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Assessment of Bacteriological Ground Water Quality in Khartoum and Khartoum North - Sudan

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Abstract: **This analytical study was conducted at Khartoum and Khartoum North (Bahri) to assess the ground water quality. Bacteriological, Coliform -Thermotolerant coliform and E.coli. 197 samples were collected for the bacteriological analysis distributed , samples from boreholes – samples after storage and samples from water distributed by vendors from boreholes not distributed by direct network , other samples taken from houses.at the interval from August 2006 to March 2007. The calculation of samples according to(1) samples per (10000) population, plus 10 additional samples (W.H.O 1993). The samples were taken in 250 ml tubes (analysis for Coliform – Thermotolerant coliform and E.coli). All 100% of boreholes not served with direct network in Khartoum were not polluted , 50% of samples taken from water towers were polluted , 11.1%of samples taken from water distributed by vendors were polluted , 81.6% of samples taken from houses not distributed by direct network were polluted. 25% of samples from boreholes distributed with direct network in Khartoum were polluted, 20% of samples taken from water towers were polluted , 34.2% of samples taken from houses distributed by direct network were polluted . All 100% of boreholes not distributed by direct network in Bahri were safe , and 100% of samples taken from water towers were polluted , and also100% of samples taken from water vendors were polluted , 82.1% of samples taken from houses not distributed by direct network were polluted. 9.1% of boreholes distributed by direct network in Bahri is polluted , 16.7% of samples taken from water towers were polluted, 27.3% of samples collection from houses distributed by direct network were polluted .**
Time and Place Limitation: This study was carried out during August 2006 to March 2007 at Khartoum and Khartoum North (Bahri).
Constrains: The natural constrains (Winds, rains and floods which affect in samples reading).

Keywords: **(Coliform – Thermotolerant – E.coli - Boreholes).**

1. INTRODUCTION

Much of the ill-health which affects humanity, especially in the developing countries can be traced to lack of safe and wholesome water supply. Water that is easily accessible, adequate in quantity, free from contamination, safe and readily available throughout the year. There can be no state of positive health and well-being without safe water. Water is not only a vital environmental factor to all forms of life, but it has also a great role to play in socio economic development of human population. Each country should develop its own water resources agency which would collect all pertinent data on water resources, exploitation and hydrology. In 1980, the United Nations General Assembly launched the International Drinking Water Supply and Sanitation Decade, 1981 -1990 – the aim being to provide all people with adequate supplies of safe water and sanitation by 1990.(1). Water is essential to sustain life, and a satisfactory supply must be made available to consumers. Every effort should be made to achieve a drinking-water quality as high as practicable. Protection of water supplies from contamination is the first line of defence.(7)

1-1 Ground Water:

Ground water is the cheapest and most practical means of providing water to small communities. Ground water is superior to surface water, because the ground itself provides an effective filtering medium.(1).

1-2 Ground Water Resources of Sudan:

Ground water is potentially available in large areas of Sudan. Major ground water aquifers cover about 50% of the surface areas of the country. The estimated probable strategic potential of these aquifers is rather huge , amounting to some hundred milliards m3 according to some estimates.

The main aquifers fall under three categories:-

i- The Nubian sand stone aquifers

ii- The Detrital quaternary . Tertiary aquifers.

ii- The recent alluvial wadi- fill aquifers.

The Nubian sand stone aquifers are the most extensive and largest aquifers in Sudan .They cover about 28% of the surface area of Sudan. The Nubian aquifers are preserved in nine basins. These are:-

The Sahara basin , The Nile basin , Atbara basin ,central Darfur basin, The Blue Nile basin , Nuhud basin , Gedaref basin, Sag Elnaam basin and Saggara basin.

The productive strata of these a aquifer are mainly of rosaceous and a rosaceous material of continental origin . Their thick ness varies between 100 to 200 m.

The Nubian aquifers are characterized by low to moderate permeability's .The co-efficient of trans emissivity range from 20 to 1500 m2/day .The storage co-efficient range from 10-2 to 10-4 and the well yields range from 40 to 160 m3/h and can reach up to 400m3/h. The static water level varies between 5 to 100 m . The aquifers are of semi-confined type . The water quality is good and generally fit for most purposes. The salinity is generally low and total dissolved solids vary from 80 to 1800 mg/l.(2).

1-3 Ground Water Collection:

Pumping is the central feature of most ground water works. for satisfactory performance , the suction lift including entrance and pipe losses, must be held below 24ft . When the water table is farther down than that, the collecting piping or conduit leading to the pump and the pumping unit itself must be lowered below ground level, or in individual wells must be equipped with deep well pumps. In filtration galleries convey their flows by gravity to pump wells, from which the water is lifted to purification works or directly to the community. Gravity flow, like that from up land surface sources, is rarely possible. Exceptions are springs at the base of mountain, collecting tunnels driven in to hill sides, and flowing artesian wells that lie high enough above the community .Suction and gravity conduits. Suction conduits in particular are vulnerable to pollution from sources in their immediate surroundings. (3).

1-4 Wells:

Traditionally wells are important source of water supply. Even today , they are important source of water supply in many communities.

1-4-1 Shallow wells:

Shallow wells tap sub soil water.

1-4-2 Deep wells:

A deep well is one which taps water from below the first impervious layer.(4).

1-5 Ground Water Quality:

The water supplies must meet the rules set by W.H.O 1996 which set basis for drinking water quality and the Sudanese standards for drinking water quality . These guide lines and standards help protection of public and human health. The water quality could generally be a measure of its suitability for a certain use. Groundwater quality is threatened mainly by human activities, although harmful substances are sometimes introduced by natural processes.(8)

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Groundwater may be plentiful in a particular area, if the quality of the groundwater has been degraded by the entry of contaminants .(9).

1-5-1 Escherichia Coli:

Escherichia coli is abundant in human and animal faeces, where numbers may attain 10^9 per gram of fresh faeces. It is found in sewage, treated effluents, and all natural waters and soils subject to recent faecal contamination, whether from human, farm animals and birds. The presence of E-coli in water always indicates potentially dangerous contamination requiring immediate attention complete identification of E-coli is too complicated for routine use, hence certain tests have been evolved for identifying these organisms rapidly with a high degree of certainty.(6).

1-5-2 Thermo-tolerant (faecal) Coliform Organisms:

These are defined as the group of coliform organisms that are able to ferment lactose at 44 – 45c◦. they comprise the genus Escherichia and to a lesser extent, species of Klebsiella, Enterobacter, and Citrobacter ,of these organisms, only E-coli is specifically of faecal origin, being always present in the faeces of humans other mammals, and birds in a large numbers, and rarely found in water or soil that has not been subject to faecal pollution. Thermo- tolerant coliforms other than E-coli may also originate from organically water such as industrial effluents or form decaying plant materials and soils.(5)

1-5-3 Coliform organisms (Total Coliforms):

Coliform organisms have long been recognized as a suitable microbial indicator of drinking water quality, largely because they are easy to detect and enumerate in water. The term "coliform organisms (total coliforms)" refers to Gram-negative, rod-shaped bacteria capable of growth in the presence bile salts or other surface, active agents with similar growth – inhibiting properties, and able to ferment lactose at 35-37c◦ with the production of acid, gas, and Aldehyde within 24-48 hours. They are also oxides negative and non-spore forming. These definitions have recently been extended by the development of rapid and direct enzymatic methods for enumerating and confirming members of the coliforms group.(1)

2. STUDY METHODS AND MATERIAL

2-1 Bacteriological analysis:

Presence – absence tests may sometimes be appropriate where positive results are known to be rare. They are not quantitative and, as their name suggests, they indicate only the presence or absence of the indicator sought. Such results are of little use in countries or situation where contamination is common and the purpose of the analysis is then to determine the degree of contamination rather than simply to indicate its presence. Thus presence – absence tests are not recommended for use in the analysis of the surface water, untreated small – community supplies in countries where operation and maintenance difficulties may occasionally occur.

2-2 E.coli test (completed test):

A loop full of brilliant green positive tubes inoculated into 5ml of peptone water and incubated at 44-45c◦ for 24hours, a drop of kovac's reagent (0.2-0.3ml)was added. The dark red colour on the surface culture indicated a positive test for indeed. The only coliform bacteria that is capable of producing in dole from medium containing tryptophan at 44-45c◦ is E.coli.(6).

2-3. Confirmative E.Coli Test:

Insulate EMB media E.Coli produce green metallic cheen.

2-4 Sample Size:

The calculation of samples according to(1) samples per (10000) population, plus 10 additional samples (W.H.O 1993).

Table 1: Number of Samples for Khartoum State

Sources	Number of Population	Total of samples
Boreholes	1775611	188

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Table 2: Total and Target Number of Boreholes in Khartoum State.

No	Area	Total of Boreholes			Target of Boreholes		
		Served by Direct Net work	Not Served by Direct Net Work	Total	Served by Direct Net work	Not Served by Direct Net Work	Total
1	Khartoum	11	0	11	1	0	1
2	Jabel Awlia	109	28	137	11	3	14
3	Omdurman	34	19	53	3	2	5
4	Karrari	53	17	70	5	1	6
5	Ombada	8	28	36	1	3	4
6	Bahri	65	12	77	7	1	8
7	Sharq Elnil	67	7	74	7	1	8
8	Total	347	111	458	35	11	46

The number of boreholes selected was 46 which represent about 10% from the total number of boreholes in Khartoum state. This sample was determined by the Ministry of health Khartoum State.

3. RESULTS

Table (1): Boreholes Not Served with direct Network in Khartoum Area

NO	Name	SB					ST					SV					X				
		Water Quality					Water Quality					Water Quality					Water Quality				
		T	S	%	P	%	T	S	%	P	%	T	S	%	P	%	T	S	%	P	%
1	Elandalus A(6)	1	1	100	-	-	1	1	100	-	-	3	3	100	-	-	12	2	25	9	75
2	Moh.Hassan Jabel Awlia	1	1	100	-	-	-	-	-	-	-	3	3	100	-	-	13	2	15,4	11	84,6
3	Soba A(6)	-	-	-	-	-	1	-	-	1	100	3	2	66,7	1	33,3	13	2	15,4	11	84,6
4	Total	2	2	100	-	-	2	1	50	1	50	9	8	88,9	1	11,I	38	7	18,4	31	81,6

SB=Samples Direct from Boreholes ST=Samples from Water Towers
SV=Samples from Water Distributed by Vendors SHV=Samples from Houses Served by Vendors
T=Target Samples S=Safe Samples
P=Polluted Sample (By Thermotolerent Coliform or by E.Coli).

Table (2): Bore holes Served with direct Network in Khartoum Area

NO	Name	SB					ST					SHN				
		Water Quality					Water Quality					Water Quality				
		T	S	%	P	%	T	S	%	P	%	T	S	%	P	%
1	Elazhari A (21)	1	1	100	-	-	1	1	100	-	-	2	2	100	-	-
2	Elazhari A (11)	1	1	100	-	-	-	-	-	-	-	3	3	100	-	-
3	Soba Elhila A(6)	-	-	-	-	-	-	-	-	-	-	4	2	50	2	50
4	Elgatea A(3)	1	1	100	-	-	-	-	-	-	-	4	2	50	2	50
5	Elawda	1	-	-	1	100	-	-	-	-	-	4	-	-	4	100
6	Elshekh Elnazer	1	1	100	-	-	-	-	-	-	-	5	5	100	-	-
7	Elkawther factory for ice	-	-	-	-	-	1	-	-	1	100	2	-	-	2	100
8	Elandalus A(3)	-	-	-	-	-	1	1	100	-	-	3	2	66,7	1	33,3
9	Elescan	1	1	100	-	-	1	1	100	-	-	2	2	100	-	-

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10	**Elwehda A(5)**	1	-	-	1	100	-	-	-	-	-	3	2	66,7	1	33,3
11	**Goreba A(1)**	1	1	100	-	-	-	-	-	-	-	3	3	100	-	-
12	**Elhilal Elahmer-Elsalama**	-	-	-	-	-	1	1	100	-	-	3	2	66,7	1	33,3
13	**Total**	8	6	75	2	25	5	4	80	1	20	38	25	65,8	13	34,2

SB=Samples Direct from Boreholes ST=Samples from Water Towers SHN=Samples from Houses Served by Network T=Target Samples S=Safe Samples P=Polluted Samples (By Thermotolerent Coliform or by E.Coli).

Table (3): Bore holes Not Served with direct Network in Bahri Area

NO	Name	SB					ST					SV					SHV				
		Water Quality					Water Quality					Water Quality					Water Quality				
		T	S	%	P	%	T	S	%	P	%	T	S	%	P	%	T	S	%	P	%
1	**Elbaraka A(1)**	-	-	-	-	-	1	-	-	1	-	3	-	-	3	100	13	-	-	13	100
2	**Elgawery Elselit**	1	1	100	-	-	1	-	-	1	100	-	-	-	-	-	15	5	33,3	10	66,7
3	**Total**	1	1	100	-	-	2	-	-	2	100	3	-	-	3	100	28	5	17,9	23	82,1

SB=Samples Direct from Boreholes ST=Samples from Water Towers SV=Samples from Water Distributed by Vendors SHV=Samples from Houses Served by Vendors T=Target Samples
S=Safe Samples P=Polluted Samples (By Thermotolerent Coliform or by E.Coli).

Table (4): Bore holes Served with direct Network in Bahri Area

NO	Name	SB					ST					SHN				
		Water Quality					Water Quality					Water Quality				
		T	S	%	P	%	T	S	%	P	%	T	S	%	P	%
1	**Wad dafea**	1	1	100	-	-	1	1	100	-	-	2	2	100	-	-
2	**Elshegla A(39)**	1	1	100	-	-	-	-	-	-	-	3	2	66,7	1	33,3
3	**Haj yousif street one A(5)**	1	1	100	-	-	-	-	-	-	-	3	2	66,7	1	33,3
4	**Eltyarab eid Babiker**	-	-	-	-	-	1	1	100	-	-	3	2	66,7	1	33,3
5	**Elnaser Elshabab camp**	1	-	-	1	100	1	1	100	-	-	2	-	-	2	100
6	**Omdwen Ban-Elseid**	1	1	100	-	-	-	-	-	-	-	4	4	100	-	-
7	**Elesilat**	-	-	-	-	-	-	-	-	-	-	5	2	40	3	60
8	**Eljaily**	-	-	-	-	-	-	-	-	-	-	4	4	100	-	-
9	**Elsororab**	1	1	100	-	-	-	-	-	-	-	5	5	100	-	-
10	**Elfaki Hashim**	1	1	100	-	-	1	1	100	-	-	3	3	100	-	-
11	**Pepsi factory**	1	1	100	-	-	1	1	100	-	-	-	-	-	-	-
12	**Eldroshab**	1	1	100	-	-	-	-	-	-	-	2	2	100	-	-
13	**Elzakerin**	1	1	100	-	-	-	-	-	-	-	4	3	75	1	25
14	**Elzakiat Elgadema**	1	1	100	-	-	1	-	-	1	100	4	1	25	3	75
15	**Total**	11	10	90,9	1	9,1	6	5	83,3	1	16,7	44	32	72,7	12	27,3

SB=Samples Direct from Boreholes ST=Samples from Water Towers
SHN=Samples from Houses Served by Network T=Target Samples
S=Safe Samples P=Polluted Sample (By Thermotolerent Coliform or by E.Coli).

4. DISCUSSION

50% of houses served from Elgatea A(3) borehole were polluted by thermotolerant coliform. 100% of houses served by net work Elawda borehole were polluted three of them were polluted by thermotolerant coliform, and one was polluted by E.coli. This pollution in boreholes may be as the result of urbanization this agreement with (Elhadi Omer 2001). (Urbanization introduces many changes to the aquifers that lie under cities .. Natural recharge mechanisms are modified or replaced and new ones are introduced .Many sub city aquifers are polluted with human wastes , septic , pits and latrines are operated in efficiently and discharged directly in to land).

Eltyarab eid Babiker borehole houses served by direct network 33,3% of samples taken from these houses were polluted by E.coli . The polluted tap water in houses connected with direct network may be as the result of leakage or cross connections between water supply pipes and sewage drainage pipes, this results is corresponding with Parks in 1997(Even if the source of water supply and it is treatment are of high standard , water pollution may still occur as often happens , due to corrosion of pipe line , leaky joint and cross connections between water supply pipes and sewage drainage pipes).

25% of samples taken from houses connected direct to net work were polluted by thermotolerant coliform. 80% of samples taken from houses connected direct with network from Elzakiat Elgadema borehole were polluted , four of them were polluted by thermotolerant coliform and one is polluted by E.coli . This contamination by E.coli is a health risk to the consumers WHO in 1986 (The problem of providing safe drinking water and adequate sanitation still prevails in many developing countries , through the occurrence of the infectious diseases caused by bacteria , viruses and parasites and chronic diseases caused by bacteria ,viruses and parasites and chronic diseases caused by chemical contaminant).

5. CONCLUSION

50% from water towers of boreholes served with direct network in Khartoum is polluted , and 11,1% from samples of water distributed by vendors are polluted and 81,6% from samples of houses distributed by direct network is polluted.

Boreholes distributed by direct network in Khartoum 25% from it are polluted, 20% from water towers are polluted , 34,2% from houses distributed by direct network is polluted.

Boreholes not distributed by direct net work in Bahri is safe by 100%, and 100% of samples of samples from water towers is polluted, and also 100% of samples taken from water vendors is polluted.

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