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Short Communication

Analysis of Physical, Chemical and Biological Aspects of Drinking Water at University of Sindh Jamshoro

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Introduction

Safe drinking water is a basic need for good health. It is critically needed to characterize drinking water, by measuring its pH and electrical conductivity, total dissolved solids, and analysing for biological contamination. Drinking water quality standards are set with some parameters and that harmful constituents should not exveed (WHO guidelines (2011). The WHO recommended drinking water pH lies in the neutral range. The electrical conductivity of water is mainly due to the presence of ionizable inorganic compounds in water. As a whole, the electrical conductivity of water is a good measure of the salinity of the water. Water quality is also influenced due to the presence of different suspended and total dissolved compounds (TDS), and microbial organisms. In general, increase in TDS (> 600 mg/L) reduces the palatability of water. The limit of TDS is maintained by the municipality during water treatment. The higher values of TDS in turbid water indicates the breach in water treatment, storage or supplies, and thus, polluted water could be associated with various health issues, change in taste, colour, smell, and hardness of water along with excessive scaling of water supplies pipes and home appliances (Tanninen et al., 2005; UNICEF, 2008). Moreover, the quality of ground or surface water is significantly influenced by human socio-economic activities and industrialization (UNICEF, 2008; WHO, 2011).

Groundwater quality is influenced by the waste discharged directly into streams and rivers, the sources of water supplies (Ali, et al., 2016). Contaminated water is a source of transmission of pathogens such as coliform bacteria; protozoa and viruses which may cause water-borne diseases including diarrhea, vomiting, and gastroenteritis (Mehmood, et al., 2013). In Pakistan, 30-50 % of hospital admissions are due to waterborne diarrhea (Ahmed, et al., 2012). The most common waterborne disease, cholera is an important cause of fatality in poor countries (Khalid, et al., 2011). Hence to determine the water contamination various approaches are adopted for the isolation of microorganisms in water. Different methods using various approaches like membrane-filtration method, multiple tubes, or most probable number (MPN) methods are common to determine the water contamination.

The objective of the present study is to evaluate the drinking water quality of the University of Sindh Jamshoro according to the WHO parameters and to conclude its suitability for drinking purpose based on various physicochemical properties and bacteriological contamination analyses of water being supplied to the campus.

Materials and Methods

Total twenty (n=20) water samples (250 ml each) were randomly collected from different locations of University of Sindh, Jamshoro campus including residential colony, Marvi girls' hostel, teacher's hostel, central library, administration block (AC-II), Model school, institute of microbiology and the reservoir pond for water supply within university campus. The samples were collected using sterile glass jars, and were immediately processed or stored at 4 ^{0}C for 24-48 hrs.

Filtration Assembly Method (FAM) was used to isolate the bacteria from the collected water samples. The water samples (100 ml) were filtered through membrane filtration assembly (Millipore, USA) containing filter paper with the pore size of 0.45 µm (Merck). The filter paper was then placed on MacConkey's agar medium plate and incubated for 24-48 hours at 37 °C. All the samples were run in the duplicates. All the isolated pure cultures were identified at the genus level with help of biochemical reactions including IMVIC (Methyl red, Voges Proskauer and Citrate) tests. The pH of all collected water samples was determined using a pH meter (Jenco, 6173, USA). Determination of TDS, salinity, and EC of collected water samples were analysed through a digital meter (JENCO, 3173 COND,

USA). The digital meter used in this study is automatically standardized to record the readings to 25 ^{0}C.

Results and Discussion

Physicochemical Characteristics of Water Samples

Physicochemical parameters include pH, electrical conductivity, salinity, and TDS. The collected water samples were transparent and odourless (Table 1).

Table 1. Physio-chemical values of drinking water samples of the University of Sindh Jamshoro.

Area/Location	Coordinates		Code	PH	EC (µS/cm)	TDS (mg/L)	Salinity (mg/L)
	N	E					
Marvi Girls Hostel	25.4131°	68.2693°	S1	7.7	467	236	0.3
			S2	7.6	466	235	0.3
Undergraduate Hostel	25.4131°	68.2693°	S3	7.6	466	235	0.3
			S4	7.7	465	233	0.3
University Teachers housing Society	25.412811°	68.267897°	S5	8.2	410	205	0.3
			S6	8.3	411	204	0.3
Housing Society	25.424945°	68.274998°	S7	8.3	405	203	0.3
			S8	8.4	405	203	0.3
Model School A SU	25.424945°	68.274998°	S9	8.21	404	218	0.3
			S10	8.21	440	219	0.3
Institute of Microbiology	25.421413°	68.265710°	S11	7.4	438	218	0.3
			S12	7.4	443	219	0.3
AC II (Administration block	25.3837°	68.3334°	S13	8.25	443	221	0.3
			S14	8.23	441	219	0.3
Administration Block SU	25.414275°	68.260776°	S15	7.4	433	217	0.3
			S16	7.3	436	216	0.3
Pond water	25.425585°	68.270088°	S17	8.3	436	220	0.3
			S18	8.33	434	220	0.28
Central Library	25.420401°	68.265287°	S19	8.1	433	217	0.3
			S20	8.21	410	206	0.3

The pH of water samples are found within the narrow range of 7.3–8.4 (Table 1) and it as found within the suggested standard limits of 6.5–8.5 (WHO, 2011). The pH of most drainage basins of the world has shown the same range of pH 6.5–8.5 (UNEP/GEMS, 2007). The conductivity of water indirectly provides the amount of overall dissolved ionic compounds in water (Yilmaz and Koc, 2014). The EC values of all water samples range from 404µs/cm to 467µS/cm with the mean/average value of 430µs/cm (Table 2).

Table 2. Min., max., mean, and st. deviation values of parameters of the different villages at Jamshoro.

Parameters	Minimum	Maximum	Mean	Standard deviation
PH	7.3	8.4	8.007	0.3
EC (µS/cm)	404	467	430	21.2
TDS (mg/L)	203	236	216	10.40
Salinity (mg/L)	0.28	0.3	0.299	0.004

It is interesting to note the lowest value of EC was obtained from the Pond water 404µS/cm (Table 1) it shows that water is contaminated during supply through pipelines. In drinking water, the range of EC is 200 to 800 µS/cm hence, the recorded EC values of water were found within the prescribed limit. The salinity of SU Jamshoro water samples was within the narrow range of 0.28 – 0.3 mg/L with an average value of 0.29 mg/L (Table 2). Surface water contains a smaller number of dissolved salts as compared to groundwater due to geographical reasons. Groundwater with higher salinity used for irrigation purpose increses soil salinity and makes it infertile (Al-Naeem, et al., 2011), whereas low salt concentration is good for irrigation purposes (Tanninen, et al., 2005). TDS values of water samples in the present study were recorded 203 mg/L - 236 mg/L with an average value of 216 mg/L (Table 2). It is far below the WHO recommended guideline value of 300 - 500 mg/L for drinking water.

Bacteriological Analysis

Out of the total 20 samples collected, 14 samples (70%) were observed positive and 6 samples (30%) negatives for the coliform or bacterial contamination. Other than coliform bacteria (Fig. 1), no lactose fermenting, gram-negative bacteria including *Salmonella species* were also isolated and identified in this study (Table 3).

Table. 3. Distribution of bacterial types from collected water samples.

S.No.	Area	Sample Code	Source	Isolates
1	Marvi Girls Hostel	S1 S2	Tap Water	*E. coli*
				Klebsiella spp
2	Undergraduate Girls Hostel	S3 S4	Tap Water	*E. coli*
				Salmonella spp
3	University teachers housing area	S5 S6	Tap Water	MBG
				MBG
4	Housing Society	S7 S8	Tap Water	*Salmonella spp*
				Klebsiella spp
5	Model School at SU Jamshoro	S9 S10	Tap Water	LF
				E. coli

6	Institute of Microbiology	S11 S12	Tap Water	LF LF
7	Administration Block SU (ACII)	S13 S14	Tap Water	MBG MBG
8	Administration Block SU	S15 S16	Tap Water	LF *E. coli*
9	Pool Water	S17 S18	Tap Water	*E. coli* NLF
10	Central Library	S19 S20	Tap Water	NLF MBG

Note: MBG = Mixed Bacterial Growth, LF = Lactose fermenter, NLF= non lactose fermenting.

Further study confirmed the identification of bacteria as *E. coli* (25%), *Klebsiella* (10%), and *salmonella* (10%) (Fig. 1). However, 55% of gram-negative bacilli were identified as total coliform.

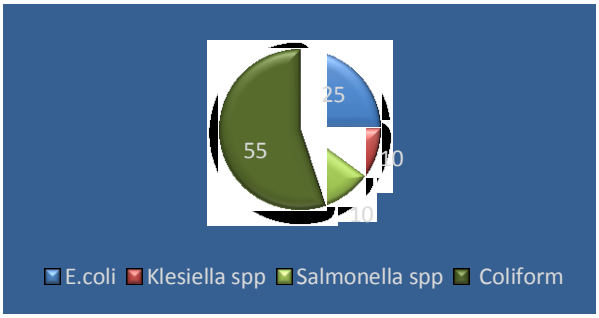

Fig. 1 Distribution of different types of bacterial species isolated from water, Samples, the most prevalent was *E. coli* (25%).

The most important factor to take into account is the principal risk to human health derives from the drinking of contaminated water. Out of twenty water samples, fourteen samples were positive and the rest were negatives for coliform/bacterial contamination. Contaminated water may cause infections which can be fatal in the remote area due to poor medical facilities. Three types of bacteria were isolated in this study are *E. coli* (25%), *Klebsiella spp* (20%), and *salmonella spp* (20%). These bacteria cause waterborne diseases like diarrhoea, dysentery, and cholera, and may cause urinary tract infections. In Pakistan, the main diseases due to contaminated drinking water are diarrhea, gastroenteritis due to coliform contamination. The typhoid caused by *Samonella typhi*, and giardiasis caused by intestinal worms *Giardia spp*, and hepatitis A caused due to hepatitis A virus. (Mehmood, et al., 2013). The most common waterborne disease cholera (caused by *Vibrio cholerae*) is widespread in poor countries and an important cause of fatality (Khalid, et al., 2011). In the current study also, the presence of coliform bacterial cells proved that water samples were not safe for drinking purpose.

Conclusion

Present study shows that physicochemical parameters of the water samples are still within the safe limits, however, bacterial contamination in water is alarming and considered unsafe for drinking purpose. It is suggested that the quality of drinking water should be monitored on a routine basis for quality assessment and to sustain safe and healthy life.

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