QUALITY EVALUATION OF SOME "SEBEEL" WATER SAMPLES IN KHARTOUM STATE

Abdel Moneim E. Sulieman, Yasir O. Yousif and Sirelkhatim B. Elhardallou

Department of Food Science and Technology, Faculty of Engineering and Technology, University of Gezira, Wad-Medani, Sudan
E-mail: moneim_ug@yahoo.com

ABSTRACT

The aim of the present study was to analyze microbiologically and chemically "Sebeel" drinking water samples which were taken in four consecutive weeks from five sites in Khartoum State (Khartoum, Omdurman and Khartoum North). Analytical results were compared with local and International Standards. Microbial analysis recorded a high level of colonic bacteria (21 – 93 MPN/100ml); faecal bacteria (4.00 MPN/100ml), faecal *streptocooci* bacteria (0–7 MPN/100ml) in (Shambat) "Sebeel" water. Data of these bacteria were less in (Mogran) "Sebeel" water. Chemical components of "Sebeel" water were in agreement with those of the Sudanese and International Standards, pH was found in the range of 7.9 – 8.00, total dissolved solids (TDS) (115 – 137 mg/L); sulfate (4.75 – 47.00 mg/L) and sodium (23.22 – 32.82 mg/L). Athawra "Sebeel" water gave better results of (TDS) in comparison with other examined "Sebeel" water samples.

Keywords: Quality, Sebeel, Microbiological examination, Chemical examination

1. INTRODUCTION

The water quality is tested by water analysis so that the primary purpose to water analysis is to determine the suitability of water for proposed use, Fadol [1]. Surface waters, particularly rivers, are difficult to protect from contamination. A range of anthropogenic activities may contaminate surface waters including , aquaculture municipal and industrial waste water discharges, overloaded or leaking sanitation systems, improper disposal of garbage and hazardous wastes, mining , deforestation / landscape alteration, incineration of waste leading to air borne deposition of heavy metals (e.g. mercury, cadmium). Industrial processes; combustion related air pollution which leads to acid rain and others (Roy *et al*, [2]).

Protection of water supplies from contamination is the first line of defence. Source protection is almost invariably the best method of ensuring safe drinking water.

There is no such thing as naturally pure water in nature, all water contains some impurities. As water flows in streams, sits in lakes, and filters through layers of soil and rock in the ground, it dissolves or absorbs the substances that it touch, some of

these substances are harmless. In fact, some people prefer mineral water precisely because minerals give it an appealing taste. However, at certain levels, minerals, just like man–made chemicals, are considered contaminants that can make water un palatable or even unsafe (EPA [3]).

There are different types of water consumption in Khartoum State, such as using of tap water, cold water in refrigerator, cold water in the (Zeer) which is made manually from the earthen ware. Sometime people put more than one (Zeer) in front of their houses or under the shadow of trees or in the streets and different places to make water available for people who passes by these areas, such (Zeers) are called (Sebeel). Sebeels are public watering places which may consist of one, two … or sometimes more "Zeers".

In classical Arabic the word "Sebeel" means "road". Also in Islam "Ibn-essabeel" literally means "The son of the road" referring to travellers or passers by (Zohour [4]).

The Sudanese commonly keep their drinking water in jars (capacity 30 to 40 liter) made of backed clay called "Zeers". These keep the water cool and refreshing due to evaporation through the walls of jars. "Sebeels" are public, street-side watering stands which may consist of one, two, or up to six Zeers. They are normally provided by economically able individuals in the community in accordance with Islamic teaching. Water from the "Sebeel" is normally served by one cup which is dipped into the Zeer whenever one wants to drink.

There are many Sebeels in different streets, mosque, schools, hospitals, and market places. These Sebeels serve a large sector of population of Khartoum (Hammad and Dirar [5]). The hygienic suitability of these "Sebeels" has been questioned. Some scientific reports have supported that these public jars may serve as a vehicle of public health hazards. However due to the need for drinking water by the street – passers and the absence of a suitable practical alternative, this "Sebeel" system can not be condemned.

A wise step is to improve this system, this step need to be preceded by sufficient research to furnish a full data on all the dimensions of the problem (Zohour [4]). The objective of this research was to assess the microbiological and chemical properties of (Sebeel) water in Khartoum State.

2. MATERIALS AND METHODS

2.1 Sampling

Twenty five samples of water were collected weekly during one month from five "Sebeels" distributed throughout Khartoum, Khartoum North, and Omdurman. Two "Sebeels" water at Omdurman (Althawra and Wad nobawi), two "Sebeels" water at

Khartoum North (Shambat and Al droshab) and one "Sebeel" at Khartoum (Almogran).

Samples of "Sebeels" water were collected and immediately transported without ice in sterile bottles to the laboratory in Khartoum University –Shambat, and examined directly.

2.2 Microbiological Examination

2.2.1 Colony count

Total viable count was carried out using the pour technique as described by Harrigan and MacCane [6]. 10 ml of each sample was transferred to 90 ml of sterile diluent, as a first dilution 10^{-1}, serial dilutions were made up to 10^{-6} and 1 ml of each dilution was transferred aseptically in duplicate into Petri-dishes. 10 – 15 ml melted plate count agar (45 - 46°C) was poured into the dishes. The dishes were then thoroughly mixed to facilitate distribution of the sample throughout the medium, the medium was allowed to solidify and plates were incubated at 37 °C for 48 hours. Colony counter (Labtech) and hand–tally were used for the determination of the total bacterial counts in terms of colony forming units per ml (C.F.U/ml).

2.2.2 Most probable test

The multiple fermentation tube or most probable technique was used for enumeration of total coliform, Feacal coliform and *Feacal* streptococcus.

Most probable number test was carried out according to APHA [7], a measured portion of water sample was placed in test tubes containing a culture medium. The tubes were then incubated for a standard time at a standard temperature; the tubes also contained a small inverted glass tube (Durham tube) to facilitate the detection of gas production.
This test comprised three steps:

(a) Presumptive test.
(b) Confirmed test.
(c) Completed test.

(a) Presumptive test

The multiple tube fermentation technique was performed as a presumptive test for total coliform using tubes containing MacCane broth and inverted Durham tubes. Inoculation was carried out as follows:

(i) To each of 3 double-strength MacCane broth tubes, 10 ml of the original sample was added.
(ii) To each of 3 double-strength MacCane broth tubes, 1 ml of the original sample was added.
(iii) To each of 3 double-strength MacCane broth tubes, 0.1 ml of the original sample was added.

All tubes were incubated at 37°C for 48 hours for the observation of gas production. First reading was taken after 24 hours to record positive tubes, and the negative ones were incubated for another 24 hours.

(b) Confirmed test

Each gas positive presumptive tube was inoculated into a tube containing 10 ml brilliant green lactose broth medium. All tubes were incubated at 37°C for 48 hours for the observation of gas production.

(c) Completed test

At least 3 loopful of each confirmed positive tube were subculture into EC broth medium and then incubated at 44.5°C for 24 hours. Tubes showing any amount of gas production were considered as positive and the probable number was recorded (the results were compared with the most probable number Table) (APHA [7].

2.2.3 Yeasts and moulds

Using spreading plate count method, potato dextrose agar was used for detection of yeast / moulds, using the serial dilutions from each sample. 0.1 ml from each dilution was taken; incubation was at 28°C for 72 hours.

2.2.4 Feacal streptococci test

Azide dextrose broth was used for the enumeration of *Feacal streptococcus*, tubes were incubated at 35°C and checked for turbidity after 48 – 72 hours. These dilutions were used (10^{-1}, 10^{-2}, 10^{-3}), from each dilution 3 tubes were prepared, and then results were recorded and compared with the most probable number Table.

2.3 Chemical Examination

Total dissolved solids (TDS), electrical conductivity (E.C), and pH were determined in the laboratory by pH meter (Hanna -instrument, model No: H 19811-5). 100 ml of "Sebeel" water sample were put in a beaker then a glass electrode was put in the sample, and the results were recorded directly.

2.3.1 Determination of minerals and minerals salts

The minerals and minerals salts contents in the different samples of sebeel water were determined according to the (AOAC [8]. The minerals and present in the ash as metallic oxides were converted to chlorides by HCl and diluted. Flame Atomic Absorption Spectrophotometer (FAAS) with a variant spectrometer (SPECTR AA-10) was used to determine calcium, sodium, chloride, sulfate and flouride.

3. RESULTS AND DISCUSSION

3.1 Microbiological analysis of " Sebeel " water

Table (1) presents the microbiological parameters of "Sebeel" water samples. Results indicate that 100% of "Sebeel" water in (Shambat) area shows the presence of total coliform and *E.coli*, which are considered as indicators of contamination, according to the WHO [9] the optimum condition of water intended for drinking: the total coliform and *E.coli* must not be detected in any 100 ml sample; therefore those water samples were unfit for drinking. In addition through the testing period results indicated that high total viable counts were associated with relative high (MPN) of total coliforms and *E.coli.* Moreover, results indicated presence of streptococci in 25% of "Sebeel" water samples. However, detection of streptococci in these water samples was exposed to contamination from human or animal faeces.

The microbiological examination also indicated that all collected samples throughout the period (all weeks) show the absence of yeasts and moulds that may refer to the proper cleaning of the storage tank or there was no defect on the pipe-lines, or water has not been contaminated during distribution.

Results in Table (1) also indicated that 100% of "Sebeel" water samples in Wad nobawi area show the presence of total coliform. However, *E. coli* were absent in these samples. These results agree with WHO [9] for drinking water. In addition, these results correspond with that reported by Zohour [4] for "Sebeel" in the streets. Zohour [4] stated that due to social habits, Sudanese people usually clean themselves, take a shower, add perfumes to their hands (ethanol kill bacteria) before they go out. Also, she stated that "Sebeel" in the streets are not usually located near toilet places, all these factors eliminate most microorganisms from "Sebeel" water; therefore contamination was reduced.

For Feacal streptococci, results in Table (1) indicate that 50% of "Sebeel" water show the presence of these organisms, so Wad nobawi "Sebeel" water was considered more safe for drinking when compared with Shambat "Sebeel" water because *E. coli* are more specific indicator of feacal contamination than feacal coliform group, WHO [10], which were found in large numbers in Shambat "Sebeel" water samples.

Results show the microbial load of "Sebeel" water in Althawra area and indicated that 100% and 75% of the water samples show the presence of total coliform and *E.coli*, respectively. That means the "Sebeel" water samples were highly contaminated with harmful bacteria which can be associated with health problems, and these organisms were indicator of pollution. Results also indicated that 25% of the samples were contaminated with *Feacal streptococci*, so Althawra "Sebeel" water was more contaminated when compared with Wad nobawi "Sebeel" water, and it had a less contamination when compared with Shambat "Sebeel".

Table 1 Microbial Load of "Sebeel Water" of five sites in Khartoum State at four Consecutive weeks

Site	Detection Period	T.V.C (CFU/ml)	Coliforms MPN/100ml		F. Streptococci (MPN/100ml)
			T.coli	E.coli	
Shambat	1st week	5.6×10^4	21	4	0
	2nd week	3.5×10^4	93	4	7
	3rd week	2.4×10^4	38	4	0
	4th week	2.4×10^4	39	4	0
	Total %	100 %	100 %	100 %	25 %
Wad. Nobawi	1st week	7.5×10^4	23	0	0
	2nd week	5.2×10^3	23	0	0
	3rd week	4.0×10^4	43	0	7
	4th week	4.0×10^4	43	0	7
	Total %	100 %	100 %	0 %	50 %
Al-Thawra	1st week	1.5×10^4	75	9	15
	2nd week	1.6×10^4	43	0	0
	3rd week	4.6×10^5	120	11	0
	4th week	5.6×10^5	120	11	0
	Total %	100 %	100%	75%	25%
Aldroshab	1st week	3.75×10^4	39	0	0
	2nd week	4.8×10^4	23	7	0
	3rd week	3.2×10^5	75	9	0
	4th week	3.2×10^5	75	9	0
	Total %	100 %	100 %	75 %	0 %
Almogran	1st week	3.25×10^4	0	0	0
	2nd week	2.6×10^6	0	0	0
	3rd week	5.0×10^4	28	0	0
	4th week	5.0×10^4	23	0	0
	Total %	100 %	50 %	0 %	0 %

Note: Yeasts and moulds growth were not detected in all weeks.
T.coli: *Total coliform*; *E.coli =Escherichia coli*; T.V.C: Total Viable Count, F.streptococci: Feacal streptococci, Cfu: colony forming unit.

Table (1) show the microbial load of "Sebeel" water in Aldroshab area, and the results indicate that 100% and 75% of "Sebeel" water samples show the presence of total coliform, and of *E.coli*, respectively. And *Feacal streptococci* were absent, this may refer to the addition of fresh water, because these samples showed high viable count, so Aldroshab "Sebeel) water could be considered unfit for drinking, when compared

with other detected "Sebeel" water samples and as well as (Althawra) "Sebeel" water samples.

Table (1) also indicted that 50% of water samples collected from Almogran show the presence of total coliform, however, throughout the testing period, both *E.coli* and *Feacal streptococci* were not detected in these water samples. That means Almogran "Sebeel" water was more safe for drinking. According to the Sudanese and International Standards (WHO [9]) for drinking water, all water intended for drinking should be free from *E.coli* or coliform bacteria and pathogenic intestinal protoza in any 100ml sample, and this result may refer to the efficiency of the water treatment system, so Almogran "Sebeel" water was more acceptable for drinking when compared with other four "Sebeel" water samples.

3.2 Chemical analysis of "Sebeel" water samples

As shown in Table (2) results show that all samples of (Shambat) "Sebeel" water had pH in the range of 7.4 – 8.2 which is acceptable according to WHO [10] for drinking water, which indicate that level of pH which is acceptable must be in the range of 6.5 – 8.5, and high levels more than 8.5 can make a soda taste on the water and according to the Standards water must be odourless, colourless and tasteless. All "Sebeel" water samples gave acceptable results for the total dissolved solids in the average 117 mg/L, according to WHO [10] for drinking water, the level likely to give rise to consumer complains are (1000 mg/L). And this level of the total dissolved solids (117 mg/L) may be due to the source of water which is from Water Corporation (Nile Water).

As shown in Table (2) all samples at Shambat "Sebeel" water gave acceptable results for sulfate in the range of 17.03 – 17.70 mg/L, according to WHO [10] for drinking water high levels of sulfate can cause damage to pipe work, give rise erosion of steel, iron and aluminum due to the action of sulfate, and which indicate that the permissible level of sulfate is (250 mg/L). All samples had sodium in the range of 7.8 – 7.9, which is acceptable according to WHO [10] which indicate that the permissible level of sodium is (200 mg/L).

Results in Table (2) show that all samples of Aldroshab "Sebeel" water had pH in the range of 7.5 – 8.3, which is acceptable according to WHO [10] for drinking water, and in the same range as shown in Shambat "Sebeel" water. All samples gave acceptable results for the total dissolved solids (139 mg/L), but had high level when compared with Shambat "Sebeel" water. The source of water was from Water Corporation (Nile Water), so the level of the total dissolved solids was high.

The chemical analysis also indicates that all Aldroshab samples had sulphate in the range of 17.09 – 17.70 mg/L which is acceptable according to WHO [10] for drinking water. All samples had sodium in the range of 10.00 – 13.00 mg/L which is acceptable, when compared with Shambat "Sebeel" water it is high level.

Table 2 The pH, total dissolved solids (T.D.S.) and chemical composition of "Sebeel" water

	Shambat	**Aldoroshab**	**Althawra**	**Wadnobawi**	**Almogran**
pH	7.90	7.90	7.90	8.00	8.00
T.D.S. (mg/L)	117	137	125	130	115
Calcium (mg/L)	23.24	23.22	32.82	32	32.75
Sodium (mg/L)	7.78	11.25	17.88	9.78	9.00
Chloride (mg/L)	7.00	7.30	18.00	5.00	7.20
Flouride (mg/L)	0.16	0.18	0.15	0.24	0.23
Sulfate (mg/L)	17.24	17.30	47.11	16.00	4.75

Table (2) shows that all samples had a pH in the range of 7.6 – 8.1 mg/L which is acceptable according to the WHO [10] for drinking water, and all samples gave acceptable results for the total dissolved solids (125 mg/L), when compared with Aldroshab and Shambat "Sebeel" water, it consider optimum level because the water source was from Ground Water. Also, all samples had a sulfate in the range of 47.03 – 47.40 mg/L, which it considers high percentage due to the source of water. All water samples contained sodium (32 mg/L), which is acceptable according to WHO [10] for drinking water.

As shown in Table (2) all samples had pH in the range of 7.9 – 8.4 mg/L, which is high when compared with other "Sebeel" water and this may be due to the efficiency of the treatment system. For the total dissolved solids, all samples gave acceptable results (130 mg/L) in the average, which is acceptable according to WHO [10] for drinking water, this result refer to the water source which was from Water Corporation (Nile Water). All samples had sulfate in the range of 15.00 – 17.00 mg/L which is acceptable according to WHO [10] for drinking water, it consider better result when compared with other three "Sebeel" water, for a sodium all samples gave acceptable results in the range of 8.00 – 11.00 mg/L.

Results in Table (2) show that all samples had pH in the range of 7.9 – 8.2 mg/L which is acceptable according to WHO [10] for drinking water, and had sulfate in the range of 4.00 – 5.00 mg/L which is optimum level when compared with other four "Sebeel" water. For the total dissolved solids, analysis indicate that all samples gave acceptable results 115 mg/L, and it consider better result of total dissolved solids

when compared with other four "Sebeel" water, and this results may be refer to the source of water which was from Water Corporation Nile Water, so Almogran "Sebeel" water gave acceptable results for pH, total dissolved solids, sulfate and sodium 9.00 mg/L.

4. CONCLUSION

Most of the weekly collected "Sebeel" water samples were highly contaminated with total coliform and *Escherichia coli*. However, Almogran "Sebeel" water samples matched with Sudanese Standards and International Standards for drinking water.

The chemical analysis which indicated that most of the water recorded relatively high levels of total dissolved solids and sulfate.

To reduce microbial contamination, the follow up of "Sebeel" water containers (Aziar) is needed. The periodical cleaning of containers and drinking cups, as well as closure after use can markedly reduce or stop microbial contamination. Further studies are recommended for comparison of "Sebeel" water with tap-water (Nile or Ground Water) sources, using both microbial and chemical analysis.

REFERENCES

[1] Fadol E.F. (2002) Wad Medani domestic water supply and aquifer characteristic. M.Sc. Thesis WMII, University of Gezira, Sudan.

[2] Roy M. Kirby, Jamie Bartran, Richard Carr (2003). Water in food production and processing: Quantity and quality concerns. Food Control, Vol. 14, pp. 283–299.

[3] EPA, (1999). Booklet in drinking water and health what do you need know Environmental Protection Agency, Washington, DC, USA, pp. 4–5.

[4] Zohour, H.H. (1978). Microbiological Examination of 'Sebeel' Water. M.Sc. Thesis. University of Khartoum, Sudan.

[5] Hammad, Z.H. and Dirar, H.A. (1982) Microbiological Examination of "Sebeel" Water, Applied and Environment Microbiology; Vol. 43, No. 6, pp. 1238–1243.

[6] Harrigan, W.F. and MacConkey, M.E. (1976). Laboratory methods in microbiology, pp. 257–303, Academic Press, London and New York.

[7] APHA. (1967). Lin: speck. Ml. (Ed). Compendium of Methods for the Microbiological Examination of Foods. American Public Health Association, Washington, DC.

[8] AOAC. 1990. Official Methods of Analysis. Helrich K. (ed.). 15th ed. Association of Analytical Chemists, Inc., USA, P 777.

[9] WHO (1997). Water pollution control: A guide to the use of water quality management principles, R. Hehmer and I. Hespanhol.

[10] WHO (2001). Water quality Guide lines standard and Health: Assessment of Risk and Risk Management of water–related infection diseases, Lorna–Sewtrell and Jamiebarcran.