

**Determination of Physical Properties and Some Inorganic
Constituents of Drinking Water in Sennar Research Station,
Sennar State, Sudan**

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Dedication

This thesis is dedicated with great love

To:

The Soul of my father and mother

My husband

Brothers and sisters

Who give meaning to my life

To all of you

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Abstract

Ground water is a kind of water that percolate into the ground and becomes source of water supply. Well water is the main source of drinking water in Sennar Research Station. The aim of this study is to determine quantitatively the physical properties and some inorganic constituents of drinking water which change the taste of water and compare the results with the standards recommended by WHO. Five samples were taken from underground well in Sennar Agricultural Research Station (Sennar State). These samples were taken at different times and analyzed for the following parameters: Electrical Conductivity (EC), pH values, Total Dissolved Solids (TDS), Hardness and anions (Cl^- , CO_3^{2-} , HCO_3^- and SO_4^{2-}) and cations (Na^+ , K^+ and Ca^{+2}). The results showed that the EC values were (400 - 432 μS). The pH values of the samples are (8.1 – 8.8). The TDS values with in the permissible values of WHO (580- 600 ppm). The concentrations of carbonate and bicarbonate in some samples were high (78 and 42 ppm) and (707.6 ppm) for carbonate and bicarbonate respectively. This may be due to the time of taking the samples. The results showed that the concentrations of chloride, sodium, potassium and calssium in the range of the standard values according to the WHO. The concentration of sulphate are very high in all samples (2386.7 – 3750.5 ppm), this disagree with WHO standard. This may be due to the nature of the soil which the water passed through it. This study showed that the water of this well needs some treatments. More studies are needed to determine the effect of these inorganic constituents of this well.

تحديد الخواص الفيزيائية وبعض المكونات اللاعضوية في مياه الشرب في محطة بحوث

سنار - ولاية سنار ، السودان

آمنه عثمان أحمد بابكر

ملخص الدراسة

المياه الجوفية هي نوع من المياه التي تنفذ إلى جوف الأرض وتصبح مصدر لإمداد المياه. تعتبر مياه الآبار هي المصدر الرئيسي لمياه الشرب في محطة بحوث سنار. الهدف من هذه الدراسة هو تحديد الخواص الفيزيائية وبعض المكونات اللاعضوية الكيميائية في هذه المياه التي قد تتسبب في تغيير طعم المياه ثم مقارنة تراكيز هذه المكونات مع التراكيز الموصى بها من قبل منظمة الصحة العالمية. أخذت خمسة عينات من مياه بئر محطة بحوث سنار؛ تم اخذ هذه العينات في أوقات مختلفة وأجريت لها التحاليل باستخدام الأجهزة والطرق الكيميائية. أوضحت النتائج الآتي:- قيم الأس الهيدروجيني تتراوح ما بين (8.1- 8.8) وهي قاعدية في جميع العينات وان كمية الأملاح الكلية الذائبة في العينات (580-600) جزء من المليون وهي في المدى المسموح به من قبل منظمة الصحة العالمية. قيم الموصلية الكهربائية (400-432) μs أما العسر الكلي للماء في العينات لا يزيد عن القيم الموصى بها من قبل المنظمة وأيضاً أشارت النتائج أن تراكيز الكربونات والبيكربونات عالية في بعض العينات 78 و 707 جزء من المليون للكربونات والبيكربونات على التوالي وذلك لان هذه العينات تم أخذها على فترات مختلفة. أما نتائج الكلور كانت في المدى المسموح به من قبل منظمة الصحة العالمية كما أن تراكيز الكبريتات عالية جدا في جميع العينات (3950.4- 2386.7) جزء من المليون ويعزى هذا الى طبيعة الأرض التي تمر خلالها هذه المياه. أثبتت هذه الدراسة أن مياه هذه البئر تحتاج إلى بعض المعالجات ومزيد من التحاليل لمعرفة تأثير هذه المكونات اللاعضوية في مياه الشرب.

Table of contents

Subject	Page No
Dedication	I
Acknowledgements	Ii
Abstract	Iii
Abstract (Arabic)	Iv
List of contents	V
List of tables	vii
List of figures	viii
CHAPTER ONE	
Introduction and Literature Review	1
1.1 Water sources	1
1.1.1 Surface water	1
1.1.2 Ground water	2
1.2 Physical and chemical properties of ground water	3
1.2.1 Colour	3
1.2.2 PH value	3
1.2.3 Total dissolved solids (TDS)	3
1.2.4 Temperature	4
1.2.5 Density	4
1.2.6 Turbidity	4
1.3 The chemical properties of water	5
1.3.1 Chloride	5
1.3.2 Sulphate	5

1.3.3 Carbonate and Bicarbonate	5
1.3.4 Total alkalinity	6
1.3.5 Hardness	6
1.3.6 Sodium	7
1.3.7 Potassium	8
1.3.8 Calcium	8
1.3.9 Water quality standard	9
1.4 Objective of the study	10
Chapter two: Materials and Methods	
2.1 Sampling	11
2.2 Apparatus used in analysis	11
2.3 Determination of Electrical conductivity (EC)	11
2.4 Determination of total dissolved solids (TDS)	12
2.5 Determination of pH value	12
2.6 Determination of hardness	13
2.7 Determination of total alkalinity	14
2.8 Determination of chloride (Cl ⁻)	15
2.9 Determination of Sulphate (SO ₄) ⁻²	17
2.10 Determination of carbonate and bicarbonate	18
2.11 Determination of calcium (Ca ⁺)	19
2.12 Determination of sodium and potassium	21
Chapter three: Results and Discussion	
3.1 Results of EC, PH and TDS (Physical parameters)	24
3.2 Electrical conductivity (EC)	24
3.3 The PH value	26
3.4 Total dissolved solids (TDS)	27

3.5 Results of chemical parameters	27
3.6 Chloride	28
3.7 Sulphate	28
3.8 Carbonate and bicarbonate	28
3.9 Hardness	28
3.10 Results of cations concentration	28
Conclusion and recommendation	30
References	31

List of tables

Table No		Page No
1	Ground water classification based on total dissolved solids	4
2	Classification of water on basis of hardness	7
3	WHO maximum permissible value of drinking water (1993)	9
4	Dates and times of collection of samples	11
5	The results of EC, PH and TDS.	24
6	Results of chloride, sulphate, carbonate, bicarbonate and hardness	27
7	The result of K^+ , Na^+ and Ca^{+2}	28

List of figures

Figure No		Page No
1	Calibration curve of determination of potassium	22
2	Calibration curve of determination of sodium	23
3	EC of water samples in μs	25
4	PH of water samples	26
5	TDS of water samples in ppm	27

CHAPTER ONE

INTRODUCTION AND LITRATURE REVIEW

Water is a wonder full material that covers more than three-fourths of the earth. Water plays an important role in life and essential for all forms of life. It is an integral part of life on this planet and it is the main constituent of all living organisms. Life can not exist without water. People can survive days or weeks or even longer without food, but only about days without water (www.mby net). About 70% of human body weight is water. Water is a tasteless and odorless substance, it is known as the universal solvent. It appears colorless to the naked eye in small quantities. Water is found in three forms(liquid, solid and steam). Most of the water on the earth is salty. We can remove salt from Ocean water but the process is very expensive. Fresh and clean water(rivers) help people to become on good health and fit to do work. Water is essential in the processes of digestion, circulation, elimination and the regulation of body temperature. Water is vital for drinking, sanitation, agriculture and industry. Nearly all processes of life depend on reactions that take place in aqueous solution.

1.1 WATER SOURCES:

The sources of water supply are divided in two major classes

1.1.1. Surface water:

Surface water includes rivers ,lakes, seas, ponds and reservoirs.

Surface water contains few minerals and is not very hard and it is easily contaminated. Turbidity and bacterial counts are high and it is difficult to protect surface water from them.

When surface water is used for supplies or for domestic purposes it must usually be treated by filtration and chlorination to make it suitable for human consumption(Forrest,1976).

1.1.2.Ground water:

Ground water is a kind of water that percolates into the ground and becomes source of water supply. The feature of ground water depends on the nature and condition of soil and rocks through which is passes (Forrest,1976).

Ground water has low turbidity and can usually meet health standards for drinking and domestic use. However ground water can contain various kinds of salts and can be very hard.

Ground water can be classified into three classes according to the layer in which it is stored (IDC,1981).

i)Surface water:

It is water that collects above the first stable impervious layer of rock. It can move freely on its surface is known as ground water surface. It is supplied mainly by rain water or percolation of rivers or lakes.

ii) Artesian water:

Artesian water stored in a water containing layer which is sandwiched between and confined by two impervious layers.

iii) perched water:

perched water exists above a sectional impervious layer, it is not widely distributed and is seasonal.

1.2. Physical and chemical properties of ground water:

1.2 .1 Color:

Color in drinking water is due to the presence of colored organic matter, e.g. humic substances, metals such as iron and manganese or highly colored industrial wastes . Drinking water should be colorless.

Change in the color of water indicates that further investigation is needed. The level for color (10-15 TCU) (True color units) (WHO,1997).

1.2.2 pH value:

The relative acid or basic level of a solution is measured by pH .The pH is measure of the hydrogen ion concentration in water, specifically the negative logarithm(Log) of the hydrogen ion concentration. Water at a pH of 7.0 is neutral, at a pH of less than 7.0 is acidic, at a pH of more than 7.0 is basic. The normal range for pH in ground water lies between 6 and 8.5 (pure water hand book).

1.2.3 Total dissolved solid (TDS):

Total dissolved solids comprise mainly inorganic salts namely: calcium, sodium and potassium for cations and carbonate or bicarbonate, chloride , sulphate and nitrate for anions and small amount of organic matter that is dissolved in water.

Total dissolved solids can be expressed in ppm and it is directly related to the electrical conductivity (WHO,1993).

Total dissolved solids can have an important effect on the taste of drinking water.

A limit of 500mg\L for domestic use is based on the taste(Allen and Mancy,1972).

The palatability of water with total dissolved solids level of less than 600 mg/L is generally considered to be good. Drinking water is unpalatable at TDS levels greater than 1200mg/L. Water with extremely low concentration of TDS may be unacceptable because of its flat taste (WHO, 1993).

Table (1): Ground water classification based on total dissolved solids

Description	Total dissolved solids mg/L
Fresh water	0 -1
Brackish water	1 – 10
Saline water	10 -100
Brine water	More than 100

Source: Fletcher (1989).

1.2.4. Temperature:

In general the rate of a chemical reaction decreases with decreasing temperature. The relative concentration of reactants and products in chemical equilibrium can also change with temperature therefore: temperature affects every aspect of treatment and delivery of potable water. Turbidity and color are inversely related to temperature, as the efficiency of coagulation is strongly temperature dependant.

1.2.5. Density:

The maximum density of pure water is 1g/cm^3 at 4C^0 . When temperature increases the density decreases.

1.2.6. Turbidity:

Turbidity is a measure of cloudiness of water. Water is turbid when it contains visible materials in suspension. Turbidity may result from living or dead algae or other organisms. It is generally caused by silt or clay. The amount and character of the turbidity will depend upon the type of soil over which the water has run and the velocity of water.

The permissible level for turbidity (1 – 5 NTU)(Nephelometric Turbidity unit) ([www. water system council.org](http://www.water system council.org)).

1.3. The chemical properties of water:

1.3.1. Chloride:

Chloride (Cl^-) salts are common water contaminants. Chloride is one of the major anions in water and present in water as sodium chloride. Water with high chloride content has to be restricted in usage for people suffering from heart and kidney diseases (WHO, 1993). The critical level of chloride depends on the intended use of the water. Ground water gets its chloride from oceans through sprays tapped rain drops. Water containing less than 250 PPM chloride is satisfactory for water supply, agricultural or industrial use with WHO standard of chloride the water gets disagreeable salt fish taste (pure water hand book. 1991, 1997).

1.3.2. Sulphate:

Sulphate (SO_4^{2-}) is very common when present in low levels. Sulphate salts create problems only for critical manufacturing processes. At high levels, they are associated with a bitter taste and laxative effect. Many divalent metal – Sulphates are virtually insoluble and precipitate at low concentrations. Sulphates in ground water are caused by natural deposits of magnesium sulphate, calcium sulphate or sodium Sulphate (pure water hand book. 1991, 1997).

1.3.3. Carbonate and bicarbonate:

Carbonate and bicarbonate in water are the two of three forms of the components of the carbonate equilibrium. the concentration of the carbonate and bicarbonate in water depends on its pH; when the pH of water is 4-5 or

less, water contains carbonate and bicarbonates and at pH 8.3 or more the content of carbonate and bicarbonate can be disregarded. The concentration of carbonate and bicarbonate in deep underground water may be quite high. When the concentration of carbonate and bicarbonate in water is high, water becomes corrosive to metals and concrete (WHO, 1978).

1.3.4. Total alkalinity:

Alkalinity is the measure of water samples ability to neutralize (hydrogen ions)- Alkalinity may be caused by dissolved strong bases such as sodium hydroxide or potassium hydroxide and other hydroxide containing compounds. It is also caused by dissolved carbonate, bicarbonate and phosphates. The measured alkalinity is the total of all of these species found in water sample. It is expressed in terms of mg Ca/L although many species other than dissolved calcium carbonate may actually contribute to alkalinity (www.uwstout.edu).

1.3.5. Hardness:

Hardness of natural water is caused largely by calcium and magnesium salts. Hardness resulting from bicarbonates and carbonates of calcium and magnesium is called temporary hardness and can be removed by boiling the water and precipitation of Ca CO_3 and Mg CO_3 . Another type of hardness called permanent hardness is due to the presence of chloride and Sulphate; this type of hardness can not be eliminated by boiling of water. Water hardness is expressed as ppm Ca CO_3 .

Table (2): Classification of water on basis of hardness

Range (mg/Ca CO ₃ /L)	Hardness level
0 – 50	Soft
50 – 100	Moderately soft
100 – 150	Slightly hard
150 – 200	Moderately hard
200 -300	Hard
Over 300	Very hard

Source (Twort, *et al.* 1985).

1.3.6. Sodium: (Na⁺)

Sodium is the third element in group A1 of the periodic table it has an atomic number of 11, atomic weight of 22.99 and valence of 1.

The sodium ion (Na⁺) is introduced naturally due to the dissolution of salts such as sodium chloride (Na Cl), sodium carbonate (Na₂ CO₃), sodium nitrate (Na NO₃) and sodium sulphate (Na₂ SO₄) (pure water hand book. 1991, 1997).

The average abundance of Na in the earth's crust is 2.5%, in soil its 0.02 to 0.62%, in stream site is 6.3 mg/L and in ground water it is generally > 5 mg/L.

The sodium ion is a major constituent of natural water. It has been estimated that food account for a approximately 90% of the daily intake of sodium whereas drinking water contributes the remaining 10%. Ground water contains high concentration of sodium and this can increase salinity in rivers and streams. Sea water contains relatively high level of sodium. Sodium level

in ground water vary widely. High level may be associated with saline soil (WHO, 1984 b).

1.3.7. Potassium (K):

Potassium is the fourth element in Group A1 of periodic table. It has an atomic number of 19, an atomic weight of 39.10 and a valence of 1. Potassium is an essential element most often found as chloride (KCL) and has similar effects but is less common than sodium chloride. The average abundance of K in the earth's crust is 1.84%, in soils it has a range of 0 to 2.6%, in streams it is 2.3 mg/L and in ground waters it has an a range of 0.5 to 10 mg/L. Potassium compounds are used in glass, fertilizers, baking powder, soft explosives and pigments. Potassium is an essential element in both plant and human nutrition, and occurs in ground waters as result of mineral dissolution, from decomposing plant material, and from agricultural run off (APHA, 1971).

1.3.8 Calcium:

Calcium is the third element in group 11A of periodic table; it has an atomic number of 20, an atomic weight of 40.08 and valence of 2. Calcium occurs in water naturally. The average abundance of calcium in the earth's crust is 4.9%; in soil it is 0.07 to 1.7%, in streams it is about 15mg/L and in ground water it is from 1 to 500 mg/L.

The most common form of calcium is calcium carbonate (calcite) and calcium magnesium carbonate (dolomite). Calcium compounds are widely used in pharmaceuticals, photography, lime, de-icing salts pigments, fertilizers and plasters. Calcium is necessary in plant and animal nutrition and is essential component of bones, shells and plant structures. The presence of calcium in water supplies results from passage over deposits of lime stone, dolomite,

gypsum and gypsiferous shale. Small concentration of calcium carbonate impacts corrosion of metal pipes by laying down a protective coating. Because precipitation of calcite in pipes and in heat exchanges can cause damage. The amount of calcium in domestic and industrial waters is often controlled by water softening (APHA, 1971).

1.3.9. water quality standards:

International standard for drinking water was first published by WHO in 1958, then have been revised and reissued in anew form in1993 and retitled as (guidelines for drinking water quality)(Table 3).

Table(3): WHO maximum permissible value for drinking water (1993):

Characteristics	Units (ppm)
TDS	1000
pH	7.5 - 8.5
Chloride	250
Sulphate	400
Total alkalinity	400
Hardness	500 as CaCO ₃
Sodium	200
Potassium	10
Calcium	200

Source: WHO, 1993.

1.4.The objective of the study:

The aim of this work is to study the quality of Sennar Research Station water and determination of the concentration of some inorganic constituents and investigate the physical and chemical properties namely pH, EC, TDS, Chloride, Sulphate, Carbonate and bicarbonate and to compare the results with those recommended by WHO.

CHAPTER TWO MATERIALS AND METHODS

2.1. Sampling:

Five samples of drinking water were taken from a well of sennar research station in a plastic container. The samples were taken by the rate of one sample per week for three week, in the fourth week two samples were taken in one day (in the morning and at night).

Table (4): Dates and times of collection of samples:

Sample	Date of collection	Time of collection
1	6/9/2013	6:00 pm
2	13/9/2013	6:00 pm
3	20/9/2013	6:00 pm
4	27/9/2013	6:00 pm
5	27/9/2013	10: 00 am

2.2. Apparatus used in analysis:

- Electrical conductivity meter, Hanna instruments, model HI 8633 conductivity meter
- PH meter, Hanna instrument, 211.
- Oven Gallen Kamb, model DV-160
- Flame photo meter CORNING, model No. 400

2.3. Determination of Electrical Conductivity (EC):

(a) Chemicals:

Potassium chloride A. R, 99.5% England.

(b) Reagents:

- Potassium chloride solution (0.01 M)
- Distilled water.
- 0.0754 gm of A. R potassium chloride was dissolved and diluted to 100 ML distilled water to make standard reference solution.

(c) Procedure:

EC was measured by electric conductivity meter. A measuring set was used with specific conductance cell and it was calibrated with (0.01M) KCl. The conductivities of samples were then determined in (μ S), (Twort, *et al.*, 1985).

2.4. Determination of total dissolved solids (TDS):

Total dissolved solids were determined by evaporating the water sample to dryness (Hoerwits, *et al.*, (1970).

(a) Procedure:

50 ml from each water samples were transferred to dry weight beaker and evaporated to dryness by heating for (1-2 hr) at 100 C⁰ to constant weight.

(b) Calculation:

$$Mg/L \text{ of TDS} = \frac{Mg \text{ residue} \times 1000}{ML \text{ of sample}}$$

2.5. Determination of PH value:

(a) Chemicals:

Buffer of PH (3, 7 and 10) buffer tablets of PH 3, 7 and 10

(b) Reagents:

Standard buffer solutions of PH (3, 7 and 10) were used. Each tablet was dissolution in 100 ml distilled water to form the buffer solution – specified.

(c) Procedure:

The PH meter was calibrated by using the standard solution of PH (3,7 and 10) at 30 C⁰ and PH of samples were then recorded.

2.6. determination of hardness:

EDTA titrimetric method was used described in standard method.

(a) Chemicals:

- Ammonia solution (sp. Gr 0.91 g/ml, m. wt. 17.01) assay 25% England.
- Ammonium chloride G.P.R. India, assay:
- EDTA (Ethylene Diamine Tetra Acetic Disodium Salt G. R (Edta Sodium) (C₁₀ H₁₄ N₂ Na₂ O₈ 2H₂ o.).
- Eriochrome black T indicator.

(b) Reagents:

(i) Ammonia buffer solution (PH = 10):

17 gm ammonium chloride (NH₄ Cl) was added to 142 ammonia solution and diluted to 250 ml with distilled water.

(ii) Standard EDTA titrant (0.01 m):

3.723 gm of Na₂ EDTA was dissolved in distilled water and diluted to 1000 ml (1 liter).

(iii) Eriochrome black T indicator:

1 gm of Eriochrome black T was mixed with 10 gm potassium nitrate.

(c) Procedure:

1 ml ammonia buffer solution and about 30 mg of Eriochrome black T indicator were added to 25 ml of water samples placed in 250 ml conical flask and then the solution was titrated with the 0.01 M EDTA solution until the colour change from wine red to blue end point (Vogel, 1978).

(d) Calculation:

Hardness as Mg Ca Co₃/L=

$$\frac{V \times 0.01 \times 100 \times 1000}{ML \text{ of sample}}$$

V= Volume of EDTA required for titration.

2.7. Determination of total alkalinity:

(a) Chemicals:

(i) hydrochloric acid (SP. Gr (1.18), M.wt (36.46). (35.4%).

(ii) Methyl orange indicator.

(b) Reagents:

- Hydrochloric acid (0.1M).
8.6 ml of concentrated HCl was diluted to 1000 ml with distilled water.
- Methyl orange indicator solution

(c) Procedure:

Alkalinity was determined as carbonate. 25 ml from each water samples were transferred to 250 ml conical Flask, then two drops of methyl orange were added. The solution was titrated with H cl (0.1 M) until the color changed from yellow to pinkish red.

(d) Calculation:

Total alkalinity as Ca Co₃.

$$Mg\ CaCo/L = \frac{M \times V \times M.wt \times 1000}{ML\ of\ sample}$$

Where:

M= Molarity of Hcl.

V= volume of Hcl required for titration

M.wt= molecular weight of Ca Co₃.

2.8 determination of chloride (cl-):

(a) chemicals:

i) potassium chromate (k₂ CrO₄) min assay 99.5% G.R. INDIA.

ii) Silver nitrate (AgNO₃) M.wt 169.871. INDIA.

(b) Reagents:

i) potassium chromate indicator (5%):

5gm of K_2CrO_4 was dissolved in distilled water, few drops of standard $AgNO_3$ were added till red precipitated formed. The solution was filtered and was diluted to 1000 ml distilled water

ii) Silver nitrate titrant (0.02 M):

3.4 gm $AgNO_3$ was dissolved in distilled water and diluted to 1000ml. The solution was then stored in dark bottle.

(c) procedure:

25 ml of each sample were placed in 250 ml conical flask, 2ml of potassium chromate indicator (K_2CrO_4) were added, then the solution was titrated with 0.02M $AgNO_3$ solution to pinkish yellow end point.

Distilled water being used as a blank was treated in same mentioned above (Vogels, 1978).

(d)Calculation:

$$MgCl/L = \frac{(A - B) \times M \times 35.45 \times 1000}{ML \text{ of sample}}$$

Where:

A= mls of $AgNO_3$ titrated with 25 ml sample.

B= mls of $AgNO_3$ titrated with blank.

M= molarity of silver nitrate titrant.

2.9 Determination of Sulphate (SO_4^{2-})

Determined as BaSO_4 .

(a) chemicals:

(i) Hydrochloric acid (SP gr (1.18) m.wt (36.46) (35.4 %).

(ii) Barium chloride (BaCl_2). G.p.R.Assay 99- 0%, England.

(b) Reagents:

(i) Hydrochloric acid (1: 1).

10 ml of concentrated HCl were diluted with 10 ml distilled water.

(ii) Barium chloride (BaCl_2) solution 10%.

10 gm of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ was dissolved and diluted to 100 ml with distilled water.

(c) Procedure:

50 ml of water samples placed in 400 ml beaker. The PH was adjusted with HCl (1:1) to PH (4- 5) by using PH meter, then heated the solution to boiling. Barium chloride (BaCl_2) solution was added while stirring until complete precipitation. The solution was kept over night and filtered through filter paper. The residue was cooled in a desiccator and weighted (Vogels, 1978).

(d) Calculation:

$$\text{MgSo/L} = \frac{\text{Mg of BaSo} \times 411.5 \times 1000}{\text{ML of sample}}$$

411.5 is gravimetric factor.

2.10. Determination of carbonate and bicarbonate:

(a) Chemicals:

(i) Hydrochloric acid (SP.gr (1.18), M.wt (36.46) (35.4%).

(ii) Phenolphthalein indicator assay (99%).

(iii) Methyl orange indicator.

(b) Reagents:

- Hydrochloric acid (0.05 m).

4.4 ml of concentrated HCl was diluted to 1000 ml with distilled water.

- Phenolphthalein indicator solution.

0.5 gm phenolphthalein was dissolved in 50 ml 95% ethanol and diluted to 100 ml with distilled water.

- Methyl orange indicator solution.

0.5 gm Methyl orange powder was dissolved in distilled water and diluted to 100 ml

(c) Procedure:

50 ml of water sample was placed in 250 conical flask then added few drops of phenolphthalein solution and the solution was titrated with (0.05m) HCl until the colour changed from purple to cloudless. The volume titrate (x) few drops of methyl orange indicator were added and the titration was continued until the colour changed from yellow to red. The titration volume (Y) was recorded (Vogels, 1978).

(d) Calculation:

X= Volume of acid = ½ carbonate.

2X= volume of acid = all carbonate in 50 ml sample.

Y= volume of acid = all carbonate + all bicarbonate.

Fore:

$$MgCo/L = \frac{0.05 \times (2x) \times M.wt \times 1000}{ML\ of\ sample \times 2}$$

Where:

2x= volume of acid required to titrate all the carbonate in 50 ml sample.

m.wt= molecular weight of Co_3^{-2} .

Fore:

$$MgHCo/L = \frac{0.05 \times (Y - 2x) \times M.wt \times 1000}{ML\ of\ sample}$$

Where:

(Y – 2X) = volume of acid required to titrate all bicarbonate in 50 ml sample.

M.wt= Molecular weight of Hco_3^- .

2.11.Determination of calcium (Ca^{+2}):

EDTA titrimtric Method:

(a) Chemicals:

(i) Sodium hydroxide (1 m).

(ii) Murexide (ammonium pupriate) indicator powder, England.

- (iii) EDTA (Ethylene diamine tetra acetic acid disodium salt) GR.
EDTA sodium ($C_{10} H_{14} N_2 Na_2 O_8 \cdot 2 H_2 O$) (Minimum assay 99%).

(b) Reagents:

- (i) Sodium hydroxide (1 m).
4 gm of A.R NaOH was dissolved in distilled water and dilute to 100 ml.
- (ii) Murexide (Amnium Purpurate) indicator (0.05gm).
- (iii) Standard EDTA titrant (0.01 m).

(c) Procedure:

25 ml of water from each samples was placed in 250 ml conical flask then added 1ml of NaoH solution to get a PH of (12 -13) and the solution was stirred (0.05 gm) of muerxide indicator was added while stirring. The solution was then titrated with (0.01 m) EDTA solution until the color changed from purple to blue (Vogel s, 1978)

(d)calculation:

$$MgCa/L = \frac{M \times V \times M.wt \times 1000}{ML \text{ of sample}}$$

Where:

M= molarity of EDTA required for titration

V= volume of EDTA required for titration

M.wt= molecular weight of calcium.

2.12. Determination of sodium and potassium:

Sodium and potassium were determined by flame photometry (Vogel 's, 1978).

(a) Chemicals:

- (i) Sodium chloride A.R (99.5%).
- (ii) Potassium chloride A.R (99.5%).

(b) Reagents – stock sodium solution:

2.54 gm of dried Na cl was dissolved in distilled water and diluted to 1000 ml to give 1000 PPM Na⁺.

- Standard sodium solution:

Stock solution was diluted with distilled water to produce standard sodium ranging from (0 – 50) PPM.

- Stock potassium solution:

1.9 gm of A.R. Kcl was dissolved in distilled water and diluted to 1000 ml to give 1000 PPM K⁺.

Standard potassium solution:

Stock solution was diluted with distilled water to produce standard potassium ranging from (0 – 20) PPM.

(c) Calibration curves were produced from the standard solution of each element. The samples were analyzed and their concentrations were obtained from the standard.

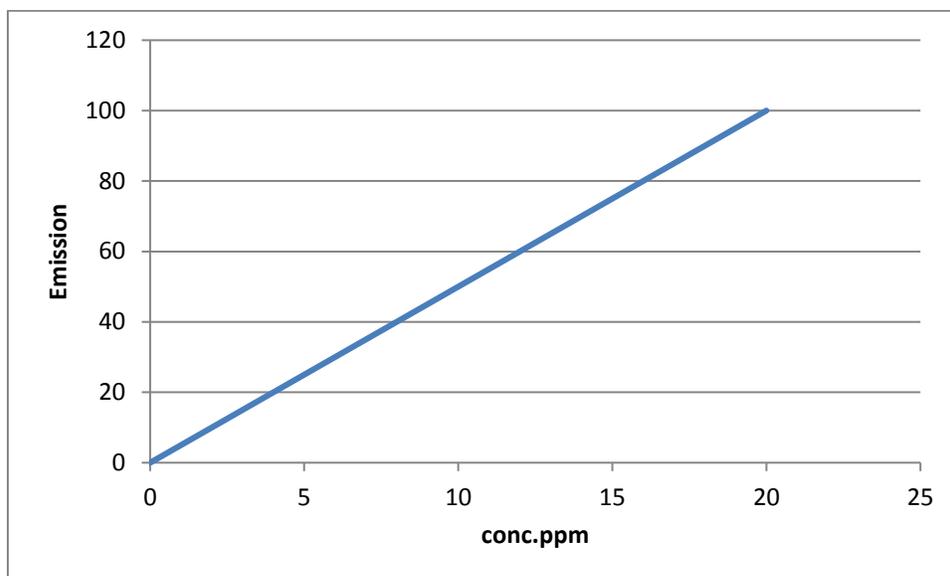
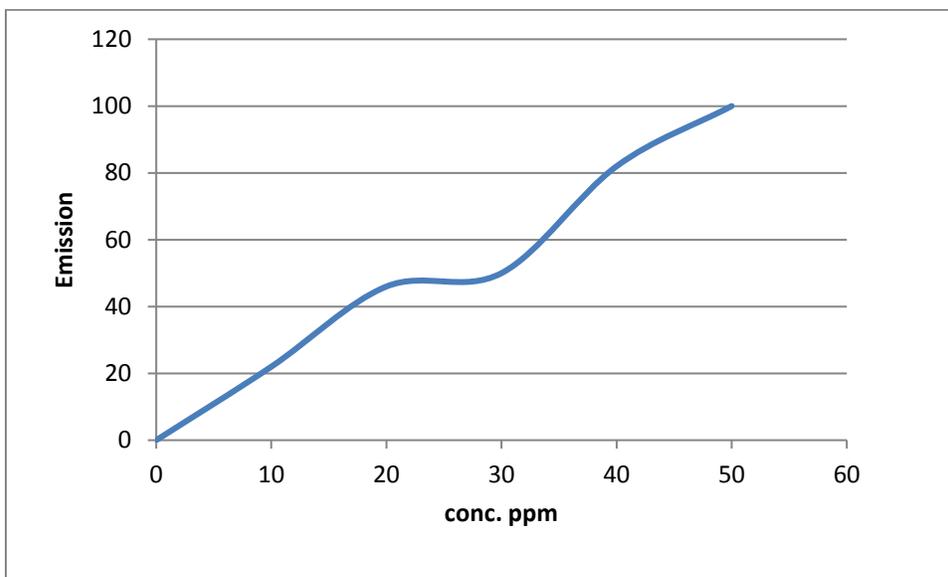


Fig. (1): Calibration curve of determination of potassium



Fig(2): Calibration curve of determination of sodium

CHAPTER THREE RESULTS AND DISCUSSION

3.1. Results of EC, PH and TDS (physical parameters):

Table (5) The results of EC, PH and TDS.

Samples	EC in μS	PH	TDS in PPM
First sample	400	8.8	580
Second sample	400	8.5	580
Third sample	432	8.4	600
Forth sample	432	8.1	600
Fifth sample	432	8.1	600

3.2. Electrical conductivity (EC):

The result showed that the first and second sample of water had same value compared to other samples which had same value too. These results were in accordance with the result of TDS, this due to concentration of ions in these samples water. (fig.3).

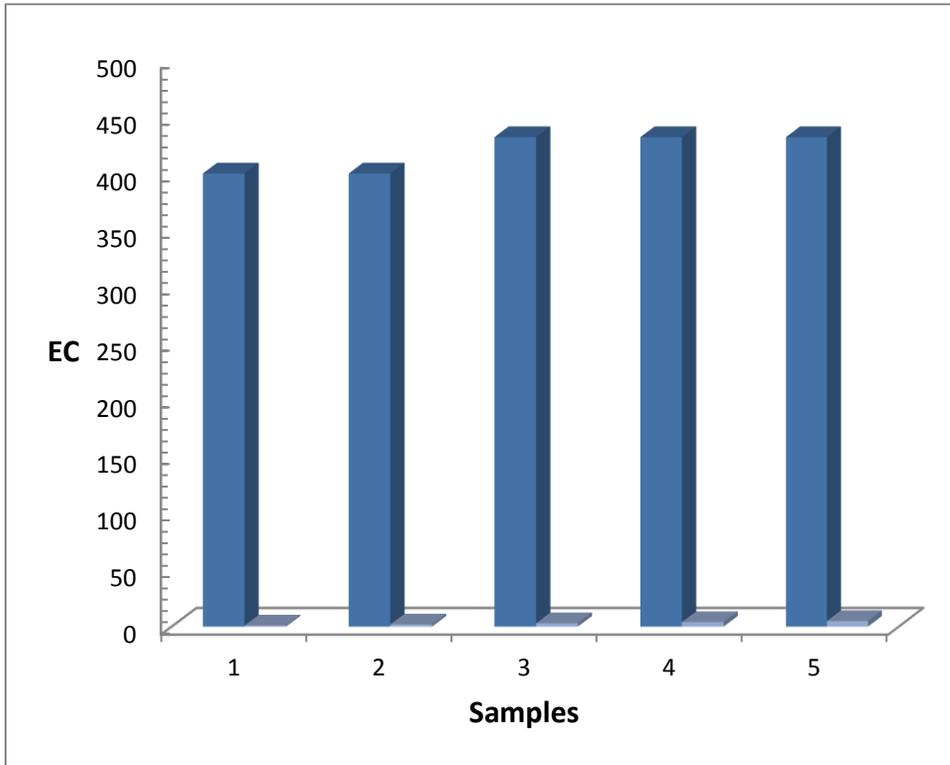


Fig. (3): EC of water samples in μs

3.3. The PH value:

The results show that the PH value varies between 8.1 and 8.8 this indicator to similar alkalinity of samples , all values are with in the WHO standards except first sample (Fig.4).

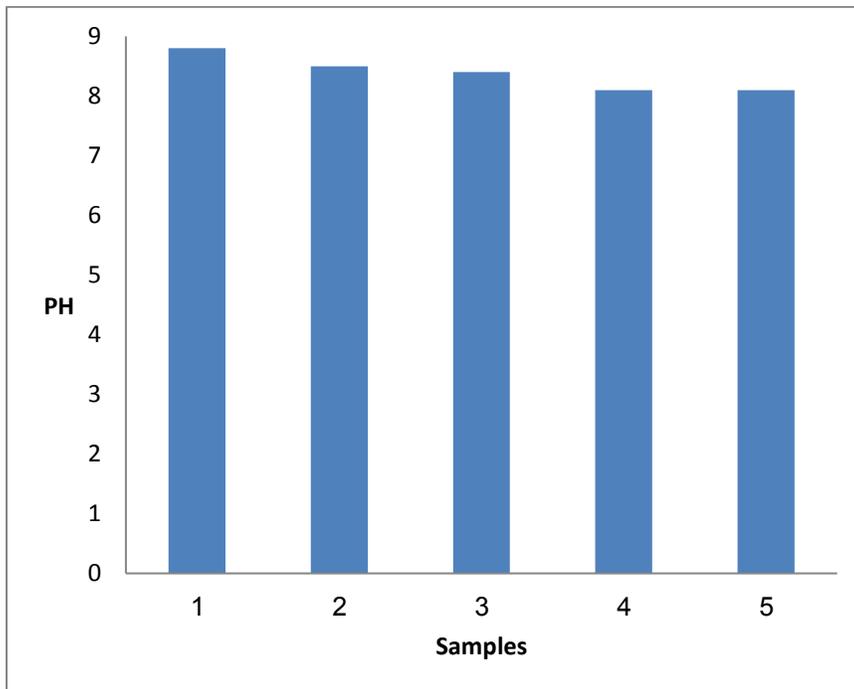


Fig.(4): PH of water samples

3.4. Total Dissolved Solids (TDS):

The result show that the TDS in first and second samples are the same value and the other samples had high value compared to the value of the first and second sample (fig 5).

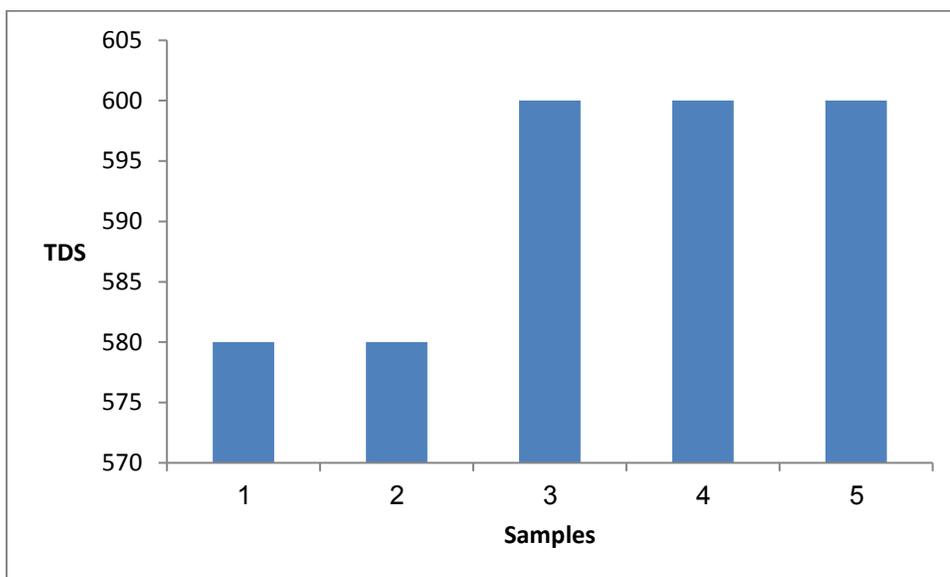


Fig.(5): TDS of water samples in ppm

3.5. Result of chemical parameters:

Table (6): Results of chloride, sulphate, carbonate, bicarbonate and hardness.

Samples	Cl ⁻ in PPM	So ₄ ⁻² In PPM	Co ₃ ⁻² In PPM	H Co ₃ ⁻ In PPM	hardness
1	41.7	3456.6	78	707.6	440
2	35.8	3785.8	18	414.8	200
3	29.8	2715.9	30	420.9	140
4	37.8	2386.7	42	390.4	200
5	31.8	3950.4	24	396.5	180

3.6. Chloride:

The result of data show that the concentration of chloride in all samples was low compared the WHO standard. This may be due to the nature of soil in this place.

3.7. Sulphate:

The result show that the concentration of sulphate in all samples are very high compared with the WHO standard. This may be due to the high concentration of sulphate in the soil which the water passed through it.

3.8. Carbonate and bicarbonate:

The result of concentration of carbonate and bicarbonate in first sample were very high as show in Table(6) but the fifth sample had lower concentration of carbonate than the other samples. This due to the time which the samples were taken (in the morning and at night).

3.9. Hardness:

The first sample is very hard but the other samples moderately hard based on the hardness level in Table (2).

3.10. Result of cations concentration:

Table (7): The result of K^+ , Na^+ and Ca^{+2} :

Samples	K^+ in PPM	Na^+ in PPM	Ca^{+2} in PPM
1	25	90	38.4
2	12	80	36.8
3	15	78	32
4	14	80	40
5	15	80	32

The result of these cations data show that the concentration of K^+ in the first sample is more than the other samples which had value nearly of the WHO standard.

The concentration of Na^+ in the first sample is high compared to the fourth sample but all the samples values are agree with WHO values.

The concentration of Ca^{+2} in all samples are lower (32 – 40 PPM) than the concentration of Ca^{+2} recommended by WHO.

CONCLUSION AND RECOMMENDATIONS

- The results of this study is concluded in the following points:
- The water samples are a basic.
- The first sample is very hard but the other samples are moderately hard.
- The concentration of (Cl^-) in all samples are low compared to the standard values.
- The concentrations of (Co_3^{-2}) and (Hco_3^-) are high in first sample.
- The concentration of (So_4^{-2}) is high in all samples.
- The concentration of cations $(\text{K}^+$ and $\text{Na}^+)$ in the first sample are high.
- The concentration of cation (Ca^{+2}) is high in the forth sample compared to others sample.
- Additional studies are needed to determine the effect of these inorganic constituents in the water of this well.
- Consequently recommended that the well water must be treated for concentration of sulphate.

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