2	3	3	444.4
S12	3	3	3	137.9	**S27**	2	2	3	116.7
S13	3	3	2	44	**S28**	3	3	2	44
S14	2	3	3	116.7	**S29**	3	2	3	137.9
S15	2	3	3	444.4	**S30**	2	0	3	49.0

in the range of 7.0-8.0 (Fig. 1). The observed values were lying within the standard limits (6.5 to 8.5) of WHO (Edition, 2011).

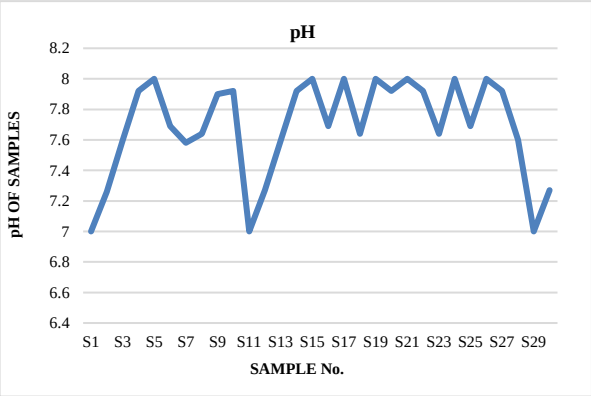

Fig. 1 Graphical Representation of pH of water samples (S1-S30)

The tested water samples (S1-S30) were found to contain the 199.6-402 mg/L TDS, 196-260 ppm EC, 196-260 ppm hardness, 0.8-17 NTU turbidity, 169-290 mg/L alkalinity, 0-0.1 ppb arsenic and 0-0.1 ppm fluoride contents. With few exceptions, most of the tested samples were found to possess these values within the standard limits of WHO i.e., TDS (<1000 mg/L), EC (<400 µS/cm), total hardness (<500ppm), turbidity (<5NTU), alkalinity (20-200 mg/L), arsenic (<0.01 ppb) and fluoride (<1.5 ppm) contents (Edition, 2011; Meride and Ayenew, 2016).

Evaluation of Total Coliforms

The results have shown that all the samples were highly contaminated with microorganisms (Table 3). More than 95% of the water samples were microbiologically contaminated with total coliforms. The amount of total coliform was lying from 44 to 444 MPN/100ml of water sample which if far beyond the standard limits of WHO (Edition, 2011). According to WHO, there should be zero presence of any coliform in every 100 ml of water sample (Edition, 2011).

Table 5: Positive combination of E. coli tubes and MPN value for different samples

S.No	Sample code	L-EMB Agar (Confirmation of *E.coli*)
1	S1, S3, S6-S11, S13, S16-S24, S25, S28, S30	Negative
2	S2, S4, S5, S12, S14-S15, S26-S27, S29	Positive

Total %age of positive sample = 27%
Total %age of negative sample = 73%

Table 4 Fecal coliforms in tested water samples (S1-S30).

Sample No.	EC Tubes Confirmation of Fecal Coliforms			MPN index/ 100ml of sample	Sample No.	EC Tubes Confirmation of Fecal Coliforms			MPN index/ 100ml of sample
	o.1 ml	1 ml	10 ml			o.1 ml	1 ml	10 ml	
S1	2	0	3	49	**S16**	2	1	2	24.9
S2	1	3	3	269	**S17**	2	1	1	14.8
S3	1	3	2	32.6	**S18**	1	2	2	25.9
S4	2	2	3	114.8	**S19**	2	1	2	24.9
S5	3	2	3	137.9	**S20**	3	1	3	27.1
S6	2	1	2	24.9	**S21**	3	2	1	26
S7	2	1	1	14.8	**S22**	2	1	2	24.9
S8	1	2	2	25.9	**S23**	1	2	2	25.9
S9	2	1	2	24.9	**S24**	2	1	1	14.8
S10	3	3	1	27.1	**S25**	2	1	2	24.9
S11	2	0	3	49	**S26**	3	2	3	137.9
S12	1	3	3	269	**S27**	1	3	2	114.8
S13	1	3	2	32.6	**S28**	1	3	2	32.6
S14	2	2	3	114.8	**S29**	1	3	3	269
S15	3	2	3	137.9	**S30**	2	0	3	49

Evaluation of Fecal Coliforms

The water samples (S1-S30) were also examined for the confirmation of fecal coliforms. It was observed that all the investigated samples were contaminated with fecal coliforms from 14.8MPN/100mL (lowest) to the highest 269 MPN/100mL (Table 4).

Evaluation of *E. coli*

The fecal coliform samples (S1-S30) were finally examined for the confirmation of *E. coli*. It was found that 27% samples (9 samples out of total 30 samples) were contaminated with *E. coli* whereas remaining 73% samples (21 samples out of total 30 samples) have not shown the presence of *E. coli*. It was demonstrated that the samples (S2, S4, S5, S12, S14-S15, S26-S27, S29) containing higher amount of fecal coliform have shown the presence of *E. coli*. It was observed that the samples (S1, S3, S6-S11, S13, S16-S24, S25, S28, S30) did not demonstrate the presence of *E. coli* although they had total coliforms (Table 5).

Conclusion

The water samples collected Saggiyan area, Lahore were evaluated for physicochemical parameters and microbiological analysis. The tested water samples (S1-S30) were found to contain 199.6-402 mg/L TDS, 196-260 ppm EC, 196-260 ppm hardness, 0.8-17 NTU turbidity, 169-290 mg/L alkalinity, 0-0.1 ppb arsenic and 0-0.1 ppm fluoride contents. The water of Saggiyan, Lahore was found contaminated with microbial contamination and thus unfit for drinking purposes. Government of Pakistan should take serious steps to ensure the clean drinking water and thus the safety of people in the investigated region.

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