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Microbiological Assessment of Drinking Water Quality in Port Sudan City

FATIMA B. MADNI
ELNASRI M. MUTWALI
HUDA M. SELMAN
Department of Biology, Faculty of Education
Alzaiem Alazhari University, Sudan

Abstract

The study was carried out to evaluate the physicochemical and microbial quality of drinking water of Port Sudan City, Sudan. The water samples were collected randomly from different sites of the city and examined for turbidity, total dissolved solids (TDS), pH, and microbial characteristics using standard method of American Public Health Association (APHA), American Water Work Association (AWWA) and Water Pollution Control Federation (WPCF). Results indicated that some samples exceeded the Sudanese standard limits and international standard WHO in some physicochemical parameters such as turbidity. Results also showed the presence of coliform, Escherichia coli and faecal streptococcus bacteria in some water samples.

Keywords: Drinking water, Microbial contamination, Water quality, Port Sudan City

1. INTRODUCTION

The majority of the world's people do not have reliable household water connections and many of these must still physically carry water and store it in their homes. Even water collected from safe sources is likely to become faecally contaminated during transportation and storage.

In many countries including Sudan, some drinking water supplies have become contaminated, which has impacted on the health of the population.

Water related diseases caused by insufficient safe water samples coupled with poor sanitation and hygiene cause 3.4 million deaths a year mostly among children.

Water used in Sudan derives from surface water resources as the ground water is used in limited areas.

The present study was undertaken to investigate the water quality and determine physicochemical and microbial properties of water sample taken from different sites from Port Sudan City.

2. MATERIALS AND METHODS

2.1 Samples collection:

The water samples from different sources and sites in Port Sudan City were collected during winter and summer for the year (2019). The samples were collected during the day in sterile scrawl cap bottles and examined in the laboratory immediately after arrival.

2.2 Microbiological examination:

Total viable bacterial count was carried out using the pour plate technique according to Harrigan (1998). The presumptive coliform test, confirmed coliform test and the most probable number (MPN), and the faecal coliform test were carried according to methods prescribed by APHA, AWWA and WPCF (1998).

2.3 Physiochemical analysis:

The water samples were examined to determine turbidity using turbidometer Model 6035, the pH measured by the pH meter Model 3510. The total dissolved solids (TDS) were analyzed using methods prescribed by APHA (1998).

3. RESULTS AND DISCUSSION

Table (1) show the physicochemical and microbial analysis of water samples collected from Middle lanes in Port Sudan City during winter. The turbidity ranged from 0.30 to 6.62 NTU, and only 10% of the samples exceeded the permissible limit of the Sudanese standard (SSMU, 295) and the WHO (2007) limit. However, in summer 60% of values fall below the threshold value of SSSM (2019) and WHO (2007) (Table 2). As it can be seen from Tables (1 and 2) the highest turbidity value were recorded in Table (2), in summer season. These samples were collected at the end of the winter and beginning of summer. In winter water receive large volume of storm water with suspended materials and this increase the turbidity values in summer. Similar results were reported by Elbakri (2009) and Khojaly (2011) in Khartoum State.

The values of total dissolved solids (TDS) varies between 205.1 and 392.4 in winter, and between 220 to 400 mg/L in summer, all these values were within the limit of SSMO (2015) and WHO (2007). Similar results were

reported by Alkhiry (2016) who found that the values of T.D.S. ranged from 135 to 460 mg/L in Khartoum City.

The pH levels of the samples taken in winter and summer (Tables 1 and 2) were within the permissible limit (6.5 – 8.5) of the Sudanese standard and meteorology Organization (SSSMO, 2015). Similar results were reported by Khojaly (2011) who found that the pH of water samples were 8.06 in Khartoum and 7.22 in Omdurman.

Table (1): Physicochemical and microbial analysis of water samples collected from Port Sudan City (Middle lane) during winter 2019.

Samples No.	Parameters measure						
	Turbidity (NTU)	**T.D.S. (mg/L)**	pH	**T.V.C.**	**Total coliform**	***E. coli***	**Faecal streptococcus**
1	6.30	369.6	8.4	7.5×10^3	2.00	50	0
2	6.62	395.5	7.3	7.6×10^5	10	3	0
3	5.00	392.4	8.0	3.5×10^4	0	0	0
4	5.58	376.0	7.9	4.0×10^5	27	0	0
5	5.00	377.4	7.0	3.6×10^3	0	0	0
6	2.60	376.5	7.8	3.8×10^2	0	0	0
7	2.40	339.9	8.3	4.5×10^2	0	0	0
8	1.57	205.1	7.7	5.6×10^2	0	0	0
9	0.61	345.2	7.7	3.6×10^2	0	0	0
10	6.81	344.5	7.9	8.0×10^4	20	5	0

Table (2): Physicochemical and microbial analysis of water samples collected from Port Sudan City (Middle lane) during summer 2019.

Samples No.	Parameters measure						
	Turbidity (NTU)	**T.D.S. (mg/L)**	**pH**	**T.V.C.**	**Total coliform**	***E. coli***	**Faecal streptococcus**
1	5.71	220	7.21	4.3×10^3	30	25	10
2	5.00	230	7.32	5.4×10^2	15	0	0
3	11.82	390	7.34	4.9×10^4	0	0	0
4	36.58	438	7.36	6.0×10^4	35	20	0
5	5.00	380	7.27	5.8×10^4	20	0	0
6	12.00	380	7.19	5.8×10^4	0	0	0
7	2.40	344	8.28	2.4×10^4	0	0	0
8	1.57	297	7.32	5.9×10^3	12	0	0
9	0.61	239	7.00	5.6×10^2	15	0	0
10	3.00	290	7.27	3.6×10^3	260	65	4.8

Tables (1 and 2) showed the values of total viable count bacteria in winter and summer. The highest count during winter was found in sample No. 2 and the least count was found in sample No. 9. However, in summer the sample No. 4 recorded the highest count and the least count achieved by sample No. 9. Results from Tables (1 and 2) indicated that 40% and 70% of Middle lane water samples showed the presence of total coliform in winter and summer respectively. Results also showed the presence of *E. coli* with percentage 30% and 40% in winter and summer respectively. On the other hand the fecal

streptococcus bacteria were detected in 20% of the samples in summer season, while in winter was not detected.

The detection of total coliform *E. coli* and fecal streptococcus means that these water samples were unfit for drinking according to the Sudanese standards (SSMO, 2019) and WHO (2007) standards. Similar results were reported by Salih (1998) who found that water samples from certain lanes in Omdurman City was contaminated by *E. coli* and coliform. Also Alkhiry (2016) found that water samples from Omdurman City and Khartoum City were contaminated by coliform, *E. coli* and faecal streptococcus bacteria. On the other hand Ebrahim *et al.* (2021) found that some water samples were contaminated by coliform, *E. coli* and faecal streptococcus in Singa City.

As it can be see from the Tables (3 and 4) the turbidity of the water samples taken from the Lane in Port Sudan City reached 3.68 NTU in sample No. 3 in winter, but in the samples No. 7 and 9 turbidity was not detected. All samples in winter were within the Sudanese Standard Metrology Organization (SSMO, 2015). However, in summer the turbidity reached 33.30 NTU in sample No. 4 and the least value 1.57 NTU was recorded in sample No. 6 and 30% of the samples exceeded the Sudanese Standard (SSMO, 2015) and WHO (2007) standard.

Table (3): Physicochemical and microbial analysis of water samples collected from Port Sudan City (East lane) during winter 2019.

Samples No.	Parameters measure						
	Turbidity (NTU)	**T.D.S. (mg/L)**	**pH**	**T.V.C.**	**Total coliform**	***E. coli***	**Faecal streptococcus**
1	3.18	396	7.29	7.2×10^4	160	55	38
2	0.90	330	7.32	3.0×10^3	0	0	0
3	3.68	398	7.30	3.5×10^4	0	0	0
4	0.66	280	7.40	4.0×10^3	20	20	0
5	0.36	300	7.30	3.2×10^2	4	4	0
6	0.70	337	7.30	3.6×10^3	0	0	0
7	ND	280	7.26	4.8×10^2	7	7	0
8	0.50	240	7.80	6.8×10^3	0	0	0
9	ND	250	7.00	4.9×10^2	0	0	0
10	4.00	300.	7.60	3.5×10^4	0	0	0

Table (4): Physicochemical and microbial analysis of water samples collected from Port Sudan City (East lane) during summer 2019.

Samples No.	Parameters measure						
	Turbidity (NTU)	**T.D.S. (mg/L)**	**pH**	**T.V.C.**	**Total coliform**	***E. coli***	**Faecal streptococcus**
1	3.10	300.5	7.7	5.6×10^4	240	67	40
2	4.00	339.9	7.7	3.0×10^2	0	0	0
3	2.85	375.0	7.8	7.3×10^3	0	0	0
4	33.30	386.5	7.3	6.5×10^4	28	15	0
5	2.80	377.3	6.8	3.8×10^4	0	0	0
6	1.57	378.0	7.2	5.9×10^2	0	0	0
7	3.50	339.2	8.0	5.4×10^4	27	9	4

8	22.70	386.0	7.9	6.0×10^4	6	0	0
9	24.00	377.0	7.9	6.4×10^4	10	0	0
10	4.00	366.0	7.7	3.7×10^2	0	0	0

The value of total dissolved solids (TDS) as shown in Tables (3 and 4), values were within the permissible limit of the Sudanese Standards (SSMO, 2015) and International Standard (WHO, 2007). In winter the highest value 398mg/L found in sample No. 3, while lowest value 240mg/L was recorded by sample No. 8. In summer the highest value reached 386.5mg/L in sample No. 4 and least one 300.5mg/L was found in sample No. 1.

The pH values in both seasons (winter and summer) were within the limit of SSMO (2015) and the WHO (2007) Standards (6.5 – 8.5). Similar observations were reported by Khojaly (2011) who stated that the pH of water samples were 8.06 in Khartoum and 7.22 in Omdurman. In connection to this, Alkhiry (2016) reported that the pH of the water samples taken from Khartoum City ranged from 7.00 to 7.90.

The highest value of total viable count of bacteria was recorded in sample No. 1 and the least one was found in sample No. 5 in winter season. However, in summer the highest value found in sample No. 4 and least one recorded by sample No. 2.

Tables (3 and 4) showed the presence of total coliform in 40% of the samples in winter and 50% of the samples in summer. The presence of *E. coli* was 20% in winter and 30% of the sample in summer. The presence faecal streptococcus was detected in some water samples and percentage was 10% and 20% in winter and summer samples respectively. The presence of coliform, *E. coli* and faecal streptococcus means that these water samples were unfit for drinking according to Sudanese standard (SSMO, 2015) and International standards (WHO, 2007). These standards stated that *E. coli* or thermotolerant coliform bacteria must not be detectable in any 100ml samples.

As it was shown in Tables (1, 2, 3 and 4) some samples showed high value of turbidity which were recorded during summer. This was so because in summer the sources of the water samples received adequate volume of storm water with suspended materials. However turbidity can interfere with disinfection and provide a medium for microbial growth excessive turbidity may also be associated with unpleasant tasks and odours (Health Canada, 2003).

The total dissolved solids all values where below the standard limits of SSMO (2015) and WHO (2007). An elevated TDS may be associated with an elevated TDS may be associated with an elevated water hardness, chemical deposits, corrosion by products, staining or salty bitter tests (WHO, 2006). The PH values were within the permissible limit of SSMO(2015) and WHO (2007). Generally low PH tends to make water corrosive while high PH will result in taste complaints (Chan *etal.*2007).

The total viable count bacteria showed variation in Middle lane and East lane samples and the highest value was obtained in summer season. Results from Tables 1,2,3 and 4 indicated that 40% of the water samples showed the presence of coliform, 30% of the samples showed the presence of E.coli and 10% showed the presence of faecal streptococcus.

It is worth mentioning that the samples with high values of turbidity showed a high count of T.V.C. bacteria and an increase in the coliform and E.coli bacteria. As turbidity can interfere with disinfection and provide a medium for microbial growth.

The presence of coliform bacteria in treated water gave an indication that water treatment system was not operated satisfactorily or the water became contaminated within the distribution system.

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