

**Determination of some Inorganic Constituents of Ground
Water in *Abu zabad* Town , North Kurdufan State, Sudan**

By

Elhassein Ahmed Adam Hamad

B.Sc. in Chemistry and Biology - University of West Kurdufan (2009)

Postgraduate Diploma in Chemistry - University of Gezira (2011)

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Major supervisor : Dr. Fath Elrahman Abbas Elshikh

Co. supervisor : Dr Mohammed Osman Babiker Ahmed

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Elhassein Ahmed Adam Hamad

The Examination Committee:

Name	Position	Signatue
1-Dr.Fath Elrahman Abbas Elshikh	Chairperson
2-Prof.Alnaeim Abdalla Ali	External Examiner
3- Dr.Mostfa Ohag Mohamed	Internal Examiner

Date of Examination: 12/05/2013

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Elhassein Ahmed Adam Hamad

Supervisor Committee:

Name	Position	Signatue
Dr.Fath Elrahman Abbas Elshikh	Major supervisor
Dr.Mohamed Osman Babiker	Co- supervisor

DEDICATION

To my Parents

To my brothers and sister

To my friends

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With respect and gratitude I thank my supervisor Dr. Fath Elrahman Abbas Elshikh for his continuous assistance , encouragement and close guidance .

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Determination of some Inorganic Constituents of Ground Water in
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Elhassein Ahmed Adem Hamad

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Department of Applied Chemistry and Chemical Technology

Faculty of Engineering and Technology

University of Gezira

Abstract

Ground water is the main source of water in *Abu zabad* town. Where is no laboratories with suitable instruments and reagents for chemical analysis of the water constituents. The aim of this study was to analyse the chemical inorganic constituents of drinking water in *Abu zabad* town and to compare their concentration with the standards recommended by WHO . Eight samples of water were collected from *Abu zabad* town, and the analyses were performed on the following parameters: pH, EC, TDS, hardness as CaCO_3 , cations: Na^+ , K^+ and Ca^{+2} , anions : Cl^- , SO_4^{-2} , CO_3^{-2} and HCO_3^- . The analyses were performed using chemical and instrumental methods.

The results showed that the pH values were between (7.7 – 8.2), hence all the samples were slightly alkaline ($\text{pH} > 7$). TDS values for all the samples (340 – 840 ppm) were within the permissible value of WHO (1000 ppm). The results of chloride (19.88 – 33.79 ppm) were in agreement with WHO standards (250 ppm Cl^-). The results showed that the concentration of sulphate (0.95 – 2.6 ppm) were in permissible level of WHO . For hardness (280 ppm), some samples were classified as hard , and other samples (300 - 480 ppm) were classified as very hard. The concentration of cations: Na^+ (18 – 30 ppm), K^+ (0.8 – 2.5 ppm) and Ca^{+2} (48 – 56 ppm) were within the permissible level of WHO (200 ppm Na^+ , 10 ppm K^+ and 200 Ca^{2+}). From

the study it was found that all water samples were acceptable for all purposes .It is recommended that frequent analyses of the water should be carried out to monitor the amounts of the constituents.

تحديد بعض المكونات الكيميائية اللاعضوية لمياه الشرب في مدينة أبوزبد

ولاية شمال كردفان، السودان

الحسين أحمد آدم حماد

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كلية الهندسة والتكنولوجيا

جامعة الجزيرة

ملخص البحث

المياه الجوفية هي المصدر الرئيسي للمياه بمدينة أبوزبد. حيث لا توجد معامل مزوده بالاجهزة والمواد الكيميائية لاجراء تحاليل مكونات الماء. الهدف من هذه الدراسة هو تحديد المكونات الكيميائية اللاعضوية لمياه الشرب في مدينة أبوزبد ، ومقارنة تراكيزها مع القيم الموصي بها من قبل منظمة الصحة العالمية. جمعت ثمانية عينات من منطقة أبوزبد ثم أجريت التحاليل التاليه: الأس الهيدروجيني ، الموصلية الكهربائية ، الأملاح الذائبة الكلية ، عسر الماء ، الأيونات الموجبة (Ca^{+2} , K^+ , Na^+) والأيونات السالبة (HCO_3^- , Cl^- , SO_4^{-2} , CO_3^{-3}).أوضحت النتائج أن قيم الأس الهيدروجيني تقع في المدى (7.7 – 8.2) وعليه كل العينات قلوية إعتقاداً علي قيم الأس الهيدروجيني ($PH > 7$) ، وكمية الأملاح الذائبة الكلية (340 – 840 ppm) وجدت أنها في المدى المسموح به من قبل منظمة الصحة العالمية (1000 ppm). أوضحت النتائج أن تراكيز الكلوريد (19.88 – 33.79 ppm) في الحد المسموح به من قبل منظمة الصحة العالمية (250 ppm) . كما أشارت النتائج أيضاً أن تركيز الكبريتات (0.95 – 2.6 ppm) يقع في المستوي المسموح به من منظمة الصحة العالمية أما بالنسبة للعسر الكلي فقد صنفت العينة (280 ppm) علي أنها عسرة ، أما بقيت العينات (300 - 480 ppm) صنفت علي أنها عسرة جدا مقارنة بالقيم الموصي بها من قبل منظمة الصحة العالمية. أشارت الدراسة إلي أن تراكيز الأيونات الموجبة Na^+ (18 – 30 ppm) ، K^+ (0.8 – 2.5 ppm) و Ca^{2+} (200 ppm Na^+) كلها تقع في الحد المسموح به من قبل منظمة الصحة العالمية ، K^+ (10 ppm) من خلال هذه الدراسة نخلص الى أن جميع عينات المياه المأخوذة صالحة لكل الاغراض .يوصى بالتحليل المتكرر للماء لمراقبة كمية المواد الموجوده فيها.

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CHAPTER ONE

INTRODUCTION

Water is one of the most important chemicals known to human. 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, (Georgel and Schultz, 1973).

Almost three fourths 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 the rapid growth of population, agriculture, and industry, (Abdelgafar, 1999).

1.1. Water sources:

The sources of water supply are divided into two major classes, surface and ground water.

1.1.1. Surface water:

There are many forms of surface water. This include rivers, streams, lakes and reservoirs(WHO ,1993) . 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 (Forrest, 1976).

1.1.2. Ground water:

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 which it passes (Forrest , 1976) .

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 (WHO,1993) .

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

i) Ground water:

It is the water that collects above the first stable impervious layer of rock. It is supplied mainly by rain water or percolation of rivers or lakes.

ii) Artesian water:

Artesian water stored in a water containing layers sandwiched between two impervious layers.

iii) Perched water:

Perched water exists above a sectional impervious layer. It is widely distributed and is seasonal. Deep ground water may contain various kinds of salts and can be very hard. Some sources of deep ground water have a high concentration of iron; fluoride and magnesium. Most of these sources contain few bacteria (El Hussien, 2000).

1.2. General properties of ground water:

Are classified into physical and chemical properties:

1.2.1. Physical properties of ground water:

1.2.1.1. Color:

Color is caused by material in solution or colloidal condition and should be distinguished from turbidity which may cause an apparent Colour (Twort ,*et al.*, 1985) .

1.2.1.2. Temperature:

In general the rate of a chemical reactions decreases, with decreasing temperature. The relative concentrations of reactants and products in chemical equilibria can also change with temperature therefore; temperature affects every aspect of the treatment and delivery of potable water. Turbidity and colour are indirectly related to temperature, as the efficiency of coagulation is strongly temperature dependant.

1.2.1.3. Density:

The density of pure water is 1 g/ml at 4°C. density decreases with the increase of temperature. Water exist in three states; solid, liquid and gas.

1.2.1.4. Turbidity:

Water is turbid when it contains visible materials in suspension. While turbidity may result from living or dead algae or other organisms, it is generally caused by silt or clay. The amount and character of turbidity will depend up on the type of soil over which the water has run and the velocity of water (Twort *et al.*, 1985).

1.2.1.5. Total dissolved solids (TDS):

Total dissolved solids in water comprise inorganic salts and small amounts of organic matter that is dissolved in water (TDS) is expressed in ppm and it is directly related to the conductivity. It has important effect on the taste of drinking water. A limit of domestic use is 600 mg/L if based on the taste, so that it is an indicator to the salinity of ground water. Water with high TDS concentration is a saline water.

Water with extremely low concentration of TDS may be unacceptable because of its fullness (WHO, 1993).

Table (1): Health criteria for TDS (WHO, 1989).

Range mg/L TDS	TDS level
Less than 300	Excellent
300 – 600	Good
600 – 900	Accepted
900 – 1200	Bad
Over 1200	Unacceptable

Source: Guide lines for drinking – water quality volume 2(1989)

1.2.1.7. Electrical conductivity (EC):

Electrical conductivity is the measure of ability of water to conduct an electric current that passes through it. EC is proportional to the amount of TDS in water and it is an excellent indicator of TDS in water(Twort *et al.*, 1985).

Pure water has very low electrical conductance, conductivity of water will increase with the presence of dissolved minerals (Fletcher, 1989).

Water with high specific conductance can cause corrosion of iron and steel.

Electrical conductivity is expressed in micro mhos per centimeter⁻¹ (μ mhos/cm) and is directly proportional to the amount of dissolved solid in water, so that it is an excellent indicator of TDS in water (Twort *et al.*, 1985).

1.2.2. Chemical properties of water:

Chemical parameters enable us to classify the water, find the degree of pollution and causes of sharp increase of polluting substances.

Chemical properties include:

1.2.2.1. pH:

The pH is the negative common logarithm of hydrogen ion activity in moles per liter (WHO, 1984-b).

The pH of most natural waters falls in the range 4 to 9. If the pH value is very low (less than 4) water has acidic taste. High pH can give taste problems and soapy feel. The majority of waters are slightly basic due to presence of carbonate (El Hussien, 2000).

1.2.2.2. Alkalinity:

An alkaline water is one with a pH value more than 7.0. The causes of alkalinity is the presence of bicarbonates, carbonates and hydroxides of calcium, magnesium, potassium and sodium. Among these the calcium bicarbonate is the most abundant substance causing alkalinity.

The presence of calcium and magnesium bicarbonate is called a temporary hardness, when the alkalinity and hardness are equal all the hardness is temporary.

If the total hardness is greater than alkalinity there is permanent hardness, sometime it happens that, the total hardness indicates the presence of the potassium and sodium salts which added to the alkalinity but do not increase the hardness. The alkalinity of many waters is in the range (100 – 200ppm) (WHO, 1963).

1.2.2.3. Chloride:

Chloride is one of the major anions in water. Chlorides are present as sodium chloride (NaCl, common salt) and to a lesser extent as calcium and magnesium chlorides (Abdelgafar, 1999).

The main problem caused by excessive chloride in water concerns the acceptability of the supply. Concentration above 250 mg/L can impart a distinctly salty taste to water (Towart, *et al.*, 1985). For people suffering from heart and kidney diseases, high chloride water usage has to be restricted (WHO, 1993). Excessive chlorides concentration increase rates of corrosion of metals in the distribution system.

1.2.2.4. Sulphate:

The concentration of sulphate in natural water can be found in various ranges from a few mg/L to several thousand mg/L.

The highest level usually occurs in ground water. The sources of sulphate are the solutions of minerals containing sulphates and oxides of sulphur, sulphides and thiosulphates. The presence of sulphate in drinking water can cause noticeable taste. The taste varies with the associated cation. Taste threshold has been found to range from 250 mg/L for sodium sulphate to 1000 gm/L for calcium sulphate, WHO, (1993) Geneva. Sulphate in domestic water contributes the major of non carbonate or permanent hardness. High levels can impart taste and when combined with magnesium or sodium can have laxative effect, WHO, (1993) .

1.2.2.5. Carbonate and bicarbonate:

Carbonate and bicarbonate in water are two of the three forms of the components of the carbonates equilibrium. The variation of pH of water affects the concentration of carbonate ions, if the pH is less than 4.5, water is free from carbonic acid. When pH is above 8.3 then carbonic acid content is disregarded. The concentration of carbonic acid and bicarbonates are usually high in ground water.

High concentration of carbonic acid in water makes the water corrosive to metals and concrete (Abdalla, 2001) .

1.2.2.6. Calcium:

The average abundance of Ca in the earth's crust is 4.9%, in soil it's 0.07 to 1.7%; in streams it is about 15 mg/L; and in ground water it is 1 to □ 500 mg/L.

The most common forms of calcium are calcium carbonate (Calcite) and calcium , magnesium carbonate (dolomite). Calcium compounds are widely used in pharmaceuticals, photography, lime, de-icing salt, pigments, fertilizer and plasters (APHA, 1998).

Calcium carbonate solubility is controlled by pH and dissolved CO₂. the CO₂, HCO₃⁻ and CO₃⁻² equilibrium is the major buffering mechanism in fresh waters. Hardness is based on concentration of calcium and magnesium salts and often is used as a measure of potable water quality (APHA, *et al.*, 1998).

Calcium is necessary in plant and animal nutrition and is an essential component of bones, shells and plant structures. The presence of calcium in water supplies results from passage over deposits of limestone, dolomite, gypsum and pestiferous shale. Small concentration of calcium carbonate combat corrosion of metal pipes by laying down a protective coating.

Because precipitation of calcium in domestic and industrial waters is often controlled by water softening (e.g, ion exchange) (APHA, *et al.*, 1998).

Calcium contributes to the total hardness of water. Chemical softening treatment reverse osmosis, electro dialysis or ion exchange are used to reduce calcium and associated hardness. Calcium concentrations in neutral water are typically < 15 mg/L. For waters associated with carbonate, rich rocks, concentrations may reach 30 – 100 mg/L, (Chapman, 1996).

1.2.2.7. Sodium:

The sodium ion is a major constituent of natural water. It has been estimated that food accounts for approximately 90% of the daily intake of Na⁺ whereas drinking water contribute the remaining 10% (Elnour, 2004).

1.2.2.8. Potassium:

It is an essential element in both plant and human nutrition, and occurs in ground waters as a result of mineral dissolution, from decomposing plant material, and from agricultural runoff. The common aqueous species is K⁺. Unlike sodium, it does not remain in solution, but is assimilated by plants and incorporated into a number of clay - mineral structures (APHA, *et al.*, 1971).

1.2.2.9. Water hardness:

When a small amount of soap is added to soft water it forms copious suds. When a small amount of soap is added to hard water it forms a precipitate or scum and no lather. Hard water contains dissolved compounds of calcium and magnesium. Soft water may contain dissolved compounds but these do not cause hardness. The calcium and magnesium compounds (which cause the hardness) react with soap to form a precipitate, thus removing the soap water. More and more soap must be added until all the hardness is removed. Only then will the soap cause lather. The

precipitated soap adheres to washed materials, making them rough so that they irritate tender skin, or washed hair, making it sticky and gummy. Food cooked in hard water is likely to be tougher than that cooked in soft water because of existence of additional minerals. When hard water is boiled, some of salts form a deposit on the side of the container in which it is heated, hard water must never be used to sterilize surgical instruments because the precipitated hardness will dull cutting edges (if iron compounds are present in water, they will cause hardness).

Temporary hardness is hardness that can be removed by boiling. It is caused by the carbonates of calcium and magnesium. Boiling converts these in soluble carbonates, thus removing parts of the hardness. Other soluble compounds of calcium and magnesium cause permanent hardness. Permanent hardness is not removed by boiling. The following is an equation for a method of removing temporary hardness.



(Georgal and Ronald, 1973).

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

Range CaCO ₃ (mg/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, 1985).

1.2.2.10. Water quality standard:

International standards for drinking water were first published by WHO in 1985, then have been revised and reissued in a new form in 1993 and entitled as guidelines for drinking water quality (Abdelgafar,1999).

Table (3) WHO maximum permissible values for drinking water (1993).

No.	Characteristic	UNITS
1	Hardness	500 mg/L as CaCO ₃
2	pH	6.5 – 8.5
3	Potassium	10 mg/L
4	Sodium	200 mg/L
5	Calcium	200 mg/L
6	Magnesium	150 mg/L
7	TDS	1000 mg/L
8	Sulphate	400 mg/L
9	Chloride	250 mg/L

Source : (WHO ,1993) .

1.3. The 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 in Abu zabad area and compare the results with those recommended by the WHO .

CHAPTER TWO

MATERIALS AND METHODS

2.1. Materials:

2.1.1. Sampling:

Eight samples of the drinking water were collected from Abu zabad area in plastic container (2 liters) and stored at room temperature . Table (4) shows the locations of the samples .

Table (4): Locations of the samples .

Sample No.	Symbol	Location
1	A	Alsog almerkazy
2	B	Alsog alkabeer
3	C	Almedina algamiah
4	D	Alruba alawel
5	E	Alruba altani
6	F	Alruba altalet
7	G	Alruba alrabi
8	H	kaga

2.1.2. Chemicals:

All chemicals and solvents were analytical grade reagents.

2.1.3. Apparatus used in analyses:

- Beakers .
- Conical flasks.
- Pipettes.
- Burettes.

- Funnels and glass rod.
- Water bath.
- Furnace.
- Flame photometer (Corning Model 400).
- Measuring cylinders.
- Crucible.
- pH – meter (PHSJ- HA).
- Electrical conductivity meter (Model DDs – IID).
- Filter paper (Ash less).
- Oven.

2.1.4. Reagents:

2.1.4.1. Hydrochloric acid (1 : 1):

2.1.4.2. Hydrochloric acid (0.0514 M):

2.1.5. Preparation of standards:

(a) Standard buffer solutions of pH 4 and 9:

Buffer tablets of pH 4 and 9 were dissolved and diluted to 100 ml with distilled water.

(b) Ammonia buffer solution (pH: 10):

16.9 gm ammonium chloride (NH_4Cl) were added to 143 ml concentrated ammonium hydroxide, and diluted to 250 ml with distilled water.

(c) Standard EDTA titrant (0.01 M):

3.72 gm of disodium EDTA salt ($\text{Na}_2 \text{H}_2 \text{C}_{10} \text{H}_{14} \text{O}_8 \text{N}_2 \cdot 2\text{H}_2\text{O}$) were dissolved in distilled water and diluted to 1 liter.

(d) Eriochrome black T indicator (solid):

1 g erichrome black T indicator + 10 gm potassium nitrate.

(e) Barium chloride (BaCl₂) solution 10%:

10 gm of A.R BaCl₂. 2H₂O were dissolved in distilled water and diluted to 100 ml.

(p) Potassium chromate indicator:

5.0 g of A.R K₂CrO₄ were dissolved in distilled water few drops of standard silver nitrate AgNO₃ were added till red precipitate was formed in the solution, then was filtered and the filtrate was diluted to 100 ml with distilled water.

(g) Silver nitrate titrant (0.014 M):

2.378 g Ag NO₃ were dissolved in distilled water and diluted to 1 liter; the resulting solution was stored in a dark bottle.

(h) Phenolphthalein indicator solution:

0.5 g phenolphthalein were dissolved in 50 ml 95% ethanol and diluted to 100 ml.

(i) Methyl orange indicator solution:

0.05 g methyl orange powder were dissolved in distilled water and diluted to 100 ml.

(t) Hydrochloric acid (0.0514 M):

4.2 ml of concentrated HCl were diluted to 1000ml with distilled water.

(k) Stock potassium solution:

1.908 of A.R KCl were dissolved in distilled water and diluted to 1000 ml to give 1000 ppm K .

(j) Standard potassium solution:

Stock potassium solution was diluted with distilled water to produce standard potassium solutions ranging from 4 to 20 ppm.

(n) Stock sodium solution:

2.54 g of dried sodium chloride (NaCl) were dissolved in distilled water and diluted to 1000 ml to give 1000 ppm Na.

(m) Standard sodium solutions:

Stock sodium solution was diluted with distilled water to produce Standard sodium solutions ranging from 10 to 50 ppm.

(o) Sodium hydroxide(1M) :

4gm of A.R. NaOH were dissolved in distilled water and diluted to 100 ml.

(p) Murexide (Ammonium purpurate, indicator, powder).

2.2. Methods:

2.2.1. Determination of pH:

pH was measured by pH meter.

2.2.2. Electrical conductivity (EC):

Electrical conductivity was measured by Hanna, instruments , model HI 8633. Electrolytic conductivity measuring set was used with specific conductance cell and it was calibrated with 0.01 KCl M (already prepared).

2.2.3. Determination of TDS:

TDS was measured by TDS meter. The electrode of TDS meter was washed using distilled water then water samples were transferred to container and the TDS was measured directly.

2.2.4. Determination of Hardness:

EDTA titrimetric method was used as described in (APHA *el al.*1971). 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 (Abdelgafar, 1999).

Calculation:

$$\text{Hardness as mg CaCO}_3 / \text{L} = \frac{\text{A} \times \text{B} \times 1000}{\text{V}} \quad (\text{general formula})$$

Where:

A = mls of EDTA required for titration.

B = mg of CaCO₃ equivalent to 1 mole EDTA titrant.

V = ml of sample

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

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 (BaCl₂) 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 (Vogel's, 1978).

Calculation:

$$\text{mg SO}_4^{-2} / \text{L} = \frac{\text{mg of BaSO}_4 \times 411.5}{\text{ml of sample}}$$

Where:

$$411.5 = \text{gravimetric factor}$$

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, (Vogel's, 1978).

Calculation:

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

Where:

A = mls of AgNO_3 required for the sample.

B = mls of the titrant for the blank.

M = molarity of AgNO_3 solution.

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).

Calculation:

$$x = \text{Volume of acid} \equiv \frac{1}{2} \text{ carbonate .}$$

Therefore :

$$2x = \text{Volume of acid required to titrate all the carbonate in 50 ml of Sample .}$$

$$y = \text{Volume of acid} \equiv \text{all carbonate} + \text{all bicarbonate.}$$

Therefore:

$$y - 2x = \text{Volume of acid required to titrate all the bicarbonate in 50 ml sample.}$$

The result were expressed as mg/L.

Therefore:

$$\text{mg CO}_3^{-2} / \text{L} = \frac{0.05 \times V \times 60 \times 1000}{50 \times 2}$$

Where:

V = Volume of acid – required to titrate all carbonate in 50 ml sample.

60 = The molecular weight of the carbonate.

$$\text{mg HCO}_3^{-} / \text{L} = \frac{0.05 \times (y - 2x) \times 61 \times 1000}{50}$$

61 = The molecular weight of the bicarbonat

2.2.8. Determination of Calcium :

100 ml of the water sample were placed in 250 conical flask; 0.5 ml NaOH solution was 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 , (Abdelgafar , 1999) .

Calculation:

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

Where:

A = mls of titrant for the sample.

B = mg CaCO₃ 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 was determined .

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 was determined .

CHAPTER THREE

3. RESULTS AND DISCUSSION

3.1. Results :

3.1.1. Results of pH , EC and TDS .

Table (5): The pH ,electrical conductivity (EC) and total dissolved solids (TDS) for (Abu zabad Area) water samples.

Sample	pH	TDS in ppm (mg/L)	Ec μ s/cm
A	8.1	480	846
B	7.7	460	804
C	8.2	340	586
D	7.9	840	1155
E	8	450	788
F	7.8	460	800
G	8	750	1040
H	7.9	650	886

3.1.1.1 pH-value :

From table (5), the active hydrogen ion concentration (pH) varies between 7.7 and 8.2 ,that means all samples fall in the alkaline side ,and (pH) values obtained for all samples shows value within the permissible level as reported by WHO (Table 3).

3.1.1.2 Electrical conductivity (EC):

The results of electrical conductivity from table (5) ,were in agreement with values reported by WHO standards .

3.1.1.3 Total dissolved solids (TDS):

The results of total dissolved solids from table (5) ,show that (TDS) values are in the permissible level compared with that stated by WHO (Table 3).

3.1.2. Results of concentrations of dissolved species :

Table (6) : 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 in ppm
A	19.88	1.5	48	707.6	400
B	33.79	0.98	36	658.8	316
C	25.85	1.2	24	463.6	280
D	25.85	1.3	36	323.3	480
E	25.85	0.95	24	268.4	420
F	23.86	2.6	24	512.3	300
G	25.85	1	48	384.3	460
H	29.82	1.8	24	256.2	360

3.1.2.1. Chloride :

The results of chloride concentrations summarized in table (6) show that all the samples have chloride content within the permissible range reported by the WHO (Table 3) .

3.1.2.2. Sulphate :

The results of sulphate concentration which was obtained and summarized in table (6) were low compared with WHO standards (Table 3) .

3.1.2.3. Carbonate and bicarbonate :

As an observation from carbonate and bicarbonate results that obtained and listed in table (6) , the carbonate values were low when compared with concentration values of bicarbonate . This may be due to the conversion of carbonate to bicarbonate . The higher values of carbonate and bicarbonate were obtained for sample (G) .

3.1.2.4. Hardness:

The results obtained for the hardness listed in table (6) show that a higher value obtained for samples(A), (F) ,(G)and (H) , low value for samples (B),(C),(D) and (E).The results were in agreement with the recommended values of WHO (500 mg/L of CaCO₃) , so sample (C) was classified as hard , sample (A),(B),(D),(E),(F),(G) and (H) classified as very hard (Table 2) .

3.1.3 Results of cations concentration :

Table (7) shows the results obtained for the listed cations sodium , potassium , and calcium in ppm .

Sample	Sodium Na ⁺	Potassium	Calcium
A	25	0.8	48
B	26	2.5	56
C	18	2	56
D	30	2	51.2
E	22	1.2	52.8
F	25	1	48
G	20	1.4	48
H	24	1	56

3.1.3.1. Sodium and potassium :

Fig (1) and (2) show A calibration curve for sodium and potassium . The concentration of the two cations (Na^+ and K^+) in the samples were obtained from their calibration curves . The results were shown in table (7) , values were in agreement with the value reported by WHO ,(Abdelgafar , 1999) .

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) as in table (3) , and therefore all samples showed values which were in agreement with the value of WHO .

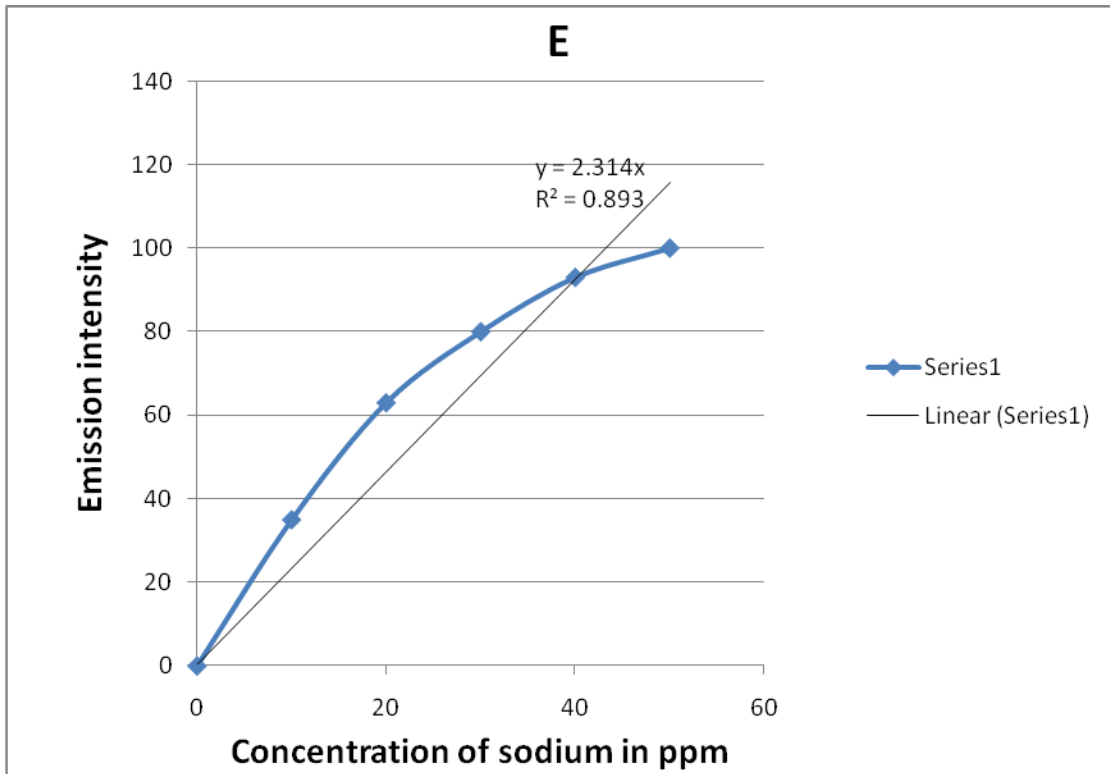


Fig. (1) : A calibration curve for determination of Sodium.

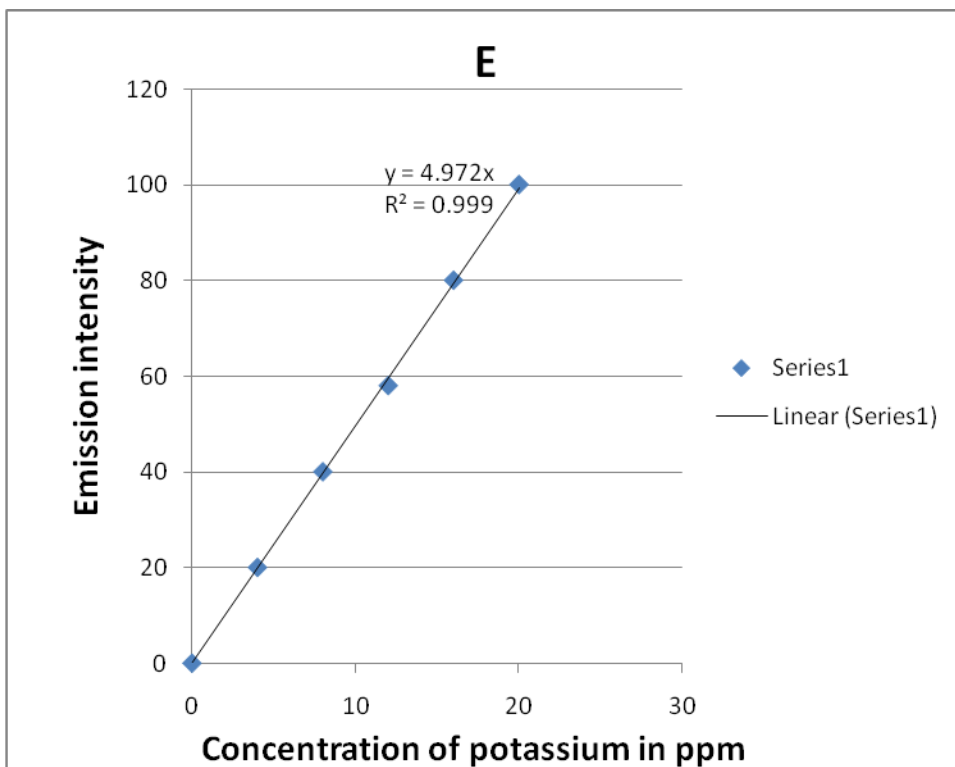


Fig. (2) : A calibration curve for determinaion of Potassium.

CONCLUSION

From the previous results , the samples showed different concentration of various kinds of dissolved species .

The results show that sample (A) from Alsog Almerkazy has value of EC , TDS, Sodium , Chloride ,and Sulphate (846 ,480 , 25, 19.88 and 1.5 ppm) .

Sample (B) from Alsog Alkaber has of EC ,TDS , Sodium ,Chloride and Sulphate (804 ,460 ,26 ,33.79 and 0.98 ppm) respectively.

Sample (C) from Almedina Algamiah has of EC ,TDS , Sodium , Chloride and sulphate (586 ,340 , 18 ,25.85 and 1.2 ppm) respectively.

Sample (D) from Alruba alawel has value of EC , TDS , Sodium , Chloride and sulphate (1155, 840 , 30 , 25.85 and 1.3 ppm) respectively.

Sample (E) from Alruba altani has value of EC , TDS , Sodium , Chloride and sulphate (788, 450 , 22 , 25.85 and 0.95 ppm) respectively.

Sample (F) from Alruba altalet has value of EC , TDS , Sodium , Chloride and sulphate (800, 460 , 25 , 23.86 and 2.6 ppm) respectively.

Sample (G) from Alruba alrabi has value of EC , TDS , Sodium , Chloride and sulphate (1040, 750 , 20 , 25.85 and 1 ppm) respectively.

Sample (H) from Kaga has value of EC , TDS , Sodium , Chloride and sulphate (886, 650 , 24 , 29.82 and 1.8 ppm) respectively.

All samples are very hard and must be treated to removal the hardness .

All water samples show PH values that were with permissible level as reported by WHO .

All samples have no problem for all species analyzed , so its suitable for human and animal consumption .

Recommendation

Chemical analyses for sodium and potassium, were not available ; because there is no cooperation in Abu zabad city.

- Regular testing and adopting practice to prevent contamination can help ensure the well supplies are with good drinking water.
- Laboratories with suitable instruments and reagents must be available for chemical analyses.
- Setting laws to prevent digging deep sapling tanks to prevent ground water contamination.

REFERENCES

Abdelgafar , A. M . (1999) : Analysis of some inorganic constituents of drinking water in some parts of Gezira state . M.Sc .Thesis . University of Gezira.

Abdalla, A . I (2001) :Determination of some inorganic constituents of drinking water in Singa. M.Sc. Thesis university of Gezira

American Public Health Association (APHA),American Water Works Association (AWWA) Water Pollution Control Federation (WPCF) (1971): Standard methods for the examination of water and wastewater .
13th Edition, U.S.A .

American Public Health Association (APHA, 1998): Standard method for examination of water 20th edition.

Chapman , Deborah ,(1996) : Water quality assessment .Aguid to use of Biota ,Sediments and water in environmental monitoring . UNESCO □ WHO □ UNEP ,2^{ed} edition .Chapter 3 . Section of water quality variable.
[http://www .who.int/](http://www.who.int/).

El Hussien , I . T .(2000) : Analysis of some inorganic constituents of drinking water in some parts of port sudan area .M.Sc . Thesis . University of Gezira.

Elnour , O. G . (2004): Treatment of some inorganic constituents of waste water from the PEPSI Factory at Wad Medani by clarifying clays .M.Sc .
Thesis University of Gezira.

Flatcher, G . Drisoell (1989) : Ground water and wells 2d edition Chapter 6 . page 90 - 120 .

Forrest , B. Wright (1976): Supply and Sanitation , Second Edition .

Georgal, Sackein and Ronald, M. Schultz, (1973) : Chemistry for the Health Sciences, Third edition, New York p. 114 – 129 .

IDC , (1981) : Rural water supply in China , International Development Center . Canada.

Twort, A.C.,F.M.law ,and F.W.Crowly (1985): water supply ,3th edition .chapter 6. P 205 –230 , revised Bassel, J. D., London.

Vogel, A.I.(1978): Text book of quantitative inorganic analysis .4th edition , revised by Bassel, J.D. London .

WHO ,(1984-b): Guide lines for drinking water quality , vol.2 part v, p 253-290.

WHO ,(1993): Guide lines for drinking water quality,2nd edition ,vol. 1 Geneva.

WHO ,(1963): International standards for drinking water , Geneva.

WHO, (1989): Guide lines for Drinking Water Quality, volume 2.