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Bacteriogical Investigation of Drinking Water in Shendi Locality, River Nile State, Sudan

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Abstract

This observational research was designed as community based cross-sectional study in the locality of Shendi, in object to microbiologically assess the quality of drinking water from the sources to the consumers. Proportional stratified sampling was followed to enroll the units of the study. Both Membrane Filtration (MF) technique and the multiple tube methods for water quality analysis was used to investigate the samples of water collected from the sources, transportation and storing vessels. Total bacterial count was performed according to standard techniques. Data were analyzed using the Statistical Package for Social Sciences (SPSS). High proportion faecal coliform and total bacteria counts were detected among the samples collected from the drinking water source, transportation and storing vessels. Thirteen out 48 (27.1%) samples collected from different sources of drinking water were contaminated with *E. coli*. The total count of bacteria significantly associated with the surface types of drinking water source. The highest proportion of contaminated samples was among those collected from water transported by barrels carried by donkey and buckets collected by individuals. Microbiological contamination of water between source and point-of-use is widespread and significant associated with open container i.e., storing barrels and buckets. Post-collection contamination during transportation and storing if not considered, it may compromise the policies that aim to improve water quality through source improvement only. It has been observed that ill-health and quality of drinking water are closely interlinked and mutually dependent, in the locality. Drinking water from sources, transportation methods and storing vessels contaminated with *E. coli* and/or with high total bacterial count has been shown to contribute to an increased incidence of the water-borne diseases.

Introduction

Clean water is essential to human life; safe quality of water supplied to communities is an important consideration in the protection of human health and well-being. Without water, life cannot be sustained beyond a few days and the lack of access to a safe water supplies leads to the spread of water-borne diseases. The microbiological quality of drinking-water has been implicated in the spread of important infections and parasitic diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis, guinea worm and schistosomiasis [1,2]. Kuitcha et al. and Ndjama et al. reported that the majority of health problems which African countries face are water related: malaria, typhoid, bilharziasis, diarrhoeal diseases, cholera, and dysenteries.

A microbiological aspect is one of the specific standards to provide a basis for judging quality of water. Water may act positively in the control of some diseases through its use in hygiene, and may act a source or vector for others where contact with water is required for disease transmission or where agents of disease or insect vectors require water in which to complete their life cycle [3]. Ideally, drinking water should not contain any microorganisms known to be pathogenic. It should also be free from bacteria indicative of pollution with excreta.

The primary bacterial indicator recommended for this purpose is the coliform group of organisms as a whole. Supplementary indicator organisms, such as faecal streptococci and sulfite–reducing clostridia, may sometimes be useful in determining the origin of faecal pollution as well as in assessing the efficiency of water treatment processes [2].

It has frequently been observed that the microbiological quality of water in vessels in the home is lower than that at the source, suggesting that contamination is widespread during collection, transport, storage and drawing of water (Van Zijl and Lindskog & Lindskog).

Water-related diseases continue to be one of the major health problems globally. An estimated 4 billion cases of diarrhoea annually represented 5.7% of the global disease burden in the year 2000 [4]. UNESCO's World Water Development Report (WWDR, (2003) from its World Water Assessment Program indicates that, 40% of the world's inhabitants currently have insufficient fresh water for minimal hygiene. It estimated 80% of all diseases and over one-third of deaths in developing countries are caused by consumption of contaminated water and on average as much as one-tenth of each person's productive time is sacrificed to water-related diseases.

The objective of this study is to microbiologically assess the quality of drinking water from the sources to the consumerism Shendi locality, River Nile state, Sudan.

Materials and Methods

Type of the study

This observational research was designed as community based cross-sectional study in the locality of Shendi, to assess the quality of drinking water and its consequences and health risk to consumers. The study involved all the population, and their drinking water sources, distribution vessels & storages utensils of drinking water in the locality of Shendi.

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Sampling and data collection

Proportional stratified sampling was followed to enroll the sources, the means of transportation the storage vessel of water and household units. Water samples were collected in sterile glass bottles, and care had been taken to prevent accidental contamination of water during collection and transportation and sent to the water analysis laboratory in Khartoum and the microbiology laboratory in Shendi University. Data regarding mode of transportation, method of storing utilization means of water were collected.

Laboratory investigation

Membrane Filtration (MF) technique for water quality analysis was used to investigate the water collected from the sources (Standard method for the examination of water & waste water, 1993). Water samples collected during transportation and from storing vessel were tested using the multiple tube methods [2]. Total bacterial count was performed according to standard techniques [2].

Data analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 11.5 to calculate frequency, percentages and means. Chi-square tests and *p* value were used to measure association significance ($p< 0.05$ was considered significant).

Results and Analysis

Thirteen of 48 (27.1%) samples collected from different sources of drinking water were contaminated with *E. coli*. Hafirs and shallow wells have shown a significantly ($p<0.001$) higher rates of *E. coli* contamination with hand pumps being free of *E. coli* (Table 1). The total count of bacteria was the highest in Hafirs followed by shallow wells, Nile stations and deep wells with hand pump wells being the lowest (Table 1).

The highest proportion of contaminated samples was among those collected from water transported by barrels carried by donkey and buckets collected by individuals (Table 2). The proportion of contaminated samples collected from storing barrels was the highest followed by storing buckets, open tanks and pots (Table 2).

Exposure rate among those used contaminated drinking water = 40/54 = 74.1%

Exposure rate among those used wholesome drinking water = 25/36 = 69.4

Relative risk of water-borne diseases among those drinking contaminated water = 40/65 + 14/25= 11.1

Type of the source	Number of Samples	*Faecal coliforms* positive		Mean total bacterial count
		No.	%	
Shallow wells	3	3	100.0	1356.00
Deep Borehole	27	5	18.5	133.37
Nile stations	11	1	9.1	558.55
Hand pump wells	3	0	0.0	9.67
Hafirs	4	4	100.0	3895.25
Total	48	13	27.1	612.98
Chi		22.767		
***P*-value**		<0.001		<0.001
F				=10.139

Table 1: Bacterial contamination among the different selected sources of drinking water.

Transportation method			Storing vessels		
	Samples			Samples	
	No.	%		No.	%
Pipeline network	2/52	3.9	**Pots (Aziar)**	16/37	43.24
Barrel carried on donkey	5/6	83.3	**Buckets**	24/25	96.00
Bucket collected by household individuals	6/10	60.0	**Open Tankes**	22/25	88.00
Tanker on cars	1/2	50.0	**Barrels**	3/3	100.00
Total	14/70	20.0	**Total**	65/90	72.22

Table 2: *E coli* contamination of drinking water in samples collected from transport means and storing vessels.

Contamination of the storage vessels	Water-borne diseases		Total
	At least one of the family individuals suffering	No one of family individuals suffering	
Yes	40	25	65
No	14	11	25
Total	54	36	90

P-value<0.01

Table 3: Incidence of water-borne diseases among individuals consuming contaminated water during survey period in Shendi locality.

Among those consuming contaminated water 40/54 (74.07%) households have at least one member with water-borne infections (e.g., Hepatitis A, Diarrhea, Typhoid, Giardiasis and Dysenteries).

The frequencies of the water-borne diseases during the period of field survey of this study were statistically significantly associated with the contamination of the storage vessels i.e., drinking water was the main sources of these diseases.

Families drawn water from contaminated storing vessels showed a risk of having water-borne diseases 11.1 times that among of families drinking wholesome water.

Discussion

The bacteriological analysis showed that about 13 (27.1%) of the drinking water sources in Shendi were probably contaminated with infectious agents and count large numbers of total bacteria colonies (Table 1). All these contaminated sources not fit for human consumption, and should be closed off. But unfortunately they are still used, because there is no any system for drinking water monitoring and safety in the locality. Add to that, high illiteracy, lack awareness and weak community involvement in supervision and management of their drinking water sources. This result goes with West, Larry, 2006 stated: "This natural resource is becoming scarcer in certain places, and its availability is a major social and economic concern". Currently, about 1 billion people around the world routinely drink unhealthy water.

Total bacterial count was significantly associated with the Hafirs which account the highest total bacterial among all others sources (Table 1), followed by shallow wells, Nile stations; Deep borehole and hand pump wells. This result agreement with Pink et al. reported: (Ground water pollution is much more difficult than surface pollution because groundwater can move great distances through unseen aquifers). Non-porous aquifers such as clays partially purify water of bacteria by simple filtration, dilution, and, in some cases, chemical reactions and biological activity: however, in some cases, the pollutants merely transform to soil contaminants. Groundwater that moves through cracks and caverns is not filtered and can be transported contaminants as easily as surface water.

High increased faecal coliform and total bacteria counts were detected among the samples collected from transportation and storing vessels (Tables 1 and 2). Water contamination between source and point-of-use indicate a decline after collection, although there is significant variation between settings (Tables 1 and 2). This contamination may lessen the health benefits of water source quality. The results imply that samples taken from storage vessels may provide a better reflection of the quality of water consumed than source samples. If water testing is performed only at sources in such settings, then results of monitoring may not reflect the quality of water actually consumed in the home.

Drinking water from sources, transportation methods and storing vessels contaminated with *E. coli* and/or with high total bacterial count has been shown to contribute to an increased risk prevalence of the water-borne diseases (Table 3). These results are in agreement with [5] evidence from a study in Philadelphia, Pennsylvania, that suggested that drinking water regulated by federal water quality standards contributed to the endemic incidence of gastrointestinal illness in the persons aged 65 years and older. Poor water quality and bad sanitation are deadly; some 5 million deaths a year are caused by polluted drinking water [4,6].

Conclusion

High contamination of the drinking water with *Escherichia coli* and total count of bacteria was detected among the samples collected from different types of the drinking water sources, transporting vessels, storage containers and drawing of water.

The contaminated sources still used for water supply in the locality due to absence of system for drinking water monitoring and safety in the locality.

Microbiological contamination of water between source and point-of-use is widespread and significant associated with open container i.e., storing barrels and buckets.

Post-collection contamination during drinking water transportation and storing if not considered, it may compromise the policies that aim to improve water quality through source improvement only.

It has been observed that ill-health and quality of drinking water are closely interlinked and mutually dependent, in the locality.

Recommendations

Based on the results, discussion and conclusion of this study the following recommendations are proposed:

- Establishing active partnerships between communities and water's providers and other sectors.
- Organizations of the community to have appropriate systems and processes to support monitoring of drinking water handling by competent well trained health professionals.
- Establishment of monitoring system, and activates the regulations responsible for health inspection and community responsibility, towards supervision their drinking water sources, and water handling; to control and grantee safe drinking water.
- The local authority must prohibit by appropriate legislation the use of contaminated sources (e.g., All the Shallow wells should be closed by concrete) and have to close them immediately.
- The rural drinking water's provider authority should improve the Nile stations water to be based on slow sand filter and increasing their treatment efficiency.
- The locality health authority should have routine inspection for water sources and activated their regulations to control; over polluting activities in the area of drinking water sources,
- The households recommended to protect water storing vessels and advised to use containers with narrow openings for filling, and dispensing devices such as spouts or taps/spigots, protect the collected water during storage and household use to control post-collection contamination.
- Safer household water storage and treatment is recommended to prevent post-collection contamination, together with point-of-use water quality monitoring.

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