Physicochemical Properties of Ground Water from Elfarshaya Area, Southern Kordufan State, (Sudan)

A. Gobara[1], **Yagoub Abdalla Ali**[2]

Department of Chemistry, Faculty of Education, Dalanj University, South Kordufan State Sudan
Department of Biology, Faculty of Education, University of Zalingei
wadgobara35[at]gmail.com

Abstract: ***Well water is main source of drinking water in Elfarshaya area, In this study four samples of water were collected from Elfarshaya area in October (2019), and analyses were performed the following parameters:(pH, EC, TDS), hardness as $CaCO_3$, cations: (Na^+, K^+ and Ca^{+2}), an aions : (Cl^-, SO_4^{-2},CO_3^{-2} and HCO_3^-). The results showed that the pH values ranging from (7.15 to 7.88), thus, all the samples were slightly alkaline (pH > 7). TDS values for all the samples in ranging from (98 to 273 ppm) were within the permissible value of WHO (1000 ppm). The results of chloride found in ranging from (22– 140 ppm) were in agreement with WHO standards (250 ppm Cl^-).The results showed that the concentration of sulphate for all the samples is (0.023 - 0.174 ppm) in permissible level of WHO. For hardness, two samples (63 - 72 ppm) were classified as moderately soft, and another two samples (140 - 186 ppm) were classified as slightly hard and moderately hard respectively. The concentration of cations: Na^+ (12.3- 34.89 ppm), K^+ (4.25 – 10.6 ppm) and Ca^{+2} (2.57 - 22.8 ppm) were within the permissible level of WHO (200 ppm Na^+, 10 ppm K^+ and 200ppm Ca^{2+}). As the result of these findings the water can be use without treating. The study recommended that more of study to determine the trace metals.***

Keywords: Ground Water, Physicochemical Properties, Elfarshaya area

1. Introduction

Water is one of the most important chemicals known to man. Without it neither animals nor plants life will exist. Water is essential in processes of digestion, circulation, elimination and the regulation of body temperature. Water is used as a solvent for many substances, [1]. Ground water quality is influenced by the geological background of the water behaving rocks of the source. Changes in source water or degraded quality of source supplies may, seriously, impair the quality of ground water supply. Municipal and an aquifer are major sources of organic and inorganic pollution. Large-scale organic pollution of ground water is infrequent, however, since significant quantities of organic wastes usually cannot be easily introduced underground, [2]. Almost three fourth of the earth's surface is covered by water. Most of this water is not suitable for human use. The demand for fresh water has increased with rapid growth of population agriculture, and industry, [3]. The sources of water supply are divided into two major classes, surface and ground water [4]. There are many sources of surface water. This includes rivers, streams, lakes and reservoirs [5]. The common characteristics of surface water are that it contains few minerals, not very hard, usually large in volume and it is convenient to many people. It is easily contaminated, and total bacterial contents are high. Therefore, proper treatment (filtration and chlorination) is required before human consumption. Ground water is supplied from rivers, reservoirs and marshes. The character of Ground water depends, up on the nature and the condition of Soil and rock through it passes [6]. In many countries ground water is the main source of water for all purposes. This is because rural communities are found close to the ground water resources [5].

1.1 Objective of the study:

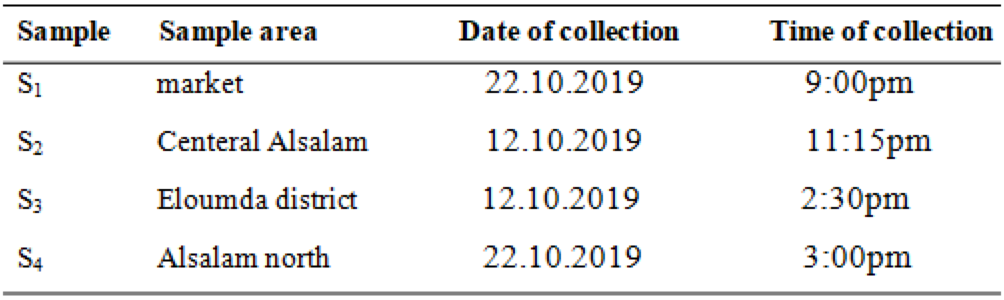
The aim of this study was to determine quantitatively some physical and chemical parameters namely, pH, EC, TDS, hardness, chloride, calcium, sulphate, carbonate, bicarbonate, potassium, and sodium of wells waters Elfarshaya area and compare the results with those recommended by the WHO.

2. Materials and Methods

2.1. Sampling:

The samples of the drinking water were collected from Elfarshaya area (Well market S_1, Well of Central Alsalam S_2, Well of Eloumda district S_3 Well of Alsalam north S_4) in different dates and times and sorted in plastic container (2 liter) at room temperature. Table (1) shows the locations of the samples, the dates and times collected.

Table 1: Locations of the samples, the dates and times collected



Sample	Sample area	Date of collection	Time of collection
S_1	market	22.10.2019	9:00pm
S_2	Centeral Alsalam	12.10.2019	11:15pm
S_3	Eloumda district	12.10.2019	2:30pm
S_4	Alsalam north	22.10.2019	3:00pm

2.2. Methods:

2.2.1. Determination of pH:

PH meter was calibrated using buffers solution (4,7 and 10), the pH of 50 ml sample was noted.

2.2.2. Electrical conductivity (EC):

Electrical conductivity is the measure of the ability of water to conduct an electrical current. The specific electrical conductance is defined as the conductance of a cubic centimeter of any substance compared with the same volume of water. Pure water has very low electrical conductance and conductivity of water will increase with the presence of dissolved minerals (Fletcher G. Driscoll 1989).Water with high specific conductance can cause corrosion of iron and steel. Electrical conductivity is expressed in micro mhos per centimeter (µmohs/cm) **[7]**.The conductivity cell was rinsed with distilled water, and then with 0.01 M KCl solution. The temperature of the conductivity meter and the sample was adjusted to 25°C, and by using water bath. The conductivity of KCl solution was measured and adjusted to 1.413 µmohs (reference solutions). The conductivities of samples were determined in the same manner (American Public Health Association **[8]**.

2.2.3. Determination of TDS:

The dissolved solids in water comprise inorganic salts and a small amount of organic matter. The principal anions contributing to the TDS include: carbonate, bicarbonate, chloride, sulphate and nitrates. Also TDS includes the cations: calcium, magnesium, potassium and sodium. TDS in water influence other qualities of drinking water, such as; taste hardness and corrosion properties **[9]**.

50 ml of water sample were transferred to weighted beaker and evaporated to dryness by heating for (1 – 2) hours at 180°C.

$$\text{mg / L TDS} = \frac{\text{mg residue}}{\text{ml samples}} \times 1000$$

2.2.4. Determination of Hardness:

EDTA titrimetric method was used as described in [10].

1 ml ammonia buffer solution and about 30 mg of eirochrome black T indicator were added to 50 ml water sample in a 250 ml conical flask, the solution was then titrated with 0.01 M EDTA solution until the color changes from wine red to blue end point (2).

Calculation:

Hardness as

$$\text{mg } CaCO_3 \text{ / L} = \frac{A \times B \times 1000}{\text{mls of sample}} \text{ (general formula)}$$

Where:

A = mls of EDTA required for titration.
B = mg of $CaCO_3$ equivalent to 1 mole EDTA titrant.

$$\text{Hardness} = \frac{V \times 0.01 \times 100 \times 1000}{50}$$

Therefore, hardness = 20 V ppm

V = Volume of EDTA required for titration.

2.2.5. Determination of Sulphate:

50 ml of water sample were placed in a 250 ml conical flask. The pH was adjusted with HCL (1:1) to (4 – 5) using pH meter. The solution was then heated to boiling. Warm barium chloride ($BaCl_2$) solution was then added while stirring until complete precipitation. The solution was kept overnight. Filtered through ash less filter paper, dried and ignited at 800°C for (2 – 3) hours. The residue was cooled in desiccators and weighted (11).

Calculation:

$$\text{mg } SO_4^{-2} \text{ / L} = \frac{\text{mg of } BaSO_4 \times 411.5}{\text{ml of sample}}$$

Where:

411.5 = gravimetric factor

2.2.6. Determination of Chloride:

50 ml of each sample were placed in a 250 ml conical flask, 1 ml of K_2CrO_4 indicator was added, the solution was then titrated with (0.014 M) $AgNO_3$ solution ($AgNO_3$ solution was standardized by mohr method using standard KCl solution) until a pinkish yellow precipitate was produced. The distilled water being used as blank was treated in the same manner, (11).

Calculation:

$$\text{mg } Cl^- \text{ / L} = \frac{(A - B) \times M \times 35.5 \times 1000}{V}$$

Where:

A = mls of Ag NO_3 required for the sample.
B = mls of the titrant for the black.
M = molarity of $AgNO_3$ soltuion.
V = mls of sample

2.2.7. Determination of Carbonate and bicarbonate:

To a 50 ml of water sample few drops of phenolphthalein solution were added, and the solution was titrated with 0.05M HCl. The burette reading (say x) was recorded. Few drops methyl orange indicator were added to titration flask and the titration was continued till the end point when the colour changes from yellow to red (burette reading y) (6).

Calculation:

x = Volume of acid ≡ $^1/_2$ carbonate.

Therefore:

2x = Volume of acid required to titrate all the carbonate in 50 ml of Sample.
y = Volume of acid ≡ all carbonate + all bicarbonate.

Therefore:

y – 2 x = Volume of acid required to titrate all the bicarbonate in 50 ml sample.

The result was expressed as mg/L.

Therefore:

$$\text{mg } CO_3^{-2} / L = \frac{0.05 \times V \times 60 \times 1000}{50 \times 2}$$

Where:
V =Volume of acid – required to titrate all carbonate in 50 ml
Sample.
60 = the molecular weight of the carbonate.

$$\text{mg } HCO_3^{-} / L = \frac{0.05 \times (y - 2x) \times 61 \times 1000}{50}$$

61 = the molecular weight of the bicarbonate

2.2.8. Determination of Calcium:

100 ml of the water sample were placed in 250 conical flasks; 0.5 ml NaOH solutions were added to get a pH of (12 – 13) and the solution was stirred. A one gm of the murexide indicator was added, while stirring, and 0.01 M EDTA solution was added slowly till the end point reached the color change from pink to purple, (2).

Calculation:

$$\text{mg } Ca^{2+} / L = \frac{A \times B \times M \times 40 \times 1000}{\text{ml of sample}}$$

Where:

A = mls of titrant for the sample.
B = mg $CaCO_3$ equivalent to 1 mole EDTA titrant.
M = Molarity of EDTA.
40 = Calcium molecular weight.

2.2.9. Determination of Sodium:

From the stock solution (1000 ppm Na) 1ml, 2ml, 3ml, 4ml and 5ml were transferred to 50 ml flasks and diluted to the mark with distilled water to give : 10, 20, 30, 40 and 50 ppm Na. The flame photometer was then used to measure the emission intensities of the standards and the samples.

The calibration curve was then constructed and from which the concentration of Na were determined [9].

2.2.10. Determination of Potassium:

From the stock solution (1000 ppm K) 20 ml transferred to 100 ml flask and diluted to the mark with distilled water to give (200 ppm K) 2ml, 4ml, 6ml, 8ml, 10 ml were transferred to 100 ml flasks and diluted to the mark with distilled water to give 4, 8, 12, 16 and 20 ppm K. The flame photometer was then used to measure the emission intensities of the standards and the samples.

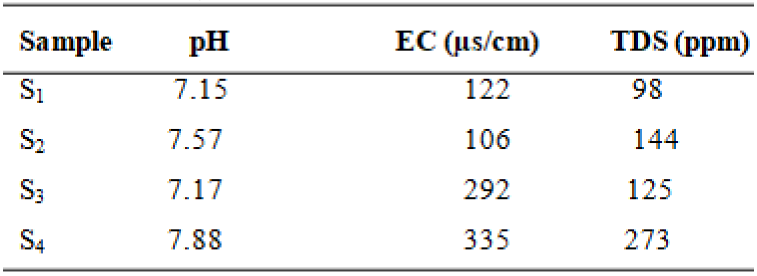
The calibration curve was then constructed and from which the concentration of K were determined [9].

3. Results and Discussion

3.1. Results:

3.1.1 Results of PH, EC and TDS

Table 2: The PH, electrical conductivity (EC) and total dissolved solids (TDS) for Elnuhud Area water samples.



Sample	pH	EC (µs/cm)	TDS (ppm)
S_1	7.15	122	98
S_2	7.57	106	144
S_3	7.17	292	125
S_4	7.88	335	273

3.1.1.1 PH value:

From table (2), the active hydrogen ion concentration (PH) varies between 7.15 and 7.88 that mean all samples fall in the alkaline side, and (pH) values obtained for all samples shows value within the permissible level as reported by WHO standards.

3.1.1.2 Electrical conductivity (EC):

The results of electrical conductivity from table (2) for all the samples were in agreement with those values reported by WHO standards.

3.1.1.3 Total dissolved solids (TDS):

The results of total dissolved solids from table (2) show that (TDS) values for all the samples in the permissible level compared with that stated by WHO (1000ppm).

3.1.2. Results of concentrations of dissolved species:

Table 3: Chloride, Sulphate, carbonate, bicarbonate and hardness

Sample	Cl^- in ppm	SO_4^{-2} in ppm	CO_3^{-2} in ppm	HCO_3^- in ppm	Hardness as $CaCO_3$
S_1	22.3	0.023	20	39.7	72
S_2	23.8	0.256	26	60.9	63
S_3	25.77	0.229	35	48.8	140
S_4	140	0.274	43	63.23	186

3.1.2.1 Chloride:

The results of chloride concentrations summarized in table (3) show that all the samples have chloride content within the permissible range reported by the WHO standards (250ppm).

3.1.2.2 Sulphate:

The results of sulphate concentration which obtained and summarized in table (3) for all the samples were low compared with WHO standards (400ppm).

3.1.2.3 Carbonate and bicarbonate:

As an observation from carbonate and bicarbonate results that obtained and listed in table (3), the carbonate values were low when compared with concentration values of bicarbonate. This may be due to the conversion of carbonate to bicarbonate. The results of carbonate and bicarbonate concentrations summarized in table (3) show that all the samples within the permissible range reported by the WHO (250ppm).

3.1.2.4. Hardness:

The results obtained for the hardness listed in table (3) show that a higher value obtained for samples (S_3) and (S_4), low value for samples (S_1) and (S_2).

The results were in agreement with the recommended values of WHO (500 ppm of $CaCO_3$), so samples (S_1) and (S_2) were classified as moderately soft, sample (S_3) classified as slightly hard and sample (S_4) classified as moderately hard.

3.1.3 Results of cations concentration:

Table 4: shows the results obtained for the listed cations Sodium, potassium, and calcium in ppm.

Sample	Na^+ in ppm	K^+ in ppm	Ca^{+2} in ppm
S_1	12.3	10.6	2.57
S_2	16.66	8.22	22.8
S_3	34.89	4.25	11.2
S_4	15.04	7.21	13.2

3.1.3.1 Sodium and potassium:

Fig (1) show the concentration of the two cations (Na^+) in the sample S3 was high in compared with other samples, but values were in agreement with the value reported by WHO (200ppm Na^+, 10ppm K^+), (2).

The guide level of potassium is (10 ppm) as reported by WHO, therefore all samples show a good agreement with the maximum WHO desirable value.

3.1.3.2 Calcium:

The guide level of calcium reported by the WHO is (200 ppm) and therefore all samples showed values which were in agreement with the value of WHO.

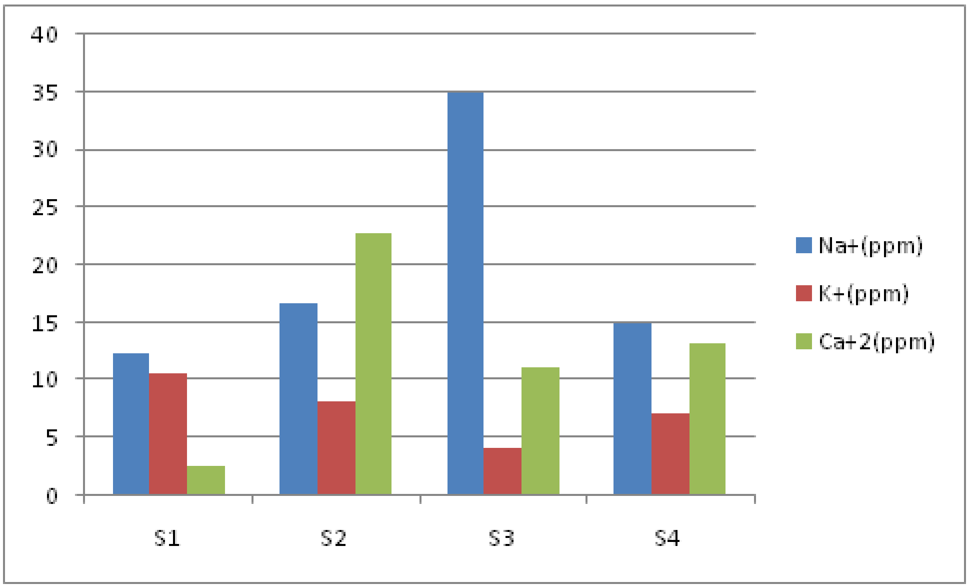


Figure 1: Shape show the concentrations of Na^+, K^+ and Ca^{+2} in ppm

4. Conclusion

In conclusion, the present study revealed that all drinking water samples set as permissible limit. The analysis showed general suitability of the analyzed water samples from the measured physical and chemical properties for drinking purpose.

Thus, all samples are suitable for human and animal consumption.

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