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Evaluation of Drinking Water Quality in Singa City, Sennar State

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Abstract:- The study was carried out on water samples collected from different sites in Singa city, Sudan. Thirty samples of drinking water were collected randomly during summer, autumn, and winter for two succesive years 2019 and 2020.The objective of the study was to determine the quality of drinking water by looking into physicochemical and microbial aspect. The physicochemical and microbial analysis were performed according to the American Public Health Association, American Water Works Association and Water Pollution Control Federation. The physicchemical analysis were performed for temperature, PH, electrical conductivity(E.C.),turbidity, and total dissolved solids (T.D.S.).The microbial analysis were performed to detect the presence of microorganisms such as total coli form, Escherichia coli and faecal streptococcus. Results showed that the temperature of the samples were within the limit in summer, but exceeded the Sudanese Standarad Limits in autumn and winter. The PH, (E.C.) and (T.D.S.)were within the Sudanese Standards .Results showed the presence of coliform, Escherichia coli and faecal streptococcus in some samples, and this indicated that some water samples were unfit for human consumtion It is recommended to carry out bacteriological examination frequently for water in the distibution system.

Keywords:- *Singa City, Microbial Analysis, Physicochemical Analysis, Drinking Water.*

I. INTRODUCTION

Access to safe drinking water is essential to health and a basic human right. Most gradual deterioration of Water quality was resulted by the increase in human populations and movement of displaced groups in cities and urbanization. Water related diseases and illnesses are responsible for the loss of productivity and death of millions of people in the developing countries.

Water used in Sudan derives from surface water resources, as ground-water is used in limited area. In many countries around the world including Sudan, Some drinking water supplies have become contaminated which has impacted on the health and economic status of the population.

The present work was undertaken to evaluate the drinking water quality, physicochemically and microbialy in Singa city, Sudan.

II. MATERIALS AND METHODS

- *Study area:*

Singa is located on the western bank of the Blue Nile River; it is the capital of Sennar State, Sudan. Most of the populations are working in agriculture. It is one of the Arabic Gum Trade Center.

- *Sample collection:*

The water samples from different sources and sites of Singa city were collected during three seasons (summer, autumn and winter) in clean polyethylene plastic containers and examined in the laboratory immediately after arrival.

- *Sample analysis:*

The water samples were examined to determine temperature, electrical conductivity, pH and turbidity. Attach Multimeter was used to measure temperature, pH and electrical conductivity., turbidity was measured by turbidometer. The total dissolved solids (TDS) were analyzed using method prescribed by APHA (1998).

- *Microbial analysis:*

Microbiological parameters were examined in the laboratory using methods prescribed by APHA (1998). The American Public Health Association and the samples were examined for total coliform, *Escherichia coli* and faecal streptococcus.

III. RESULTS AND DISCUSSION

The data presented in Table (1, 2, and 3) showed the physiochemical and bacteriological analysis of water samples collected from different sites in Singa city during summer, autumn and winter in the year 2019. The temperature of water samples in summer ranged from 23.1 to 25.6^{o}C. All samples in summer were within the limit of the Sudanese Standards and Meteorology Organization (SSMO, 2015) except sample No. 1, which exceeded the optimal temperature (25^{o}C). In autumn 2019 the temperature ranged from 27 to 33^{o}C, all these samples were above the level of SSMO (2015). In winter 2019 only 40% of the samples were within standard limit and 60% were above the standard limit of SSMO (2015). However, in the year 2020, in summer only one sample was within the

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standard limit, while other samples were above the standard limit (Table (4). In autumn 2020 three samples fall within the standard limit, while seven samples exceeded the optimal temperature (25°C) ((Table 5). In winter 2020 five samples exceeded the optimal temperature and the other samples fall within the standard limit (Table 6). The relatively high temperature of water samples recorded in the year 2020 is attributed to time and period of sample collection.

Cool water is generally more acceptable than warm water especially in tropical countries, and warm water may affect the acceptability of inorganic constituents which may affect taste.

Generally high water temperature enhances the growth of micro-organisms and may increase taste, odour, colour and corrosion problem (WHO, 2008).

The pH levels of samples taken in summer, autumn and winter in 2019 were within the permissible limit (6.5 – 8.5) of Sudanese Standard and Meteorology Organization (SSMO, 2015) (Tables 1, 2, 3). However in the year 2020, the pH of all samples in summer, autumn and winter were within the limit except one sample No. 2 in summer exceeded the permissible limit (Tables 4, 5 and 6). Similar observation were reported by Abdel Halim (2010) who found the pH value in ground water between 7.63 – 8.02 and Khojaly (2011) who stated that the pH of water samples were 8.06 in Khartoum and 7.22 in Omdurman.

The electrical conductivity (E.C.) in the year 2019 ranged from 173.5 to 419µs/cm, all samples were within the permissible limit of the Sudanese Standards and Meteorology Organization (SSMO, 2015) (Tables 1 and 2). In winter the E.C. ranged from114 to 634µs/cm, all readings fall below the acceptable level of the SSMO (2015) (Table 3),similar observations were obtained by Ali(2008) who found that the E.C. ranged from 223-175.4µs/cm in Khartoum State, and Khojaly (2011) reported that the E.C of the sample ranged from 305-1356µs/cm in Khartoum State.

The low conductivity values measured in summer were higher than for the autumn that was so, because of excessive evaporation of water in summer.

The turbidity in summer 2019 showed only one value exceeded the limit of SSMO (2015) and all other samples were within the permissible limit. On the other hand in autumn 2019, 80% of samples exceeded the standard limit and only 20% of the samples values fall within the standard limit (5NTU). However, in winter 2019, three samples exceeded the permissible limit and70% of the samples was below the permissible limit. In the yea 2020, in summer 70% of the sample value exceeded the standard limit and only 30% of the samples fall within the standards limit. In autumn 2020 60% of the samples exceeded the standard limit and 40% fall below the standard limit (Table 5). In winter 2020 only 30% of the samples were above the standard limit and 70% fall within permissible limit. Similar results were reported by Ali (2008) who found the turbidity level ranged from 1.00 to 8.60 NTU in Khartoum State. Turbidity may indicate the presence of disease causing organism. Exessive turbidity can protect pathogenic microorganisms from the effects of disinfectants and may constitute a health risk. `

The total dissolved solids as measured in summer 209, ranged from 116 to 248mg/L and in autumn the range from 157 to656 mg/L, and in winter 2019 ranged from 76.78 to 42478 mg/L. all these values were within limited of SSMO (2015) (1800mg/L). However, in the year 2070 in summer the values of TDS ranged from 239.30 to 893.66mg/L and in autumn the lowered value recorded 131mg/L and the highest one measured 371.50mg/L. In winter the highest value reached 491.82mg/L at sample No.W10 and the lowest value 140.7mg/L was found in sample no.W7. similar observation was reported by Elbakri (2009) who reported that TDS highest value 757mg/L was found in water sample in Khartoum and the lowest one 33mg/L was found in surface water. On the other hand, Ali (2008) found that TDS ranged from 133.7 to 1548mg/L in Khartoum State.

An elevated TDS may be associated with an elevated water hardness, chemical deposits, corrosion by-products, staining or salty bitter taste 9WHO 2006).

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Table (1): Physicochemical and microbial analysis of water samples collected from Singa 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	23.7	7.40	332	4.78	222.00	4	0	0
S2	23.0	7.41	352	1.76	236.00	2	0	0
S3	24.0	7.40	222	1.10	148.70	0	0	0
S4	23.6	7.40	214	1.30	143.90	0	0	0
S5	25.0	7.44	177	3.90	118.00	0	0	0
S6	24.0	7.50	273.5	2.46	116.00	0	0	0
S7	24.0	7.44	370	5.10	248.00	5	2	3
S8	24.0	7.57	357	3.20	239.00	4	1	2
S9	24.0	7.32	320	3.90	214.00	5	2	3
S10	25.6	7.80	419	4.60	246.70	3	0	2

Table (2): Physicochemical and microbial analysis of water samples collected from Singa 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	27.0	7.2	325	6.19	278	4	1	3
A2	27.1	7.4	242	1.50	157	0	0	0
A3	27.3	7.0	260	7.22	255	6	2	4
A4	27.3	7.4	254	0.12	165		0	0
A5	27.1	7.4	176	8.16	141	5	1	3
A6	32.5	7.3	208	10.0	183	9	4	5
A7	33.0	7.3	332	6.3	305	8	5	7
A8	31.0	7.6	316	5.6	256	7	2	4
A9	33.0	7.4	277	8.0	235	9	4	6
A10	31.0	7.2	410	6.40	201	11	3	5

Table (3): Physicochemical and microbial analysis of water samples collected from Singa 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	28.0	8.0	486	6.20	291.62	15	8	4
W2	25.4	8.0	270	1.20	180.90	4	2	0
W3	25.3	7.8	114	2.20	76.78	6	0	0
W4	25.4	7.8	410	5.20	240.00	13	0	5
W5	25.8	7.8	311	5.00	208.40	0	0	0
W6	24.4	7.8	341	0.38	241.00	0	0	0
W7	25.0	8.1	348	0.50	228.40	0	0	0
W8	24.0	7.7	634	5.33	424.78	2	0	0
W9	24.0	7.6	302	0.28	202.34	0	0	0
W10	25.0	7.4	365	0.50	244.55	0	0	0

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Table (4): Physicochemical and microbial analysis of water samples collected from Singa 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	26.0	7.2	844	5.26	893.45	9	0	0
S2	27.0	8.6	1023	6.22	704.23	45	0	22
S3	255	7.8	826	8.50	745.43	35	8	3
S4	25.5	7.7	737	5.72	672.54	11	2	0
S5	26.6	8.3	1026	8.16	893.66	24	0	0
S6	27.0	8.2	680	0.30	448.00	5	0	0
S7	25.4	7.8	308	6.70	239.30	37	9	11
S8	23.7	7.8	374	4.60	250.26	7	0	2
S9	27.7	8.0	759	6.87	582.00	21	0	9
S10	30.0	7.4	694	3.40	451.00	0	0	0

Table (5): Physicochemical and microbial analysis of water samples collected from Singa 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	24.0	7.20	358	6.10	239.80	40	7	22
A2	24.4	7.30	359	5.30	240.53	3.3	0	19
A3	25.4	7.30	196	6.04	131.00	11	5	0
A4	26.0	7.60	656	6.70	371.50	40	0	16
A5	25.8	7.41	215	6.20	244.00	40	2	15
A6	25.7	7.40	352	4.40	235.80	0	0	0
A7	25.6	7.30	495	5.20	230.60	25	5	4
A8	25.3	7.50	207	4.10	138.60	30	0	8
A9	25.6	7.40	397	5.40	265.90	30	0	12
A10	25.0	7.20	220	5.20	147.40	18	7	6

Table (6): Physicochemical and microbial analysis of water samples collected from Singa 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	25.0	7.4	365	0.50	244.55	8	0	0
W2	24.0	7.6	302	0.28	202.4	34	2	0
W3	24.4	7.7	634	0.33	424.78	0	0	0
W4	25.0	8.1	341	6.40	228.40	22	0	5
W5	24.4	7.8	341	0.38	241.80	21	0	9
W6	25.4	7.8	311	1.20	208.40	0	0	0
W7	25.4	7.8	210	3.20	140.70	15	0	4
W8	25.3	7.8	114	5.20	176.78	15	0	7
W9	25.4	8.0	270	1.20	180.90	30	5	12
W10	25.3	8.0	886	5.20	491.62	33	5	15

➢ *Microbial analysis:*

The total coliform percentage reached 60% of the sample in summer, 80% in autumn and 50% in winter in 2019. However in the year 2020 the total coliform were 90, 90 and 80% in summer, autumn and winter respectively.

The presence of *Eschericha coli* in water samples in the year 2019 were 30, 80 and 20% in summer, autumn and winter respectively. In the year 2020 the percentage of *E. coli* were 30, 50 and 30% in summer, autumn and winter respectively.

The faecal streptococcus was found in 40% of the sample in summer 2019 and 80% in autumn and 20% in winter. In the year 2020 the highest value of total coliform was found in sample No.S 2 in summer and the percentage of prevalence was 60%, however, in autumn the percentage was 80% and in winter 60%. Similar results were reported by Habib Allah (1981) who found the presence of coliform bacteria in samples collected from tap water in Omdurman city, Khartoum and Bahri city. Alkhiry (2015) found that the water from Omdurman city, Bahri and Khartoum were contaminated by coliform, *E. coli* and faecal streptococcus bacteria. Also Salih (2013) found that water from wells of Harat 7, 9 and 29 and Alneal city was contaminated by *E. coli* and coliform. When comparing the three seasons, winter was the least contaminated, then summer and the most contaminated samples were that taken in autumn. This was so because in autumn the turbidity of the Blue Nile River was very high, and that can protect the pathogenic microorganism from the effects of disinfectants, and stimulate the growth of bacteria during water storage.

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

IV. CONCLUSION

The study concluded that some water samples physicochemical parameters exceeded the standard liit of SSMO (2015) and some samples were contaminated by coliform, *E. coli* and faecal streptococcus. Water distribution system in Singa city need more effort in limiting the numbers of microorganisms released into distribution system. It is highly recommended to carry out bacteriological examination frequently and regularly for water entering the distribution system and the water in the distribution system.

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