



(RESEARCH ARTICLE)



Physicochemical and microbiological assessment of drinking water quality in Swakin city

Fatima B. Madni, Elnasri M. Mutwali * and Huda M. Selman

Faculty of Education, Alzaiem Alazhari University, Sudan.

GSC Biological and Pharmaceutical Sciences, 2022, 18(03), 108–112

Publication history: Received on 09 February 2022; revised on 10 March 2022; accepted on 12 March 2022

Article DOI: <https://doi.org/10.30574/gscbps.2022.18.3.0072>

Abstract

The study was carried out on water samples collected from different sites in Swakin City and Arbat area in Sudan. Five samples were collected during two seasons (winter and summer) to determine the quality of the drinking water by looking into physicochemical and microbial aspect. Results showed that some samples exceeded the Sudanese and international standards in turbidity and some samples showed the presence of coliform, *E. coli* and faecal streptococcus bacteria. It is recommended to carry out microbial examination frequently for water in the distribution system.

Keywords: Water; Contamination; Drinking Water quality; Swakin City

1. Introduction

The provision of drinking water of adequate quality and quantity remains a major public health need in many African countries. Many of the existing improved sources in developing countries do not provide water of adequate quality for domestic purposes. The principal cause of concern is microbiological contamination especially from faeces [1].

Diarrheal disease problems from contaminated water represent a serious hazard in developed countries and chronic one in developed countries [2].

Most gradual deterioration of water quality was resulted by the increase in human population and the displacement of people to big cities.

The objective of this study was to determine the microbiological and physico-chemical quality of water samples collected from Swakin city during 2019.

2. Material and methods

2.1. Samples collection

The water samples from different sources and sites in Swakin 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.

* Corresponding author: Elnasri M. Mutwali
Faculty of Education, Alzaiem Alazhari University, Sudan.

2.2. Microbiological examination

Total viable bacterial count was carried out using the pour plate technique according to Harrigan [3]. 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 [4].

2.3. Physicochemical 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 [4].

3. Results and discussion

All values of turbidity fall below the threshold value of the Sudanese standards [5]. and the international WHO [6]. The highest value in winter (Table 1) was 4.75 NTU in sample No. 1 and lowest one was 0.02 NTU which was recorded by sample No. 5.

The total dissolved solids showed variation (Table 1) and they ranged from 251.3 mg/L at sample No. 5 to 552.2 mg/L at sample No. 1. All these values were within the Sudanese Standard (1000 mg/L) and International [6] limits. Elbakri [7] reported that the TDS highest mean value 757 mg/L was found in ground water in Khartoum and the lowest one 152 mg/L was found in surface water. On the other hand Abdel Halim [8] found that TDS ranged from 111.20 to 412 mg/L in ground water while surface water the range was 110.5-125.3 mg/L. Al Khiry *et al.* [9] reported that the TDS ranged from 460 to 100 mg/L in Omdurman city and from 530 mg/L to 170 mg/L in Bahri City, while in Khartoum city it ranged from 500 to 139 mg/L.

An elevated TDS may be associated with elevated water hardness, chemical deposits, corrosion by-product staining or salty bitter taste [10].

The pH values (Table 1) of all samples were within permissible limit of Sudanese Standards [5] and the WHO [6] Standards (6.5-8.5). Similar results were obtained by Abdel Halim [8] who found the pH value in ground water between 7.63 and 8.02 and Khojaly [11] found that the pH for well was 8.06 in Khartoum and 7.22 in Omdurman.

The highest total viable count was found in sample No. 5 and the least one recorded by sample No. 4 during winter (Table 1). All samples showed the presence of coliform bacteria and the highest count was found in sample No. 5, while the least one in sample No. 4.

Table 1 Physicochemical and microbial analysis of water samples collected from Swakin city during winter 2019.

Samples No.	Parameter's measure						
	Turbidity (NTU)	T.D.S. (mg/L)	pH	T.V.C.	Total coliform	<i>E. coli</i>	Faecal streptococcus
1	4.75	552.2	8.2	6.5 x 10 ³	48	0	0
2	3.05	489.3	8.1	8.9 x 10 ⁵	30	4	0
3	0.05	320.8	8.1	5.6 x 10 ⁴	15	0	6
4	0.04	370.1	8.3	6.3 x 10 ⁵	8	0	0
5	0.02	251.3	7.7	7.6 x 10 ⁴	300	165	80

Table (1) indicated the presence of coliform in all samples and 80% of the samples were contaminated by *E. coli* and faecal streptococcus bacteria. These results indicated that these samples were unfit for human use according to the Sudanese Standards [5] and International Standards [6]. In connection to this, Elbakri [7] found that the drinking water samples were contaminated by coliform and *E. coli* in Elhasahisa city and Al Khiry [12] found that water from Omdurman city was contaminated by coliform and *E. coli* bacteria. On the other hand, Ebrahim *et al.* [13] found that some of the samples of water collected from Sennar city were contaminated by coliform, *E. coli* and faecal streptococcus.

Table (2) showed the water analysis in summer season in Swakin city. The turbidity values were within the standard limits of the Sudanese and International value (5 NTU). All values of the total dissolved solids were below the Sudanese Standards [5] and WHO [6] Standards.

The pH levels were within optimum limit of the Sudanese and International Standards.

In summer season (Table 2) the total viable count of bacteria was higher than in winter (Table 1) and the percentage of total coliform, *Escherichia coli* and *faecal streptococcus* were 100%, 80% and 60% respectively. These results indicated that these water samples were unfit for drinking according to the Sudanese Standards [5] and the International Standards [6] for drinking water, which stated that *E. coli* of thermotolerant bacteria must not be detected in any 100ml sample. Similar results were reported by Al Khiry *et al.* [9] who found that some samples of water collected from Omdurman city were contaminated by coliform, *E. coli* and faecal streptococcus bacteria. Ebrahim *et al.* [13] found some samples of water collected from Singa city contaminated by coliform, *E. coli* and faecal streptococcus bacteria. The presence of coliform bacteria, *E. coli* and faecal streptococcus gave an indication that water treatment system was not operated satisfactorily.

Table 2 Physicochemical and microbial analysis of water samples collected from Swakin city during summer 2019.

Samples No.	Parameters measure						
	Turbidity (NTU)	T.D.S. (mg/L)	pH	T.V.C.	Total coliform	<i>E. coli</i>	Faecal streptococcus
1	3.23	422.2	7.9	5.5×10^3	50	0	0
2	2.05	349.1	8.0	$73. \times 10^4$	49	19	13
3	0.03	310.7	8.1	4.8×10^2	28	10	0
4	0.02	280.1	8.3	6.6×10^3	25	15	8
5	0.01	221.3	7.7	7.6×10^4	300	185	90

Tables (3 and 4) showed the physicochemical and microbial analysis of water samples collected from Arbaat area, where is the source of the water for Swakin city. The turbidity values ranged from 4.13 to 14.10 NTU for samples No. 2 and 5 respectively. All the values of total dissolved solids (T.D.S.) fall below the permissible limit of SSMO [5] and WHO [6] and ranged from 340.3 mg/L to 635 mg/L.

The pH values were within optimum limit of the Sudanese Standards and the International Standard (6.5-8.5).

The highest count of the total viable count was found in sample No. 1 and the least one found in sample No. 3. All samples of the water were contaminated by coliform bacteria and the highest count was in sample No. 1 and the least one in sample No. 5. Table (3) showed that *E. coli* was found in 40% of the samples with the highest count in sample No. 1. The faecal streptococcus bacteria was found only in sample No. 1. However, in summer season (Table 4) the turbidity ranged from 3.13 in sample No. 2 to 13.10 NTU in sample No. 5. Some samples exceeded the permissible limit of the Sudanese Standard. The total dissolved solids ranged from 222 mg/L to 536 mg/L and all value fall below the standard limits of [5] and [6]. The pH values of all samples were within the standard limit. The total viable count was higher than that of the winter season (Table 3), with the highest count in sample No. 1 and the least in sample No. 4. The total coliform bacteria were found in 80% of the samples, with the highest one in sample No.1 and was not detected in sample No. 4. The presence of *E. coli* was found in 60% of the samples with the highest value in sample No. 1. However, the faecal streptococcus was present in two samples out of the total five samples and the highest value was in sample No. 1. Similar results were reported by Idris [14] who found that water in Omdurman city was contaminated by the coliform, *E. coli* and faecal bacteria and Alkhiry [12] found that water in Omdurman was contaminated by the coliform, *E. coli* and faecal streptococcus bacteria.

The presence of coliform bacteria in treated water gave an indication that water treatment system was not operated satisfactorily.

Table 3 Physicochemical and microbial analysis of water samples collected from Arbaat sources during winter 2019.

Samples No.	Parameters measure						
	Turbidity (NTU)	T.D.S. (mg/L)	pH	T.V.C.	Total coliform	<i>E. coli</i>	Faecal streptococcus
1	10.00	432.0	7.8	5.6×10^5	145	45	35
2	4.13	636.4	7.9	1.8×10^3	28	13	0
3	5.20	420.8	7.9	4.3×10^2	27	0	0
4	5.66	354.0	7.9	7.0×10^3	6	0	0
5	14.10	340.3	7.9	3.6×10^3	3	0	0

Table 4 Physicochemical and microbial analysis of water samples collected from Arbaat sources during summer 2019.

Samples No.	Parameters measure						
	Turbidity (NTU)	T.D.S. (mg/L)	pH	T.V.C.	Total coliform	<i>E. coli</i>	Faecal streptococcus
1	5.56	322	7.8	3.8×10^5	240	68	50
2	3.13	536	7.9	6.6×10^3	39	26	10
3	4.80	320	7.2	2.4×10^4	29	19	0
4	5.60	222	7.3	3.7×10^3	0	0	0
5	13.10	240	8.0	5.1×10^3	10	0	0

It is worth mentioning that the samples which were collected in summer season were more contaminated than that collected in winter season. This may be attributed to the higher temperature in summer which increases the water temperature, therefore enhances the growth of microorganism.

4. Conclusion

The study concluded that water distributed in Swakin city and Arbaat area need more effort in limiting the numbers of microbial organisms released into distribution system. It is highly recommended to carry out bacteriological examination frequently and regularly for water entering the distribution system.

Compliance with ethical standards

Acknowledgments

The authors thank the members of the Biology Department of the Faculty of Education, Alzaiem Alazhari University, Khartoum, Sudan.

Disclosure of conflict of interest

The authors have declared that no competing interests exist .

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