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POTABLE WATER QUALITY ASSESSMENT FROM LOCAL RESTAURANTS: STUDY FROM SOUTH CENTRAL COASTAL DISTRICT OF BANGLADESH

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ABSTRACT

This study was conducted to measure physiochemical, i.e., pH, Electrical Conductivity (EC), Total Dissolved Solid (TDS), Chloride (Cl^-), Iron (Fe^{2+}), Sulphate (SO_4^{2-}) and microbial parameters, like Total Viable Bacteria Count (TVBC), Total Coliform Count (TCC), Fecal Coliform (FC), *Salmonella spp.* and *Vibrio spp.* for suitability of drinking water of local restaurants in Noakhali. Total 18 samples were collected from six sampling stations, i.e., Noakhali Science and Technology University Campus (NSTU), Sonapur, Maijdee, Chowrasta, Chowmuhani and Sonaimuri, respectively. The result revealed that pH, EC, TDS, Fe^{2+}, Cl^- and SO_4^{2-} were ranged from 7.19-8.47, 250-6710µs/cm, 130-370mg/l, 0.03-0.15mg/l, 46.79-2602.03mg/l, and 7.01-54.67mg/l, with the mean of 7.61, 2097.78µs/cm, 1077.22mg/l, 0.0566mg/l, 684.03mg/l and 15.40mg/l, respectively. The TVBC, TCC, FC, *Salmonella spp.* and *Vibrio spp.* were ranged from 4×10^4-1.81×10^5 cfu/100ml, 4×10^3-1.67×10^5 cfu/100ml, 0-9.2×10^4 cfu/100ml, 0-1.6×10^4 cfu/100ml, respectively but *Vibrio spp.* were totally absent throughout the study. The correlation between physicochemical and microbial parameters were strongly positive with TDS:EC (r=0.997), EC:Cl^- (r=0.930), TDS:Cl^- (r=0.929) at 0.05 level of significance and significant negative correlation between p^H:EC (r=-0.563), TDS:p^H (r= -0.577), SO_4^{2-}:p^H (r=-0.449), respectively but TVBC and TC were positively (r=0.499) correlated. The study concluded that almost all water samples were contaminated by microbial contamination and all the result of physicochemical parameters were not suitable for consumption that might be a negative impact on human health.

Contribution/Originality: People always consumed potable drinking water from local roadside restaurant during their taking meals/eating. The five microbial parameters (TVBC, TCC, FC, *Salmonella spp.* and *Vibrio spp.*) were counted in this study with six physiochemical parameters. Human health should be decelerated due to consumption of contaminated potable drinking water.

1. INTRODUCTION

Fresh water is crucial for existence of any forms of lives and the demand of potable water is increasing day by day [1] that accelerates water demand with global increasing of world population. Drinking water quality is very important in determining human health [2] as well as environmental health which accelerates/decelerates the total ecosystem of any region. It is characterized as that having satisfactory quality as far as its physiochemical and biological standard parameters that is securely utilized for drinking and cooking purposes [3]. Potable water

quality has continuously been a key issue in various developing countries, like Bangladesh [4]. Bangladesh is blessed with a lot that meet her whole population's demand from both surface and ground water sources. These water sources would be polluted by biological and chemical contaminants arising from different point and non-point sources. Human induced activities pollute surface water and deteriorates the consumptive use for drinking, industrial and agricultural purposes [5]. Globally, fresh water is essential for human consumption but huge portion of the world are underprivileged from pure water including Bangladesh [6]. And this demand will be exceeded by fifty percent in the developing parts of the world by 2030 [7]. Guidelines, rules, policies and regulations involved into water quality are desired to confirm that fresh drinking water should be accessed for all human beings [8]. Most of the water collected from surface or ground is not possible for human consumption without any primary oe secondary sorts of treatment or purification [9] because of surface water pollution and ground water contamination through different chemicals used in agricultural practices and industrial effluents. Proper purification process of raw water (ground/surface) in many countries were not maintained thus, many people were suffered from different water borne diseases [10] in the world as well as in Bangladesh. Raw water existed impurities which is essential to eradicate chemical and microbial contaminants by proper treatment or purification for human consumption [11]. Chemical and microbial contaminated untreated water is consumed continuously by people for drinking in Bangladesh, which may cause several water-borne diseases [12]. The water quality of Noakhali is not within the tolerable limit and the water supply system is not so good studied by several researcher [13, 14].

In Bangladesh, a large number of people take their meals specially launch in different roadside local restaurants. In Noakhali, service individuals always took mainly launch and sometimes dinner from neighboring hotels/restaurants during working hours. In this time, they optioned for drinking water free or exchange of money. The free water collected from local tap or shallow tube wells and paid water collected from local suppliers with plastic container (mainly 20 liters) that is declared as highly treated with reverse osmosis by the supplier. For this reason, potable supplier's water was collected from six sites to conduct the study. The objectives were to assess physio-chemical parameters, pH, Electrical Conductivity (EC), Total Dissolved Solid (TDS), Chloride (Cl^-), Iron (Fe^{2+}) and Sulphate (SO_4^{2-}) and microbial parameters, Total Viable Bacteria Count (TVBC), Total Coliform Count (TCC), Fecal Coliform (FC), *Salmonella spp.* and *Vibrio spp.* were measured in different local restaurants supplied drinking water and compare it with World Health Organization (WHO) guidelines [15] and Bangladesh standard (BDS) [16].

Table 1. Testing methods of the parameter.

Sl.	Parameters	Symbol	Unit	Method
1	Electrical conductivity	EC	µs/cm	Conductivity meter
2	pH	pH	unitless	pH meter
3	Total dissolve solids	TDS	mg/l	TDS meter
4	Chloride	Cl^-	mg/l	Titration method
5	Sulphate	SO_4^{2-}	mg/l	Spectrophotometer
6	Iron	Fe^{2+}	mg/l	Atomic absorption spectrophotometer
7	Total Viable Bacteria Count	TVBC	CFU/100ml	Spread plate method
8	Total Coliform Count	TCC	CFU/100ml	Spread plate method
9	Fecal Coliform	FC	CFU/100ml	Spread plate method
10	*Salmonella spp.*		CFU/100ml	Spread plate method
11	*Vibrio spp.*		CFU/100ml	Spread plate method

2. METHODOLOGY

Noakhali is a district in south-central Bangladesh located in the Chattagram Division with an area of 3600.99 km^2 bounded by Cumilla and Chandpur Districts on the north, the Bay of Bengal on the south, Feni and Chattagram Districts on the east, Lakshamipur and Bhola Districts on the west. Six different busiest sampling stations of this district namely, Noakhali Science and Technology University Campus (NSTU), Sonapur, Maijdee, Chowrasta, Chowmuhani and Sonaimuri were selected based on the popularity of the restaurants. Total 18 water

samples were collected from above mentioned six stations. The water was collected between 9am to 12.30pm in July to August, 2019 in sterilized glass bottle and transported to laboratory remaining temperature below 4^{0}C in ice bags. The samples were measured by following methods with symbol and unit listed in Table 1. The collected data were studied through Statistical Packages for the Social Sciences (SPSS) and Microsoft Excel software.

Table 2. Physico-chemical properties of drinking water samples.

Location	Sample No.	Latitude (N)	Longitude (E)	pH	EC (µs/cm)	TDS (mg/l)	Fe^{2+} (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)
NSTU campus	S-1	22°47′38″	91°6′11″	7.26	4410	2160	0.08	1128.73	54.67
	S-2	22°47′43″	91°6′12″	7.80	800	410	0.07	215.54	13.04
	S-3	22°47′42″	91°6′12″	7.35	2290	1440	0.06	754.38	32.65
Sonapur	S-4	22°49′31″	91°6′4″	7.65	630	320	0.07	143.22	11.80
	S-5	22°49′32″	91°6′4″	7.19	2630	1340	0.05	608.32	9.97
	S-6	22°49′32″	91°6′5″	7.42	4360	2180	0.05	1351.35	9.01
Maijdee	S-7	22°51′48″	91°5′47″	7.61	2400	1210	0.06	1646.30	18.19
	S-8	22°51′56″	91°05′48″	8.05	610	320	0.05	144.64	10.04
	S-9	22°52′12″	91°05′48″	7.65	670	450	0.04	144.64	15.00
Chowrasta	S-10	22°56′42″	91°06′16″	7.85	610	310	0.04	46.79	13.62
	S-11	22°56′41″	91°06′17″	7.44	2620	1320	0.05	775.65	7.92
	S-12	22°56′40″	91°06′18″	7.76	1070	540	0.03	141.80	8.03
Chowmuhani	S-13	22°51′13″	91°07′07″	7.67	660	340	0.15	175.83	8.08
	S-14	22°52′58″	91°07′24″	7.44	2870	1470	0.04	1062.08	20.08
	S-15	22°54′52″	91°07′29″	7.24	3150	1570	0.05	1151.42	21.81
Sonaimuri	S-16	23°02′18″	91°05′49″	7.62	6710	3370	0.05	2602.03	8.95
	S-17	23°02′22″	91°05′46″	8.47	250	130	0.04	82.24	7.32
	S-18	23°02′18″	91°05′46″	7.56	1020	510	0.04	137.55	7.01
Maximum				8.47	6710	3370	0.15	2602.03	54.67
Minimum				7.19	250	130	0.03	46.79	7.01
Bangladesh standard (BDS)				6.5– 8.5	1000	1000	0.3–1.0	150–600	400
World Health Organization standard (WHO)				6.5– 8.5	750	1000	0.3-1.0	250	250

3. RESULTS

3.1. Physio-chemical Properties

Figure 1 illustrates graphical presentation of six variables of water in the study area. The result revealed that pH value in the studied area ranges between 7.19-8.47. 100% sampling points showed pH value were within the satisfactory limit prescribed by World Health Organization (WHO) and Bangladesh standard (BDS). Electrical conductivity (EC) ranged between 250-6710 µs/cm. 61.11% samples showed higher EC values and rest were within the permissible limit set by WHO and BDS. The mean values of TDS from NSTU, Sonapur, Maijdee, Chowrasta, Chowmuhani and Sonaimuri locations were found 1336.67, 1280, 660, 723.33, and 1126.67 mg/l respectively. 50% samples of TDS were exceeded the acceptable limit set by both WHO and BDS (Table 2). Table 2 represented the sampling station wise values of different variables with their geographical location and Table 3 represented the water rating based on the TDS. The result revealed that only one sample (S-17) was categorized into excellent and eight samples were categorized into good rating, respectively.

Table 3. Quality of drinking water based on the level of TDS

*TDS level (mg/L)	No. of Sample	Water Rating
<300	S-17	Excellent
300-600	S-2, S-4, S-8, S-9, S-10, S-12, S-13, S18	Good
601-900	----	Fair
900-1200	----	Poor
>1200	S-1, S-3, S-5, S-6, S-7, S-11, S-14, S-15, S-16	Unacceptable

Note: *TDS level were classified by Rahman, et al. [17].

Iron is not a health concern but taste and appearance of water might be affected at much lower concentrations [18]. The Fe concentrations were ranged between 0.15 mg/l (S-13) to 0.03 mg/l (S-12). The BDS and WHO has set the permissible limit for Fe is 0.3-1.0 mg/l. The mean values of Fe ranged from NSTU, Sonapur, Maijdee, Chowrasta, Chowmuhani and Sonaimuri locations were 0.07, 0.57, 0.05, 0.04, 0.08, and 0.04 mg/l, respectively, of which 100% samples were within the acceptable limits. Chlorides (Cl^-) naturally occur in waters in varying concentrations from surface and ground water. Excessive ingestion of chloride were not harmful for human being [19]. The standard concentrations of Cl^- were ≤250 mg/l (WHO) and ≤600 mg/l (BDS), and the ranges were varied between 46.79-2602.03 mg/l.

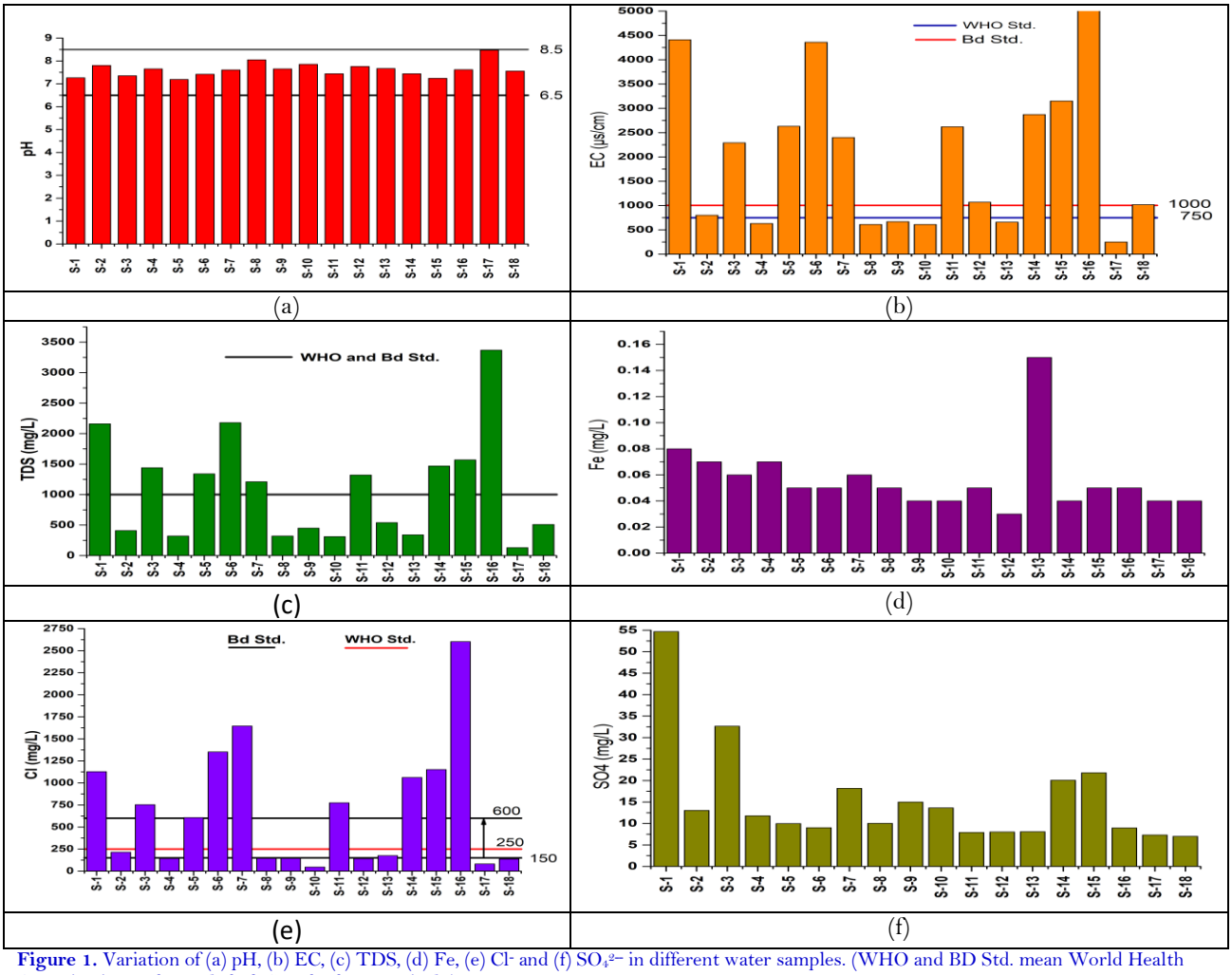

Figure 1. Variation of (a) pH, (b) EC, (c) TDS, (d) Fe, (e) Cl^- and (f) SO_4^{2-} in different water samples. (WHO and BD Std. mean World Health Organization and Bangladesh Standard, respectively).

The mean values of Cl^- from NSTU, Sonapur, Maijdee, Chowrasta, Chowmuhani and Sonaimuri locations were 699.55, 700.96, 645.19, 321.41, 796.44 and 940.61 mg/l, respectively, of which 100% sampling stations exceeded the limit set by WHO and BDS except Chowrasta station. The WHO and BDS have established the highest desirable limit of sulfate (SO_4^{2-}) in drinking water were 250 and 400 mg/l, respectively and the study found the concentration of sulfate ranged from 7.01-54.67 mg/l. The mean value of sulphate from NSTU, Sonapur, Maijdee, Chowrasta, Chowmuhani and Sonaimuri location were 33.45, 10.26, 14.41, 9.8567, 16.66 and 7.76 mg/l, respectively (Table 4) those all were within the acceptable limit. The result revealed that concentration of SO_4^{2-} in this study was lower than the permissible limit and it might not be detrimental to human health.

3.2. Microbiological Analysis

Figure 2 represents 6 locations wise four microbial variables and Figure 3 represents 18 sampling station wise data of the study area. The microbial study, TVBC, TCC, FC, *Salmonella spp.* and *Vibrio spp.* were performed on randomly selected from NSTU, Sonapur, Maijdee, Chowrasta, Chowmuhani and Sonaimuri local restaurant's supplied drinking water. The detection of coliforms bacteria can be an indication of the presence of organisms that can cause different diseases.

Table 4. The mean value of pH, EC, TDS, Fe, Cl^- and SO_4^{2-} at different locations.

Location	Mean ± SD* (pH)	Mean ± SD (EC*)	Mean ± SD (TDS*)	Mean ± SD (Fe*)	Mean ± SD (*Cl^-)	Mean ± SD (*SO_4^{2-})
NSTU Campus	7.47±0.289	2500±1814.13	1336.67±879.57	0.07±0.01	699.55±459.06	33.45±20.83
Sonapur	7.42±0.23	2540±1866.63	1280±931.45	0.057±0.012	700.96±609.37	10.26±1.42
Maijdee	7.77±0.24	1226.67±1016.58	660±480.73	0.05±0.01	645.19±866.99	14.41±4.11
Chowrasta	7.68±0.22	1433.33±1053.11	723.33±529.37	0.04±0.01	321.41±396.24	9.857±3.26
Chowmuhani	7.45±0.22	2226.67±1363.98	1126.67±683.11	0.08±0.06	796.44±539.32	16.66±7.48
Sonaimuri	7.88±0.51	2660±3528.47	1336.67±1771.14	0.04±0.006	940.61±1439.101	7.76±1.04

Note: *SD, EC, TDS, Fe, Cl^- and SO_4^{2-} mean standard deviation, electrical conductivity, total dissolve oxygen, iron/ferrous, chloride ion and sulphate ion, respectively.

The TVBC were ranged between 1.81×10^5 cfu/100 ml (sample 18) to 1.2×10^4 cfu/100 ml (sample 12). The result showed that 100% water samples were exceeded the WHO limit (1.0×10^3 cfu/100 ml) and similar type of result was found in previous research [7]. The TCC has been designated as the prime indicator of suitability for bacteria for causing diseases in drinking water [20]. The TCC were ranged between 1.7×10^5 cfu/ml (sample 3) to 4×10^3 cfu/ml (sample 1, 12), respectively. The study resulted that TCC were exceeded the WHO standard (0/100 ml) in 100% samples. So, the portable water was unsuitable for drinking purpose without any purification or treatment. FC is also another indicator for fecal coliform contamination of water sample [11]. The FC was ranged between 0 to 9.2×10^4 cfu/100ml and 38.89% samples were fecally contaminated that exceeds WHO limit. *Salmonella spp.* is an omnipresent intestinal pathogen [21] and *Vibrio spp.* is halophytic microorganisms. These organisms were one of the leading causes of intestinal illness mostly known for creating cholera [11] all over the world. The ranges of *Salmonella* were 0 to 1.6×10^4 cfu/ml (sample 5) whereas 100% samples were free from *Vibrio spp.* that is acceptable for drinking purposes according to World Health Organization [15] and BDS [16].

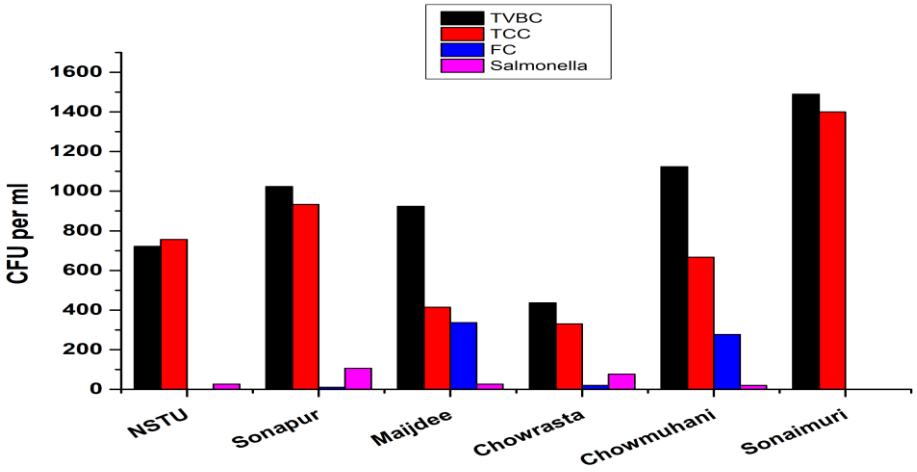

Figure 2. Variation of microbial parameters at different sampling locations.

3.3. Correlation Analysis between Physicochemical Properties and Microbial Parameters

Pearson correlation (r) was performed to comprehend the interconnections between studied physiochemical and microbial parameters. The study resulted that there was significant positive relationship between EC: Cl^- (r=0.930),

TDS: Cl^- (r=0.929), and TDS: EC (r=0.997) at 0.05 level of significance. The positive correlations were found between SO_4^{2-}: Cl^- (r=0.239), SO_4^{2-}: EC (r=0.329), SO_4^{2-}: Fe^{2+} (r=0.153) and TDS: SO_4^{2-} (r=0.347). The pH, Fe^{2+} and TDS were negatively correlated with most of the parameters. There was significant negative correlation between pH: EC (r= -0.563), TDS: pH (r= -0.577) and SO_4^{2-}: pH (r= -0.449)). The negative correlation value is found between Fe^{2+}: Cl^- (r= -0.053), Fe^{2+}: EC (r= -0.068), pH: Fe^{2+} (r= -0.107), and TDS: Fe^{2+} (r= -0.073), respectively. In spite of this, there was a positive relationship between TVBC: TC (r=0.499) at significance value of 0.05 (Table 5).

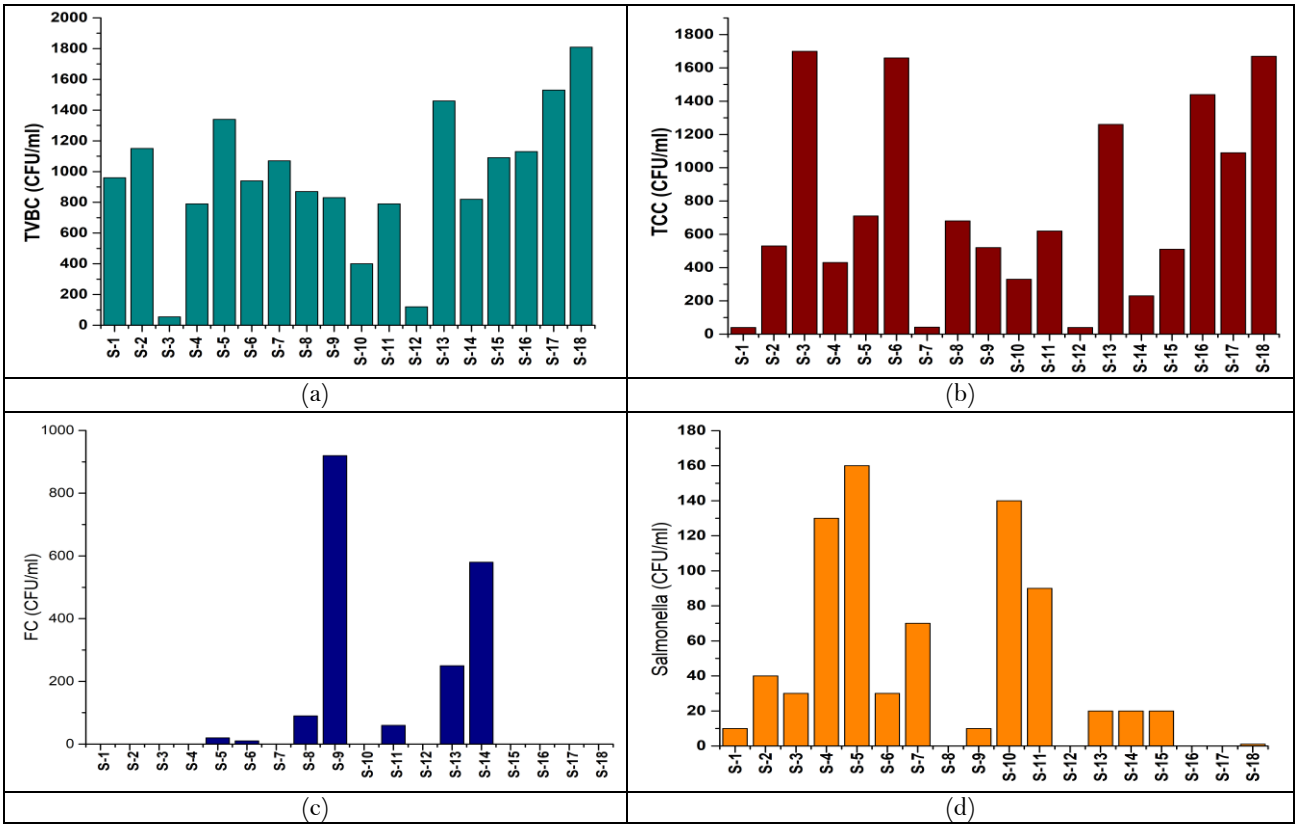

Figure 3. (a) TVBC, (b) TCC, (c) FC and (d) *Salmonella spp.* found at different water samples.

Table 5. Pearson's correlation coefficient analysis between physicochemical and microbial parameters.

Variables	pH	EC	TDS	Fe	Cl^-	SO_4^{2-}	TVBC	TCC	FC	*Salmonella spp.*
pH	1									
EC	-0.562*	1								
TDS	-0.577*	0.997**	1							
Fe	-0.107	-0.068	-0.073	1						
Cl^-	-0.438	0.930**	0.929**	-0.054	1					
SO_4^{2-}	-0.449	0.330	0.347	0.153	0.239	1				
TVBC	0.073	0.081	0.058	0.293	0.116	-0.205	1			
TCC	-0.206	0.335	0.322	0.167	0.297	-0.429	0.499*	1		
FC	-0.025	-0.175	-0.155	-0.026	-0.149	-0.012	-0.083	-0.040	1	
Salmonella spp.	-0.362	-0.051	-0.054	0.065	-0.052	-0.137	-0.001	-0.046	-0.196	1

Note: *Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed).

4. DISCUSSION

The World Health Organization [10] has predicted that around 80% of all global illness/disease is produced by unhygienic cleanliness and sanitation, or inaccessibility of contaminated/polluted water and at least 5000000 yearly deaths were responsible for various water borne diseases. The physiochemical indicators, such as pH, EC, TDS, Fe^{2+}, Chloride (Cl^-) and Sulphate (SO_4^{2-}) provides useful information on water quality or the potential of

water to support bacterial growth. The pH of water samples collected from six stations different local restaurants were in the range of 6.5 to 8.5 which indicates that it can be used as drinking water. Although, pH indicated the acidity and alkalinity of the water samples which is very important but it should not be impacted directly on consumers [3]. The ranges of EC was 6710 µs/cm to 250 µs/cm. Higher EC in consumptive water is not always safe because it might be the cause of high blood pressure, kidney dysfunction, and stone deposition for human being while drinking the water for long period [1]. The TDS values ranged from 130 to 3370 mg/l. Water with higher TDS may cause constipation effects [22] and potable drinking water should not exceeded the permissible limit (1000 mg/l). Continuous consumption of water with high TDS can harmful for human whereas low TDS is suitable for drinking purposes. Higher concentrations of iron can give bad metallic taste and odor [1] which can be responsible for the growth of bacteria [23]. Sampled water from the study area were characterized by low concentration of Fe and were within WHO and BDS acceptable limits of 0.3mg/l, so it is suitable for drinking purpose. The Cl^- varied from 46.79 to 2602.03 mg/l and higher amount of chloride is harmful for human and susceptible to heart or kidney diseases [10]. Drinking water from the studying areas generally had low SO_4^{2-} concentration ranging from 7.01-54.67 mg/l that 100% were within the WHO tolerable limit.

Table 6. Microbiological parameters at different local restaurants.

Sample ID	TVBC. (CFU/100ml)	TCC (CFU/100ml)	FC (CFU/100ml)	*Salmonella spp.* (CFU/100ml)	*Vibrio spp.* (CFU/100ml)
S-1	9.6×10^4	4×10^3	0	1×10^3	Absent
S-2	1.15×10^5	5.3×10^4	0	4×10^3	Absent
S-3	5.5×10^4	1.7×10^5	0	3×10^3	Absent
S-4	7.9×10^4	4.3×10^4	0	1.3×10^4	Absent
S-5	1.34×10^5	7.1×10^4	2×10^3	1.6×10^4	Absent
S-6	9.4×10^4	1.66×10^5	1×10^3	3×10^3	Absent
S-7	1.07×10^5	4.2×10^4	0	7×10^3	Absent
S-8	8.7×10^4	6.8×10^4	9×10^3	0	Absent
S-9	8.3×10^4	5.2×10^4	9.2×10^4	1×10^3	Absent
S-10	4×10^4	3.3×10^4	0	4×10^3	Absent
S-11	7.9×10^4	6.2×10^4	6×10^3	9×10^3	Absent
S-12	1.2×10^4	4×10^3	0	0	Absent
S-13	1.46×10^5	1.26×10^5	2.5×10^4	2×10^3	Absent
S-14	8.2×10^4	2.3×10^4	5.8×10^4	2×10^3	Absent
S-15	1.09×10^5	5.1×10^4	0	2×10^3	Absent
S-16	1.31×10^5	1.44×10^5	0	0	Absent
S-17	1.53×10^5	1.09×10^5	0	0	Absent
S-18	1.81×10^5	1.67×10^5	0	1×10^3	Absent
BDS*	-----	0	0	0	0
WHO*	-----	0	0	0	0

Note: * BDS, WHO, TVBC, TCC and FC mean Bangladesh standard, World Health Organization standard, total viable bacteria count, total coliform count and fecal coliform, respectively.

Table 7. Average value of microbiological parameters of various locations.

Location	Microbiological Parameters			
	TVBC* (Mean ± SD)	**TCC*** (Mean ± SD)	**FC*** (Mean ± SD)	***Salmonella spp.*** (Mean ± SD)
NSTU	721.67±585	756.67±852.89	0	26.67±15.28
Sonapur	1023.33± 284.31	933.33±644.69	10±10	106.67±68.07
Maijdee	923.33± 128.58	414±331.95	336.67±507.18	26.67±37.86
Chowrasta	436.67± 336.50	330±290	20±34.64	76.67±70.95
Chowmuhani	1123.33± 321.29	666.67±532.58	276.67± 290.92	20±0
Sonaimuri	1490± 341.76	1400±292.06	0	0.33±0.58

Note: *TVBC, TCC and FC mean total viable bacteria count, total coliform count and fecal coliform, respectively.

Table 6 presented the sampling station wise microbial parameters and Table 7 depicted the average microbial indicators for six sampling sites of the study area. The result showed that 100% water samples were presence of high number of bacteria, The highest mean of TVBC, TCC, FC and *salmonella spp.* were present in Sonaimuri

(1490± 341.76), Sonaimuri (1400±292.06), Maijdee (336.67±507.18), and Sonapur (106.67±68.07), respectively. The FC were totally absent in the sample of NSTU and Sonaimuri area. The lowest mean of TVBC, TCC and *salmonella spp.* were present in NSTU (721.67±585), Chowrasta (330±290), Sonaimuri (0.33±0.58), respectively (Table 7). The ranges of TVBC found in sample 18 (1.81×10^5 cfu/100ml) and sample 12 (1.2×10^4). The existence of different coliforms in water presumed the existence of different pathogens, i.e., *Salmonella spp.* and *Vibrio spp* [24]. The ranges of FC and *Salmonella* were 0 to 9.2×10^4 cfu/100ml and 0 to 1.6×10^4 cfu/100ml. All the samples were free from *Vibrio spp.*

5. CONCLUSION

The quality of potable water collected from local restaurants were not always satisfactory and varied from one sampling stations to another because the sources of water were not same. The study revealed that some parameters were within the permissible limit set by WHO and BDS for some sampling stations and some were exceeded the permissible limit for few sampling stations. The physiochemical parameters were not always harmful for human consumption but microbial parameters were responsible for creating water borne diseases. In this connection, the potable water contaminated with biological parameters should be harmful and responsible for outbreaking the water borne diseases in the study area, i.e., presence of *Salmonella spp.* and *Vibrio spp.* should be the cause of typhoid and cholera diseases, respectively. So, the local authority (municipality) or government should take immediate proper initiatives by monitoring and raising awareness for mass people and controlling the quality of potable water in roadside restaurants for ensuring safe drinking water for the people. Finally, the potable water quality should be improved for ensuring better human health and it should be properly treated before human consumption.

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