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SHORT COMMUNICATION

Drinking Water Quality Assessment of Metro Bus Stations of Islamabad and Rawalpindi

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Introduction

Water is the most wonderful substance. Almost 70% of our planet consists of water. The human body comprises almost 60% of water. Safe and clean water is necessary for all purposes in daily life which include different practices like washing, drinking, cooking, and personal cleanliness (Frances and Brack, 2018). Water is known as a universal solvent because it can dissolve a large proportion of natural or man-made substances (Balasubramanian, 2015). Fecal contaminated water is the main reason for waterborne disease. With quick urbanization, the chemical feature of water quality has contributed to increasing concerns as toxic chemicals industrial effluents pose a high hazard to life (Alurralde et al., 1998). Pakistan has been blessed with water resources, but unfortunately over the years, industrial development, overpopulation, and rapid growth have decelerated the water resources (Daud et al., 2017). Different studies show that the majority of the supplies of potable water are polluted (Aziz, 2005). Pakistan ranks 80 out of 122 nations, and both ground and surface drinking water sources are polluted throughout the country with toxic metals, microbes, and pesticides (Nabeela et al., 2014). Even currently some rural areas in Pakistan have no availability of fresh and clean water for regular use (Shahid et al., 2014). The quality of drinking water in Pakistan is reducing day by day due to the waste and pollutants released by the industries. Channeled water also gets contaminated because the network of the pipeline is not planned and laid poorly (Imran et al., 2018).

Materials and Methods

The area selected for the study was the metro bus station of Rawalpindi and Islamabad where the water coolers are installed (Fig. 1). The Rawalpindi-Islamabad Metro bus is a 23.2 km (14.0 mi) transport fast travel framework operating in the Islamabad Rawalpindi Metropolitan territory of Pakistan. The 23.2 km land has 10 transport stations in Rawalpindi, and 14 in Islamabad. Water supply in Islamabad and Rawalpindi Metro bus stations are electric water coolers.

A sum of 24 water samples was collected from Islamabad and Rawalpindi Metro bus stations. For microbiological assessment, each sample was collected in a 100 ml sterilized bottle. For physicochemical investigation, 150 ml water samples were collected for each test in plastic bottles. All the samples were moved to the lab for examination where all the tests were carried out according to standard protocols (Apha, 2012).

Temperature, turbidity, EC, pH, total salts TDS, total alkalinity, carbonates, sodium (Na), chloride (Cl), Total Hardness, Calcium (Ca), Magnesium (Mg), total bacteria, *E.coli*, Total coliform, and *Salmonella and Shigella* were tested in water samples.

Results and Discussion

Physical Analysis of Drinking Water Quality

The pH that is considered to be normal for drinking water, as defined by WHO and NDWQS guidelines, is between 6.5 and 8.5. The pH values of all the drinking water samples are found to be in the range between 7.21 and 7.91, where the lowest value is from sample 21 and the highest value is from sample 2 respectively (Table 1). As it is filtered water, its pH is maintained to be neutral. The water sample of Metrobus stations is within the desirable range as per WHO drinking water standards. The perfect water temperature is between 6°C and 12°C. Our water sample value lies between 11°C to 11.5°C, that is desirable, since it lies within the permissible limit.

The EC analyzed for samples of Metro bus stations ranges from 310cm to 675cm, respectively, which is lower than WHO standard 1000 µS/cm accordingly. The TDS analyzed for Metro bus stations drinking water ranged from 220 to 479 which is lower than WHO

standard (500 mg/l). The turbidity analyzed for Metro bus stations drinking water were ranged from 0.00 to 0.33 which is lower than WHO standard <5 NTU (Mann et al., 2007). The permissible limit for salts inside the drinking water is 200 mg/l. The salts analyzed for Metro bus stations drinking water ranged from 155 mg/I to 346mg/I, showing that salts of water samples taken from some of the Metro bus stations are exceeding the permissible limits of WHO. Maximum salts were recorded in the filter cooler of Metro bus station 18 (Rehmanabad).

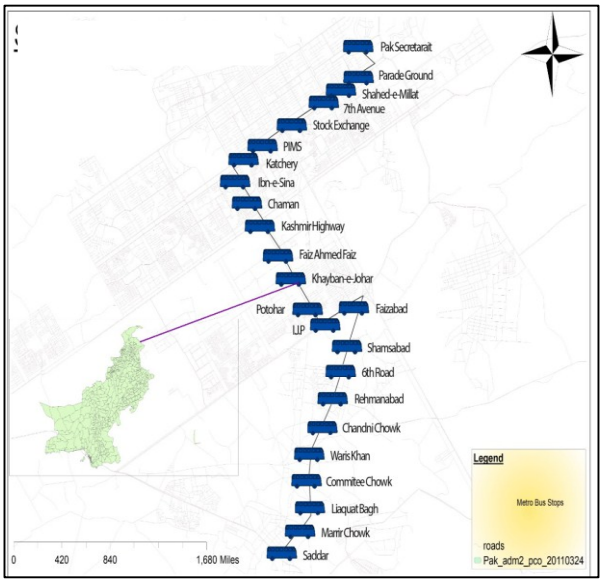

Fig. 1 Sample location map.

Table 1 Result of physical parameters of water samples

Station/ Sample No.	pH	°C	NTU	µS/cm	Conc.(mg/l)	
		Temp.	Turbidity	EC	Salts	TDS
1	7.56	11.3	0.00	454	229	322
2	7.91	11.2	0.00	396	200	282
3	7.67	11.4	0.00	465	234	329
4	7.82	11.0	0.00	580	332	461
5	7.76	11.0	0.00	602	309	430
6	7.64	11.5	0.03	587	300	417
7	7.67	11.5	0.00	581	298	414
8	7.73	11.0	0.00	570	290	405
9	7.75	11.5	0.00	443	224	315
10	7.74	11.2	0.00	462	234	328
11	7.72	11.3	0.00	452	228	321
12	7.76	11.2	0.00	473	239	336
13	7.71	11.0	0.00	470	238	334
14	7.71	11.3	0.00	534	272	379
15	7.58	11.12	0.00	643	329	457
16	7.73	11.2	0.03	468	237	333
17	7.28	11.0	0.00	641	327	455
18	7.40	11.1	0.00	675	346	479
19	7.31	11.0	0.00	603	306	427
20	7.67	11.4	0.00	493	250	350
21	7.21	11.2	0.00	635	325	451
22	7.72	11.2	0.00	326	164	232
23	7.72	11.2	0.33	316	158	224
24	7.80	11.5	0.00	310	155	220
Min	**7.21**	**11**	**0**	**310**	**155**	**220**
Max	**7.91**	**11.5**	**0.33**	**675**	**346**	**479**
Standard	**6.5-8.5**	**30 °C**	**<5**	**1000**	**200**	**500**

Chemical Analysis of Drinking Water Quality

The permissible limit of Cl inside the drinking water is 200 mg/l. The Cl concentrations of samples of Metro bus stations ranged between 13.82 to 60.12mg/l. All the samples collected from Metro bus stations are within the defined limits of WHO (Table 2).

Table 2. Result of chemical parameters of water samples.

	mg/l	mg/l	mg/l					Carbonates(mg/l)			
S.	T.A	T.H	Ca	Mg	NaCl	Na	Cl	$NaHCO_3$	Na_2CO_3	HCO_3	CO_3
1	10.8	2.22	1.66	0.56	58.5	23.05	35.45	0.42	0.53	0.305	0.3
2	7.2	1.08	0.81	0.27	70.2	27.66	42.54	0.504	0.636	0.366	0.36
3	10.4	2.66	1.13	1.53	52.65	20.75	31.91	0.336	0.424	0.244	0.24
4	15.8	0.76	0.48	0.28	46.8	18.44	28.36	0.336	0.424	0.244	0.24
5	13.4	2.36	1.73	0.63	35.45	23.05	35.45	0.588	0.742	0.427	0.42
6	17.8	3.26	2.43	0.83	64.35	25.36	38.99	0.67	0.85	0.488	0.48
7	16.6	3.16	2.17	0.99	46.8	18.44	28.36	0.336	0.424	0.244	0.24
8	16	2.84	1.22	1.62	81.9	32.27	49.63	0.588	0.742	0.427	0.42
9	9.4	2	0.84	1.16	55.57	21.9	33.67	0.67	0.85	0.488	0.48
10	9.8	2.44	1.42	1.02	52.65	20.75	31.9	0.336	0.424	0.244	0.24
11	8.2	2.26	1.59	0.67	76.05	29.97	46.08	0.336	0.424	0.244	0.24
12	11.8	2.48	1.76	0.62	64.35	25.36	38.99	0.84	1.06	0.61	0.6
13	10.4	2.46	1.32	1.14	101.79	41.67	60.12	0.252	0.318	0.183	0.18
14	13.8	2.9	1.75	1.15	81.9	32.27	49.63	0.42	0.53	0.305	0.3
15	15.8	3.72	2.79	0.93	76.05	29.97	46.08	0.84	1.06	0.61	0.6
16	12	2.5	1.33	1.17	64.35	25.36	38.99	0.504	0.636	0.366	0.36
17	16.4	3.8	2.1	1.7	52.65	20.75	31.9	0.924	1.166	0.671	0.66
18	17.8	4.1	2.45	1.65	76.05	29.97	46.08	0.67	0.85	0.488	0.48
19	15.8	3.58	2.69	0.89	64.35	25.36	38.99	1.008	1.272	0.723	0.72
20	11.8	2.5	1.16	1.34	46.8	18.44	28.36	0.588	0.742	0.427	0.42
21	15.2	2.06	0.98	1.08	81.9	32.27	49.63	1.176	1.484	0.854	0.84
22	9.2	1.2	0.53	0.67	40.95	16.77	24.18	0.336	0.424	0.244	0.24
23	7.4	1.3	0.88	0.42	35.1	14.37	20.73	0.504	0.636	0.366	0.36
24	9	1.26	0.93	0.33	23.4	9.58	13.82	0.588	0.742	0.427	0.42
Min	**7.2**	**0.76**	**0.48**	**0.27**	**23.4**	**9.58**	**13.82**	**0.252**	**0.318**	**0.183**	**0.18**
Max	**11.8**	**4.1**	**2.79**	**1.65**	**101.79**	**41.67**	**60.12**	**1.176**	**1.484**	**0.854**	**0.84**
Standard	**200**	**500**	**75**	**50**	**ND**	**200**	**200**	**ND**	**ND**	**500**	**ND**

Sodium concentrations of samples of Metro bus stations ranged between 9.58 to 41.67 mg/l, which is lower than WHO standard (200 mg/l). The carbonates concentrations of samples of Metro bus stations ranged between 0.252mg/1 to 1.176 mg/l for $NaHCO_3$, 0.318 to 1.484 for Na_2CO_3, 0.183 to 0.854mg/1 for HCO_3,mg/1 and 0.18mg/1 to 0.84 mg/1 for CO_3. All the concentrations of samples collected from Metro bus stations are within the permissible limits. The total alkalinity of samples of Metro bus stations ranged between 7.2 to 11.8 mg/l which is lower than WHO standard (200 mg/l) (Edition, 2011). The total hardness of samples of Metro bus stations, ranged between 0.76 to 4.1 mg/l, which is lower than WHO standard (500 mg/l). All the samples collected from Metro bus stations are beyond the defined limits of WHO (Edition, 2011). The calcium concentrations of samples of Metro bus stations ranged between 0.48 to 2.79 mg/l which is lower than WHO standard (100 mg/l). The magnesium concentrations of samples of Metro bus station ranged between 0.27to 1.65mg/l, which is lower than WHO

standard (30 mg/l).

Microbiological Analysis of Drinking Water Quality

Total bacterial count

On average water samples taken from Metro bus stations of Islamabad and Rawalpindi were having less microbial growth (Table 3). This shows that the water is clean except from stations 7 (Katchery), 15 (Faizabad), and 19 (Chandni Chowk) in which microbial growth was observed on the SS agar. There is possibility that the bacterial contamination has been caused by human waste. Another possible reason that pipelines and filter coolers are neither regularly maintained, cleaned nor checked for leakage.

Table 3 Results of microbiological parameters of water samples.

	CFU/ml		
Samples	**NA**	**EMB**	**SS**
1	0	0	0
2	13	0	0
3	6	0	0
4	11	0	0
5	17	0	0
6	5	0	0
7	38	0	12
8	9	0	0
9	18	0	0
10	15	0	0
11	14	0	0
12	0	0	0
13	15	0	0
14	9	0	0
15	22	0	3
16	7	0	0
17	56	0	0
18	20	0	0
19	26	0	5
20	22	0	0
21	8	0	0
22	30	0	0
23	13	0	0
24	49	0	0
Min	0	0	0
Max	56	0	12
Standard	**>100**	**0**	**0**

Conclusion

All the tested physical parameters are within the permissible limits of WHO standards except for the fact that some of the samples have a high concentration of salts. In microbiological analysis, it was observed that the Total Bacteria was within the optimum range, *E. Coli*/ Total Coliforms were absent, *Salmonella/ Shigella* were present in three samples. By considering microbiological parameters, most of the station's water contains gram-positive bacteria and very few of them contain gram-negative bacteria. This shows that the filtered water of the Metro station is suitable for drinking purposes. While in the case of chemical parameters, all the samples are within the permissible limits given by WHO. It clearly shows that the water is clean.

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