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Evaluation of coliform (*E. coli*) load of the drinking water collected from Kosti and Rabak Cities, White Nile State, Sudan

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Abstract

Microbial drinking-water quality testing plays an essential role in measures to protect public health. However, such testing remains a significant challenge where resources are limited. The aim of this study was to evaluate the coliform load of drinking water from White Nile State. Samples of the drinking water were collected from Kosti and Rabak, White Nile State, Sudan, in clean disposable plastic bottles from random sites. The estimation of *E. coli* bacterium test was performed in Microbiology Laboratory, University of Gezira. The results showed that, Rabak samples had high mean number (92 ± 22.27) of colonies/plate than Kosti samples (29.33 ± 14.11), and this denotes a significant difference between them during (March, 2022), but those samples collected during (October 2022) and (March 2023) showed non-significant differences in microbial count, although Rabak samples showed high mean number of colonies/plate than Kosti samples. It was also noticed that, the contamination of the drinking water increased gradually throughout the study periods and sites. This reflect the increase in the organic waste and decrease in treatment of pollutants in both Kosti and Rabak cities during the study period.

Keywords: *E. coli*; Drinking Water; Kosti; Rabak; White Nile State; Sudan

1. Introduction

Drinking water quality is a very important issue in the health sector and it involves the check of some parameters through standard methods and limits. These methods can be roughly divided into three main classes: physical, chemical and biological methods, which are able to assess bioavailability, bioaccumulation and the real risks posed by the presence of chemical contaminants in environmental matrices [1].

Standard methods were used for determining of chemical and physical characteristics of the water samples. Cu, Fe, Pb, Ni and Mn contents of the drinking water samples were determined by atomic absorption spectrometry. The concentrations of investigated parameters in the drinking water samples were within the permissible limits of the WHO drinking water quality guidelines and the Water Pollution Control Regulation of the Turkish authorities [2].

Water pollution is a major global problem which has been the leading cause of morbidity and mortality worldwide and requires evaluation and revision of bottled water policy. Almost 90% of child deaths are due to dehydration resulting from diarrheal disease as the sporadic, endemic, and epidemic cases of diarrhea are responsible for the deaths of around 1.5 million people/ year [3].

The common feature of all these routine screening procedures is that the primary analysis is for indicator organisms rather than the pathogens that might cause concern. Indicator organisms are bacteria such as non-

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specific coliforms, *Escherichia coli* and *Pseudomonas aeruginosa* that are very commonly found in the human or animal gut and which, if detected, may suggest the presence of sewage. Indicator organisms are used because even when a person is infected with a more pathogenic bacteria, they will still be excreting many millions times more indicator organisms than pathogens. It is therefore reasonable to surmise that if indicator organism levels are low, then pathogen levels will be very much lower or absent. Analysis is usually performed using culture, biochemical and sometimes optical methods. When indicator organisms levels exceed pre-set triggers, specific analysis for pathogens may then be undertaken and these can be quickly detected (where suspected) using specific culture methods or molecular biology [4].

The most reliable methods are direct plate count method and membrane filtration method. mEndo Agar is used in the membrane filtration while VRBA Agar is used in the direct plate count method. VRBA stands for violet red bile agar. A media that contains bile salts which promotes the growth of gram negative and has inhibitory characteristic to gram positive although not complete inhibitory. These media contain lactose which is usually fermented by lactose fermenting bacteria producing colonies that can be identified and characterized. Lactose fermenting produce colored colonies while non lactose fermenting produce colorless ones. Because the analysis is always based on a very small sample taken from a very large volume of water, all methods rely on statistical principles [5].

2. Materials and Methods

2.1. Study area

Kosti and Rabak Cities, White Nile State, Sudan, were selected to conduct this study. The drinking water in these cities were filtered from the White Nile stream, but sometime people used to drink the unfiltered water directly from the White Nile.

2.2. Water samples

The drinking water samples were collected in new and clean disposable plastic bottles from random sites of each of the study area. The water samples were collected from the drinking water-container scattered within the study areas. 500 ml of each water sample was taken after autumn (October) and winter (March) seasons of 2022 and 2023. The collected samples were kept in a refrigerator of the Microbiology Laboratory while the microbial assessment was being performed the remaining bottles were stored at (4°C). The determinations of the microbiological tests were performed within one week after sample collection.

2.3. Microbiological test

This test was conducted in the Microbiology Laboratory, Faculty of Engineering and Technology, University of Gezira. The technique used was the direct pour and spread plate count method, using 1.0 ml of the tested drinking water and membrane lauryl sulphate agar media (which is selective to coliform bacteria). The type of the required microorganism was the bacterium *E. coli*. Water temperatures (22 °C and 37°C) was concerned. The time taken to obtain results, was 48 hours, after which the number of the formed colonies (pale yellow in color) on the agar plate were counted.

The preparation of the membrane lauryl sulphate agar media started with **s**uspended of 92.2 g of the medium (casein peptone (40 g), lactose (30 g), agar (15 g), yeast extract (6 g), sodium lauryl sulfate (1.0 g), and phenol red (0.2 g)) in one liter of distilled water, and the mixture was dissolved by heating with frequent agitation for one minute, then sterilized in autoclave at 121ºC for 15 minutes, cooled to 45-50ºC, mixed well and dispensed into Petri-dishes. The prepared medium was stored at 15°C [6].

3. Results

3.1. Microbiological test of the drinking water

The test for *E. coli* colonies within Kosti and Rabak drinking water samples collected after winter season (March, Table 1) showed range of 8 to 56, and 64 to 136 colonies/plate, respectively. Rabak samples showed high mean number (92 $\pm$ 22.27) of colonies/plate than Kosti samples (29.33 $\pm$ 14.11), hence, there was a significant difference between them, because these values were not interfered.

Table 1 Number of *E. coli* colonies/plate within Kosti and Rabak drinking water (March 2022)

Site	Kosti samples	Rabak samples
Rep-1	8	76
Rep-2	24	64
Rep-3	56	136
Mean±SE	29.33 ± 14.11	92.0 ± 22.27

The test for *E. coli* colonies within Kosti and Rabak drinking water samples collected after autumn season (October, Table 2) showed range of 24 to 88, and 16 to 224 colonies/plate, respectively. Rabak samples showed high mean number (101.33 ± 62.88) of colonies/plate than Kosti samples (53.33 ± 18.67), hence, no significant differences between them, because these values were interfered.

Table 2 Number of *E. coli* colonies/plate within Kosti and Rabak drinking water (October 2022)

Site	Kosti samples	Rabak samples
Rep-1	88	64
Rep-2	24	16
Rep-3	48	224
Mean±SE	53.33 ± 18.67	101.33 ± 62.88

The test for *E. coli* colonies within Kosti and Rabak drinking water samples collected after winter season (March, Table 3) showed range of 84 to 180, and 140 to 284 colonies/plate, respectively.

Table 3 Number of *E. coli* colonies/plate within Kosti and Rabak drinking water (March 2023)

Site	Kosti samples	Rabak samples
Rep-1	180	140
Rep-2	144	140
Rep-3	84	284
Mean±SE	136.0 ± 28.0	188.0 ± 48.0

The mean number of *E. coli* colonies within Kosti and Rabak drinking water samples collected during all study periods (Table 4) showed range of 29.33 to 136 and 92 to 188 colonies/plate, respectively.

Table 4 Mean number of *E. coli* colonies/plate within Kosti and Rabak drinking water

Site	Kosti samples	Rabak samples
March 2022	29.33	92.0
October 2022	53.33	101.33
March 2023	136	188
Mean±SE	72.88 ± 32.31	127.11 ± 30.56

4. Discussion

The test for *E. coli* colonies within Kosti and Rabak drinking water samples collected after winter season (March, 2022) confirmed a significant difference between them, but those collected during (October 2022) and (March 2023) showed

non-significant differences in microbial count, although Rabak samples showed high mean number of colonies/plate than Kosti samples. It was also noticed that, the contamination of the drinking water increased gradually throughout the study periods and sites. This reflect the increase in the organic waste and decrease in treatment of pollutants in both Kosti and Rabak cities during the study period.

Drinking water is an important constituent for all types of living beings. Groundwater is one of the most valuable natural resources, which supports human health, economic development and ecological diversity. Groundwater is a valuable dynamic and replenishes able natural resource in present day and limited in extent. Groundwater resource assessment of a region involves a detailed study of the sub-surface water, including geology and hydrogeology, monitoring and production of well data. The water quality guidelines provide a Limit Value for each parameter for drinking water. It is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. It is necessary to know details about different physico-chemical parameters such as color, temperature, acidity, hardness, pH, sulphate, chloride, alkalinity used for testing of water quality. Heavy metals like Pb, Cr, Fe, Hg etc. are of special concern because they produce water or chronic poisoning in aquatic animals [7].

With a wide variety of tests available, researchers and practitioners have expressed difficulties in selecting the most appropriate test(s) for a particular budget, application and setting. The searched for available faecal indicator bacteria tests and collated this information was studied. From total of 44 tests, 18 of which yield a presence/absence result and 26 of which provide enumeration of bacterial concentration. The suitability of each test was also assessed and catalogued. The cost per test was found to vary from $0.60 to $7.50, though it is likely to be small of the overall costs of testing. This will be of value to organizations responsible for monitoring national water quality, water service providers, researchers and policy makers in selecting water quality tests appropriate for a given setting and application [8]. This article reflected the importance and cost of the tests of microbial drinking water tests.

Water pollution is a major global problem that has been the leading cause of morbidity and mortality. The microbiological assessments were performed. Out of 100 samples, 48% of samples were found to be contaminated with *E. coli* was the predominant strain among the coliforms. Out of 100 samples, 48% of samples were found to be contaminated with total coliform. Microorganisms survive in bottled water as they have many nutrients required for the microorganism in ionic form. Surveillance is lacking by the license-providing organizations followed by governmental organizations [9].

Access to safe drinking water is one of the basic human rights and is critical to health. However, much of the world's population lacks access to adequate and safe water. Approximately 884,000, 000 people in the world still do not get their drinking water from safe sources; Sub-Saharan Africa accounts for over one third of this number. It is estimated that 80% of all illnesses in the world are related to use of unsafe and contaminated water [10].

5. Conclusions

Rabak drinking water was polluted with *E. coli* more than Kosti, but those collected during (October 2022) and (March 2023) showed non-significant differences in microbial count, although Rabak samples showed high mean number of colonies/plate than Kosti samples. It was also noticed that, the contamination of the drinking water increased gradually throughout the study periods and sites. This reflect the needs for treatment of pollutants in both cities throughout the year.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclose.

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