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Evaluation of Drinking Water Quality in Sennar City, Sennar State

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Abstract

The study was conducted to evaluate the physicochemical and microbial quality of drinking water of Sennar city. The water samples were collected randomly from different sites of the city and examined for temperature, pH, electrical conductivity (E.C.), total dissolved solids (TDS), turbidity and microbial characteristic using standard method of American Public Health Association (APHA), American Water Works Association (WWA) and Water Pollution Control Federation (WPCF). Results indicated that some parameters of physicochemical analysis exceeded the standard limits. Results also showed the presence of coliform, Escherichia coli and faecal streptococcus bacteria in some water samples. The study recommended an adequate process for purifying water.

Keywords: Physicochemical analysis Drinking Water, Microbial Test, Sennar City

INTRODUCTION

Water is essential for life on earth and safe water is a precondition for health and development and a basic human right, yet it is still denied to hundreds of millions of people throughout the world (UNICEF, 2008). The provision of drinking water of adequate quality and quantity remains a manor public health need in many African countries, where diarrheal diseases continue to cause extensive morbidity and mortality (Duse *et al*., 2003).

Water used in Sudan derives almost exclusively from surface water resources, as ground water is used in only very limited areas. In Sudan some drinking water supplies have become contaminated, which has impacted on health and economic status of the population.

The present work was undertaken to investigate water quality and determine the physicochemical and microbial quality of water samples collected from different sites of Sennar city for two successive years (2019 and 2020), during summer, autumn and winter.

MATERIALS AND METHODS

Study area

Sennar city is located on the western bank of Blue Nile River south to Khartoum in Sennar State in central Sudan. It was the capital of Fonj sultanate in the 18th century. Today it is a junction of railways in Sudan and one of the biggest trading center.

Water sampling

The water samples from different sources and sites of Sennar city were collected during the year 2019 and 2020. Ten samples were collected during winter, summer and autumn in clean polyethylene plastic container and examined in the laboratory immediately after arrival.

Sample analysis

The water samples were examined to determine temperature, pH, electrical conductivity, turbidity, total dissolved solids. A Hatch Multimeter was used for monitoring temperature, pH and conductivity. Turbidity was measured by turbid meter. The total dissolved solids (TDS) were analyzed using methods prescribed by APHA (1998).

Microbial examination

Microbiological parameters were analyzed in the laboratory using methods prescribed by APHA (1998) ad examined for total coliform, *Escherchia coli* and faecal streptococcus.

RESULTS AND DISCUSSION

Table (1) showed the analysis of water samples in summer, 2019. Only 30% of the samples temperatures were within the optimal water temperature (25^{o}C), while 70% exceeded the permissible limit of Sudanese Standards and Meteorology Organization (SSMO, 2015). However, in autumn 2019 only 10% of the samples fall within the limit and the other samples 90% were higher than the limit (Table 2). In winter 2019 80% of the samples temperature exceeded the standard temperature (25^{o}C) and only 20% of the samples fall within the limit. In the year 2020 in summer the temperature of almost all samples exceeded the permissible limit except one sample (No. 4) fall within the limit (Table 4). However, in autumn and winter the temperature of all samples exceeded the standard limit (Tables 5 and 6),

High water temperature enhances the growth of microorganisms and may increase taste, odour, colour and corrosion problems (WHO, 2008).

The pH of the samples recorded in summer ranged from 7.5 top 8.3 and in autumn ranged from 7.7 to 8.1 in the year 2019. These values were within the limit of World Health Organization (WHO, 2008) and the Sudanese Standards and Meteorology Organization (SSMO, 2015). In winter 2019 one sample No. 9 (4.44) fall below the optimal limit, however, other samples were within the standard limit. In the year 2020 the pH of all samples fall below the acceptable level of WHO (2008) and SSMO (2015) (Tables 4, 5, 6). The values of the pH ranged from 6.8 to 8 in summer, from 6.0 to 79 in autumn and from 7.5 to 83 in winter. Similar results obtained by Abdel Halim (2010) who found the pH value in ground water between 7.63 and 8.02 and in bottled water 7.5 to 8.20. Khojaly (2011) found that the pH for well was 806 in Khartoum and 7.22 in Omdurman city.

The pH usually has no direct impact on consumers, but it is one of the most important operational water qualities of water, but the corrosive effect on distribution systems is a more urgent problem (IEPA, 2001).

Table (1) showed the electrical conductivity during summer 2019. The highest value was 747µs/cm found in sample No. 8 and the lowest value 270µs/cm found in sample No. 5. In autumn the values ranged from 350 to 896µs/cm and in winter the range was from 177 to 700µs/cm. However, in the year 2020 in summer the E.C. ranged from 260 to 1019µs/cm, in autumn from 208 to 983µs/cm and in winter the range from 231 to 1058µs/cm. As it can be seen from Tables (1, 2, 3, 4, 5 and 6) all the values were within the limit of WHO (2008) and SSMO (2015) except sample No. 10 in winter (2020), which exceeded the permissible limit (1000µs/cm).

The turbidity was shown in Tables (1, 2 and 3) in the year 2019 in summer, autumn and winter respectively. In summer, some samples recorded 8.60, 577, 6.4, 6.36, 5.33 and 5.81 for samples No. 1, 2, 3, 4, 7, and 8 respectively, these samples exceeded the limit of WHO (2008) and SSMO (2015). As in autumn 2019, almost all samples values exceeded 5NTU, except samples No. 1 and No. 10. The turbidity values in winter 2019 ranged from 1.03 to 6.5 and 60% of the samples exceeded the maximum limit of SSMO (2015). However, in the year 2020 in summer 70% of the samples exceeded the limit of the WHO (2008) and SSMO (2015) with the highest value 7.90 NTU found in samples No. 8 and he lowest value 1.37NTU recorded by samples No. 4. In autumn 80% of the samples recorded values above 5NTU and only two samples were within the permissible limit of WHO (2008) and SSMO (2015). In winter 2020 four samples values were within the limit of the standard regulations and 60% of the samples were above the acceptable level of WHO (2008) and SSMO (2015). Similar results were reported by Elbakri (2009) who stated that turbidity level in ground water ranged from 0.8 to 0.95 NTU and the surface water from 5.5 to 197 NTU, and Ali (2008) reported that the turbidity level ranged from 0.1 to 8.6 NTU in Khartoum State.

Table (1): Physicochemical and microbial analysis of water samples collected from Sennar city during summer 2019.

Sample code	Temp. (°C)	pH	E.C. µs/cm	Turb NTU	T.D.S.	Total coliform	*E. coli*	Faecal streptococcus
S1	30.0	7.6	650	6.60	422.00	16	7	4
S2	36.6	7.7	449	577	319.00	5	1	2
S3	37.0	7.5	517	6.40	336.00	4	0	1
S4	36.6	7.6	510	6.36	331.00	3	0	2
S5	25.4	8.0	270	1.20	180.90	2	0	0
S6	25.0	7.6	302	1.28	202.34	0	0	0
S7	24.4	7.7	634	5.33	424.78	4	0	2
S8	30.0	8.3	747	5.81	500.00	6	2	3
S9	25.0	7.6	522	3.40	320.00	0	0	0
S10	26.0	7.8	450	4.20	320.00	0	0	0

Table (2): Physicochemical and microbial analysis of water samples collected from Sennar city during autumn 2019.

Sample code	Temp. (°C)	pH	E.C. µs/cm	Turb NTU	T.D.S.	Total coliform	*E. coli*	Faecal streptococcus
A1	25.9	8.0	345	3.80	131	15	0	0
A2	25.5	7.8	461	5.50	274	8	0	0
A3	26.0	8.1	561	6.10	370	7	0	0
A4	28.9	7.9	508	6.00	340	6	2	3
A5	27.5	7.7	896	6.60	415	4	1	2
A6	27.4	7.8	861	7.60	406	5	1	3
A7	27.0	7.9	765	8.30	513	7	2	4
A8	25.5	7.7	437	5.70	392	8	0	0
A9	24.6	7.9	412	8.16	276	6	0	3
A10	25.9	7.7	470	2.76	320	0	0	0

Table (3): Physicochemical and microbial analysis of water samples collected from Sennar city during winter 2019.

Sample code	Temp. (°C)	pH	E.C. µs/cm	Turb NTU	T.D.S.	Total coliform	*E. coli*	Faecal streptococcus
W1	32.0	8.00	389	1.03	284	0	0	0
W2	29.5	7.40	405	6.56	350	5	0	0
W3	30.0	5.90	514	1.08	341	0	0	0
W4	30.0	8.20	518	5.90	213	4	0	0
W5	30.0	8.10	400	6.01	268	2	0	2
W6	30.0	8.00	548	5.44	333	18	1	4
W7	29.0	8.30	636	6.02	425	18	2	5
W8	24.0	7.35	273	2.46	116	0	0	0
W9	20.0	4.44	177	3.90	118.6	11	0	0
W10	27.3	7.00	700	6.22	455	8	0	2

Table (4): Physicochemical and microbial analysis of water samples collected from Sennar city during summer 2020.

Sample code	Temp. (°C)	pH	E.C. µs/cm	Turb NTU	T.D.S.	Total coliform	*E. coli*	Faecal streptococcus
S1	30.0	7.6	650	6.60	422	16	7	3
S2	28.6	7.9	412	6.10	376	36	0	14
S3	28.0	7.6	417	7.90	371	33	0	10
S4	25.0	7.7	432	1.37	286	4	0	0
S5	28.0	7.4	680	6.40	387	30	5	7
S6	28.0	8.0	546	3.20	331	0	0	2
S7	26.0	7.8	260	2.10	174	5	0	2
S8	28.0	7.6	1019	7.90	663	22	5	7
S9	26.0	6.8	351	5.00	236	8	0	0
S10	27.0	7.7	352	7.10	335	20	10	5

Table (5): Physicochemical and microbial analysis of water samples collected from Sennar city during autumn 2020.

Sample code	Temp. (°C)	pH	E.C. µs/cm	Turb NTU	T.D.S.	Total coliform	*E. coli*	Faecal streptococcus
A1	25.6	7.6	311	0.26	208	0	0	0
A2	25.1	7.6	228	7.20	152	22	2	10
A3	26.6	7.9	280	016	187	0	0	0
A4	28.5	6.8	983	8.41	510	40	3	21
A5	33.0	7.4	543	8.59	353	20	0	0
A6	34.0	7.4	600	6.56	390	30	0	8
A7	28.4	7.8	208	6.70	139	35	9	18
A8	26.0	7.7	231	5.30	181	15	0	11
A9	27.0	7.5	350	6.40	167	25	3	5
A10	26.0	7.7	311	8.26	208	30	5	9

Table (6): Physicochemical and microbial analysis of water samples collected from Sennar city during winter 2020.

Sample code	Temp. (°C)	pH	E.C. µs/cm	Turb NTU	T.D.S.	Total coliform	*E. coli*	Faecal streptococcus
W1	28.0	7.9	381	7.50	247.00	34	0	6
W2	28.0	8.0	397	0.74	280.00	0	0	0
W3	27.0	7.5	430	5.60	288.00	14	2	0
W4	27.0	7.9	231	6.30	181.57	27	9	7
W5	26.0	8.3	1058	0.80	687.72	4	0	0
W6	26.0	81	979	6.30	631.00	23	5	11
W7	25.9	7.7	469	5.76	320.39	5	0	0
W8	26.0	7.7	231	0.30	153.78	0	0	0
W9	27.0	7.5	350	6.40	267.50	29	0	11
W10	27.0	8.1	1032	1.20	675.00	11	0	3

It is clear from Tables (1, 2, 3, 4, 5 and 6) that the highest values of turbidity were recorded in autumn in both years 2019 and 2020, as during the rainy season the Blue Nile River received large volume of storm water with suspended material and this increased turbidity of the water. Igbal *et al.* (2004) reported that minimum value of turbidity was observed in December and the highest in July as flood and rains bring sand and organic matter from adjoining areas.

Turbidity may indicate the presence of disease causing organism. However, turbidity can interfere with disinfection and provide a medium for microbial growth.

The total dissolved solids of the samples were presented in Tables (1, 2, 4, 4, 5 and 6) in summer, autumn and winter in the year 2019 and 2020. The highest value 687 recorded by sample No. 5 in winter 2020, and the lowest value 116 was found in sample No. 8 in winter 2019. All readings fall below the threshold value of the Sudanese Standards and Meteorology Organization (SSMO, 2015). Similar observation was reported by Elbakri (2009) who reported that the TDS highest mean value 757mg/L was found in ground water in Khartoum and the lowest one (152-33mg/L) was found in surface water. Also Khojaly (2011) found that TDS ranged from 137 to 1080 mg/L in some locations and in bottled water 184mg/L. total solids showed positive correlation with turbidity as observed by Chaudhary *et al.* (1990).

The low conductivity and TDS values measured reflect freshness of the water source (Aiyesami, 2006).

Microbial analysis

Results from Tables (1, 2, 3, 4, 5 and 6) indicated that 70, 90 and 70% of the samples in the year 2019 showed the presence of total coliform bacteria in summer, autumn and winter respectively. However, in the year 2020 the percentage of total coliform was 90, 90 and 80 in summer, autumn and winter respectively.

The presence of *Echerichia coli* in water samples were presented in Tables (1, 2, 3, 4, 5 and 6). The percentage was 30, 40 and 20% in the year 2019 in summer, autumn and winter respectively. However, in the year 2020 (Tables 4, 5 and 6) the percentage value was 50, 50 and 30% in summer, autumn and winter respectively.

The presence of faecal streptococcus bacteria was detected in some water samples and the percentage was in 2019 respectively. However, in the second year data 2020, the percentages were 80, 70 and 50% in summer, autumn and winter respectively. The presence of coliform, *E coli* and faecal streptococcus bacteria means that these water samples were contaminated and the water unfit for drinking according to the Sudanese Standards (SSMO, 2015) and the International Standards of WHO (2008) for drinking water. These standards stated that *E. coli* or thermotolerant coliform bacteria must not be detectable in any 100ml sample. Similar results were reported by Chan *et* a*l*. (2007) Kurup *et al*. (2010) in Guyana, Rafi *et al*. (2011) in India and El Amin *et al*. (2012) in Sudan. They reported that some water samples were contaminated by coliform, *E. coli* and faecal streptococcus bacteria.

As it can be seen from the results of this tudy, the highest percentage of bacterial contamination of the water samples were observed in autumn in both years (2019 and 2020), that was so because in autumn (rainy season) the Blue Nile river have high turbidity which can protect the pathogenic microorganisms from the effect of disinfectants and stimulate the growth of bacteria during storage.

The high temperature, turbidity and TDS, these factors can affect the growth of pathogenic bacteria and increase the percentage of their presence in water samples as seen in autumn in both years (Table 2, 5). The high contamination in the rainy season, may be attributed to the influx received by the Blue Nile River in autumn, which carried microorganisms originating from different places as garbage and domestic waste.

CONCLUSION

The results indicated that most of the samples examined were contaminated physicochemically and microbially and this may constitute a serious hazard to public health. The study recommends the application of more adequate disinfection processes before distribution for domestic uses.

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