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(Research Article)

Evaluation of some physical and chemical characteristics of the drinking water collected after winter and autumn seasons from Kosti and Rabak Cities, White Nile State, Sudan

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Abstract

Drinking water quality is a very important issue in the health sector and it involve the check of some physical, chemical and biological parameters through some standard methods and limits. The current study aimed to determine some physical and chemical parameters of the drinking water collected from White Nile after autumn and winter seasons. The drinking water samples were collected from Kosti and Rabak Cities, White Nile State, Sudan, in clean disposable plastic bottles from random sites of each city. The determinations of the physiochemical tests were performed within one week after sample collection at University of Gezira Laboratories. The results of this study show that, the drinking water that collected after winter season showed good physical quality, as same as that collected after autumn season except the slight problem in color (less transparent). The tested chemical parameters of Kosti and Rabak drinking water that collected after winter season showed good quality except, those of sulphate, carbonate (0 mg/L) and chloride of 28.4 and 31.95 (ppm) as same as that collected after autumn season, except hardness (500 mg/L) which seemed to be an autumn problem of Rabak city. Although there were some signs of physical and chemical pollutions, serious steps towards treatment of their causes should be done.

Keywords: Physical; Chemical; Drinking Water; Kosti; Rabak; White Nile; Sudan

1. Introduction

Analytical methods of drinking water are procedures used to measure the amount of particular contaminants in water samples. In general, an analytical method are applies to routine analyses of samples, measures the drinking water contaminant(s) within a specific upper and lower limit, provides data that are required to demonstrate compliance, or meet monitoring objectives in a wide variety of drinking water conditions, and also incorporates appropriate quality control criteria so that acceptable method performance is demonstrated during sample analysis (EPA, 2018).

Water chemistry analyses are carried out to identify and quantify the chemical components and properties of water samples. The type and sensitivity of the analysis depends on the purpose of the analysis and the anticipated use of the water. Chemical water analysis is carried out on water used in industrial processes, on waste-water stream, on rivers and stream, on rainfall and on the sea. In all cases the results of the analysis provides information that can be used to make decisions or to provide re-assurance that conditions are as expected. The analytical parameters selected are chosen to be appropriate for the decision making process or to establish acceptable normality. Water chemistry analysis is often the groundwork of studies of water quality, pollution, hydrology and geothermal waters. Analytical methods routinely used can detect and measure all the natural elements and their inorganic compounds and a very wide range

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of organic chemical species using methods such as gas chromatography and mass spectrometry. In water treatment plants producing drinking water and in some industrial processes using products with distinctive taste and odours, specialized organoleptic methods may be used to detect smells at very low concentrations (Environment Agency, 2017).

Samples of water from the natural environment are routinely taken and analyzed as part of a pre-determined monitoring programme by regulatory authorities to ensure that waters remain unpolluted, or if polluted, that the levels of pollution are not increasing or are falling in line with an agreed remediation plan. An example of such a scheme is the harmonized monitoring scheme operated on all the major river systems in the UK. The parameters analyzed will be highly dependent on nature of the local environment and/or the polluting sources in the area. In many cases the parameters will reflect the national and local water quality standards determined by law or other regulations. Typical parameters for ensuring that unpolluted surface waters remain within acceptable chemical standards (DEFRA, 2013).

Biological testing of water was used to assess and forecast the status of water, and to evaluate the health of a body of water (to estimate the numbers and species of coliform or fecal bacteria present) and, if needed, to find out what sort of bacteria they are. Total count or agar plate count test, are used to examine water (Szczerbińska and Gałczyńska, 2015).

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. The determinations of the physiochemical tests were performed within one week after sample collection.

2.3. Physical tests of drinking water

All physical and chemical tests were run according to APHA (2005) standard methods. Color and odor of drinking water were tested according to the simple human sense. pH which reflected the base, acid or neural state of water, was determined using the digital pH-meter.

2.4. Chemical tests of drinking water

Electric Conductivity (EC): EC of drinking water was determined by calibration of the conductivity meter as per the directions given by the manufacturer's manual using standard solutions, then the cell was rinsed within the sample.

The Total Dissolved Solids (TDS): The conductivity meter device was used to measure the (TDS) using the TDS mode of the meter.

Total hardness: 25 ml of sample was put in a conical flask, then 1 to 2 ml buffer solution followed by 1 ml inhibitor and a pinch of Eriochrome black T were added and titrated with standard EDTA (0.01M) till wine red colour changes to blue, then the volume of EDTA required (A) was noted. A reagent blank was run, and the volume of EDTA (B) was also noted. The volume of EDTA required by sample was calculated, C = A − B. Calcium hardness was also calculated by taking 25 ml sample in a conical flask, and 1 ml NaOH was added to raise pH to 12.0 then a pinch of muroxide indicator was added and titrated immediately with EDTA till pink colour changed to purple. Similarly, the volume of EDTA used (A1), (B1) and C1 were calculated.

Total hardness as $CaCO_3$ (mg /l) = [D x C x 1000] / volume of sample in ml

(D = mg $CaCO_3$ equivalent to 1 ml EDTA titrant (1 ml 0.01 M EDTA ≡ 1.000 mg $CaCO_3$))

Calcium ion was measured by complex titration with standard solution of ETDA using Patton's and Reeder's indicator under the pH conditions of more than 12.0. These conditions were achieved by adding a fixed volume of 4N Sodium Hydroxide. The volume of the used EDTA solution against the known volume of sample were used to calculate the concentration of calcium in the sample.

Chloride (Cl): 50 ml of water sample was added and diluted to 100 ml with distilled water. Aluminum hydroxide was added, filtered. The pH was adjusted to 7-8 by adding acid or alkali. Potassium chromate indicator was added and the mixture was titrated with silver nitrate solution until a colour change occurs. Chloride was calculated by using the volume of silver nitrate as 1:1 reaction ratio. The result was expressed as ppm.

Sulphate: Natural water contains sulphate which is soluble in water. Sulphate was measure by UV Spectrophotometer.

Carbonate: 25 ml of water was pipetted into a clean dry flask, then 5 drops of **phenolphthalein was added**. The formation of pink color denotes the presence of carbonates. Acid from the burette was added drop wise till the solution becomes colour less. The volume of the used solution were used to calculate the carbonate in the sample.

3. Results

3.1. Physical test of the drinking water

The tested physical parameters of Kosti and Rabak drinking water of the samples collected after winter season (Table, 1) showed a transparent color and odorless smell while the pH were 7.2 and 6.5, respectively.

Table 1 Physical characteristic of Kosti and Rabak drinking water after winter (March) season

Site	**Kosti samples**	**Rabak samples**
Color	Transparent	Transparent
Odor	Odorless	Odorless
pH	7.2	6.5

The tested physical parameters of Kosti and Rabak drinking water of the samples collected after autumn season (Table, 2) showed a less transparent color and odorless smell while the pH were 7.2 and 7.8, respectively.

Table 2 Physical characteristic of Kosti and Rabak drinking water after autumn (October) season

Site	**Kosti samples**	**Rabak samples**
Color	Less transparent	Less transparent
Odor	Odorless	Odorless
pH	7.2	7.8

3.2. Chemical tests of the drinking water

The tested chemical parameters of Kosti and Rabak drinking water of the samples collected after winter season (Table, 3) showed respectively, an EC of 220 and 225 (μS/cm), TDS of 101 and 180 (mg/L), Hardness of 180 (mg/L) for both, sulphate and carbonate of 0 (mg/L) for both, Ca of 20 and 24 (ppm) and chloride of 28.4 and 31.95 (ppm).

The tested chemical parameters of Kosti and Rabak drinking water of the samples collected after autumn season (Table, 4) showed respectively, an EC of 211 and 212 (μS/cm), TDS of 80 (mg/L) for both, Hardness of 250 and 500 (mg/L), sulphate and carbonate of 0 (mg/L) for both, Ca of 30.4 and 16 (ppm) and chloride of 24.85 and 28.40 (ppm).

Table 3 Physical characteristic of Kosti and Rabak drinking water after winter (March) season

Site	Kosti samples	Rabak samples
EC (µS/cm)	220	225
TDS (mg/L)	101	180
Hardness (mg/L)	180	180
Sulphate (mg/L)	0	0
Carbonate (mg/L)	0	0
Ca (ppm)	20	24
Chloride (ppm)	28.4	31.95

Table 4 Physical characteristic of Kosti and Rabak drinking water after autumn (October) season

Site	Kosti samples	Rabak samples
EC (µS/cm)	211	212
TDS (mg/L)	80	80
Hardness (mg/L)	250	500
Sulphate (mg/L)	0	0
Carbonate (mg/L)	0	0
Ca (ppm)	30.4	16
Chloride (ppm)	24.85	28.40

4. Discussion

The drinking water of Kosti and Rabak that collected after winter season showed good physical quality, as same as that collected after autumn season except the slight problem in color (less transparent). The tested chemical parameters of Kosti and Rabak drinking water that collected after winter season showed good quality except, those of sulphate, carbonate of 0 (mg/L) and chloride of 28.4 and 31.95 (ppm) as same as that collected after autumn season, except hardness (500 mg/L) which seemed to be an autumn problem of Rabak city.

Drinking water quality standards describes the quality parameters set for drinking water. Ground water is the major sources of drinking water. 65% of human body made by water. Out of the total water consumed by human beings, more than 50 % of it is consumed for industrial activity and only a small proportion is used for drinking purposes (Manoj *et al.*, 2014). Good Quality of Drinking water is very necessary for improving the life of people and to prevent from diseases (Mohamed and Zahir, 2013). 70% surface of earth is covered by water, Majority of water available on the earth is saline in the nature only 3 % of exists as fresh water. Fresh water has become a scare commodity due to over exploitation and pollution (Ghose and Basu, 1968; Mahish and Thiske, 2015). Pollution of surface and ground water is great problem due to rapid urbanization and industrialization. In present review it is emphasize the various parameter of drinking water by various agencies.

Patil (2012) reported pH ranged from minimum of 6.6 to maximum of 8.4, chlorides from 132.5 to 820.4 mg/l, hardness ranged from 74 to 281 mg/l, CO_2 from 2.1 to 5.09, BOD from 4.437 to 112.432 mg/l, sulphate 0.192 to 5.12 mg/l, nitrates 0.5 to 1.012. The minimum pH value of 6.3 mg/l was found during winter season and maximum of 8.93 mg/l in summer. The pH shows general decline from upstream to downstream. The electrical conductivity of drinking water should be 200 to 800 (µS/cm), while the TDS should be less than 300 (mg/L). Ca should be 20 – 30 mg/l in the drinking water. From the data collected it can be concluded that the inverse relationship, which is known to exist between pH and CO_2, is not existing in the present investigation (Sawane *et al.*, 2006). WHO (1992) reported ground water quality of industrial area of Kishangarh for various physicochemical parameters seasonally without and after addition of marble slurry in different proportions. From the study it is clear that these parameters increase with the addition of marble slurry leading to deterioration of the overall quality of the groundwater.

Human activities have, in many ways, exerted increasing pressure on water environment. The chemical contaminants in drinking water have been noticed during the last decades, such as industrial activities (oil, gas exploitation and ship activities). These contaminants can be divided into two main categories: compounds that are known to be hazardous to the environment and therefore are regulated, and chemicals that are not yet regulated, due to the lack of information to support a reliable environmental risk assessment (Batuira *et al.*, 2022).

During 2021, Ali *et al.*, evaluated the physical, chemical and microbiological quality of drinking water of Kosti, White Nile State, Sudan, with collaboration of Blue Nile National Institute for Communicable Diseases, University of Gezira. They found signs of pollution and poor filtration treatment of water.

During 2022, contamination of White Nile water with lead (Pb) was also detected by the Central Laboratory, University of Gezira when they examined several fish meats collected from the White Nile river of Kosti city for their nutrient mineral contents and heavy metals (Malik *et al.*, 2022).

5. Conclusions

The samples of drinking water taken from Kosti and Rabak cities, showed signs of physical and chemical pollutions, which required serious steps towards treatment of their causes.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclose.

Statement of ethical approval

No experiments were run directly or indirectly on any animal or human.

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