Sudan University of Science and Technology
College of Graduate Studies

Quality assment of Drinking Water of AlHebika Village

تقييم جودة مياه الشرب بقرية الهيبيكة

A Thesis Submitted to the College of Graduate Studies as Partial Fulfillment of the Requirements for the Degree of Master of Science in Chemistry

By

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إستهلال

قال تعالى:

﴿أَوَلَمْ يَرَ الَّذِينَ كَفَرُوا أَنَّ السَّمَاوَاتِ وَالْأَرْضَ كَانَتَا
رَتْقًا فَفَتَقْنَاهُمَا ۖ وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ ۖ
أَفَلَا يُؤْمِنُونَ (30)﴾

صدق الله العظيم

سورة الأنبياء الآية(30)

Dedication

To

Dearest people in my life

My mother

My father

My children,

My sisters.

Acknowledgments

My great thanks to Allah for everything.

My deep gratitude to my supervisor Dr.Abd Alsalam Abdallah Dafallah Mohammed for his invaluable guidance, fruitful discussions and comments throughout this work. Also very special thanks are extended to my teachers, friends and colleagues.

Abstract

This work was conducted in the White Nile area of Alhebika village near Algettina city to determine the quality of the water.

Four samples were taken from each of the three sources of water (Well, Biara, Tap) to examine the quality of drinking water in the region in February for four consecutive weeks one week per sample The twelve samples were analyzed at Almnara Water station in Umdurman-sudan. The average value of analysis of the well, biara and tap are respectively ,as follows ; The pH (8.44, 8.41, 8.05); electrical conductivity (737, 554.25, 534) microscimens per centimeter; total dissolved solids (406.26, 304.77, 294.15) mg /L ; turbidity (0.252, 0.157, 0.345); alkalinity (249.5, 245, 209.75) and water hardness (12, 77.2 5,59.5); calcium (0, 16, 10.4); magnesium (2.88, 8.94, 8.04); chloride (17.25, 13, 11.5) and fluoride (1.09, 0.54, 0.917).

The study compared our findings with WHO specifications. Most outcomes within the allowable limit and some exceeding the allowable limit, such as alkalinity and PH.

المستخلص

أجريت هذه الدراسة بمنطقة النيل الابيض بقرية الهبيكة بالقرب من مدينة القطينة وذلك لمعرفة نوعية المياه .

أخذت أربعة عينات من كل مصدر من المصادر الثلاثة للمياه وهي (بئر,بيارة,ماسورة) لفحص جودة مياه الشرب بالمنطقة في شهر فبراير لمدة اربعة اسابيع متتالية اسبوع لكل عينة وحللت العينات الاثني عشر في محطة مياه المنارة بامدرمان وأخذ متوسط نتائج العينات وكان متوسط نتائج التحليل للبئروالبيارة والماسورة على التوالي ان الرقم الهايدروجيني (8.44 ,8.41 , 8.05) ونتائج الموصلية الكهربية (737 , 554.25 , 534) مايكروسيمنز لكل سنتميتر, ومحتوى المواد الصلبة (406.26 , 304.77 , 294.15) ملجم لكل لتر والعكورة(0.252 , 0.157 , 0.345) والقلوية (249.5 , 245 , 209.75) وعسر الماء(12 , 77.25 ,59.5) والكالسيوم (0 , 16 , 10.4) والماغنيزيوم (2.88 , 8.94 , 8.04) والكلوريد (17.25 , 13 , 11.5) والفلوريد(1.09 , 0.54 , 0.917).

وقامت الدراسة بمقارنة تلك النتائج مع منظمة الصحة العالمية وقد كانت معظم النتائج داخل الحد المسموح به بالمواصفة وبعضها قد تجاوز الحد المسموح به مثل القلوية والرقم الهايدروجيني.

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CHAPTER ONE

1.Introduction

Water related diseases remain an issue of major global public health concern, with the water-sanitation-hygiene risk complex globally accounting for about ten percent of the global burden of disease (Pruess et. Al., 2008). Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection (WHO, 2008). A person requires about three liters of potable water per day to maintain the essential fluids of the body (Fetter, 2007). Water is the major constituent of the human body, since sixty percent of adult body weight is due to water (WET, 2010). The chemical formula of water is H_2O, meaning that each molecule of water contains one Oxygen and two Hydrogen atoms jointed by covalent bond. Water is the liquid state of H2O at standard temperature and pressure and is transparent, tasteless, odorless and colourless chemical substance. Water is found in streams, rivers, lakes, oceans and voids underground. It covers about 71% of the earth's surface and is one of the most important natural resource that man is endowed with and is very vital for all forms of life. There is a steady rise in the demand for groundwater in most hard rock areas, most of which cannot boast of any constant surface source of water supply (Adamu, 1994). Groundwater is generally less susceptible to contamination and pollution when compared to surface water bodies.

1.1 Importance of Water

Water is vitally important for life maintenance. Over years, water quantity and quality has been regarded as limiting factor in controlling the size and shape of human settlement. Water is so important, because, of many reasons. Basically in biochemistry water is an excellent stable solvent needed for dehydration synthesis and hydrolysis. On the other hand there is a surprising connection between quality of drinking water and health. As a waste carried it can be responsible from many water born diseases such as cholera and typhoid fever (Imad 1993).

1.2 Water Resources

Water resources are natural resources of water that are potentially useful. 97% of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice ,The remaining unfrozen freshwater is found mainly as groundwater, with only a small fraction present above ground or in the air.[2] Natural sources of fresh water include surface water, under river flow, groundwater and frozen water.

Water resources are useful to human, animals and plants. Many uses of water including agricultural, industrial, household, recreational and environmental activities virtually require fresh water. Only 3% of water on the earth is fresh water and over two third of this is frozen in glaciers and polar ice caps. (Mark 1981). Water demand already exceeds supply in many parts of the world and more areas are expected to experience this imbalance in the near future. The framework for allocating water resources to water users is known as water rights. (Mark 1981)

1.3 Drinking Water

Drinking water or potable water is water pure enough to be consumed or used with low risk of immediate or long term harm. The most developed countries the water supplied to household, commerce and industry is all of drinking water standard.

1.4 Ground Water Occurrence

Groundwater is fresh water located in the subsurface pore space of soil and rocks. It is also water that is flowing within aquifers below the water table. Sometimes it is useful to make a distinction between groundwater that is closely associated with surface water and deep groundwater in an aquifer (sometimes called "fossil water").

Groundwater can be thought of in the same terms as surface water: inputs, outputs and storage. The critical difference is that due to its slow rate of turnover, groundwater storage is generally much larger (in volume) compared to inputs than it is for surface water. This difference makes it easy for humans to use groundwater unsustainably for a long time without severe consequences. Nevertheless, over the long term the average rate of seepage above a groundwater source is the upper bound for average consumption of water from that source.

The natural input to groundwater is seepage from surface water. The natural outputs from groundwater are springs and seepage to the oceans.

If the surface water source is also subject to substantial evaporation, a groundwater source may become saline. This situation can occur naturally under endorheic bodies of water, or artificially under irrigated farmland. In coastal areas, human use of a groundwater source may cause the direction of seepage to ocean to reverse which can also cause soil salinization. Humans can also cause groundwater to be "lost" (i.e. become unusable) through pollution. Humans can increase the input to a groundwater source by building reservoirs or detention ponds.

1.5 The Chemistry of Water

Water has a simple molecular structure. It is composed of one oxygen atom and two hydrogen atoms. Each hydrogen atom is covalently bonded to the oxygen via a shared pair of electrons. Oxygen also has two unshared pairs of electrons. Thus there are 4 pairs of electrons surrounding the oxygen atom, two pairs involved in covalent bonds with hydrogen, and two unshared pairs on the opposite side of the oxygen atom. Oxygen is an "electronegative" or electron "loving" atom compared with hydrogen

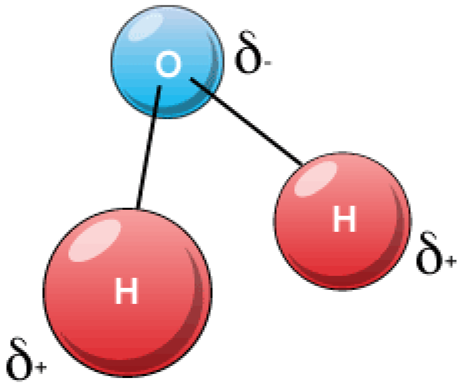

Fig (1) shape bent

1.5.1 The polarity of Water

Water is a "polar" molecule, meaning that there is an uneven distribution of electron density. Water has a partial negative charge ($\delta -$) near the oxygen atom due the unshared pairs of electrons, and partial positive charges ($\delta +$); near the hydrogen atoms The H–O–H bond angle in water is 104.5, which means that the molecule has a bent shape. This bent geometry and the accumulation of electrons on the oxygen side of the molecule cause the water molecule to have a negative charge on one side, the oxygen side, and a positive charge on the other side, the hydrogen side. Molecules with negative regions and positive regions are called polar molecules.

1.5.2 Hydrogen Bond

In water electrostatic the attraction between the partial positive charge near the hydrogen atoms and the partial negative charge near the oxygen results in the formation of hydrogen bond between molecules as shown in fig (2)

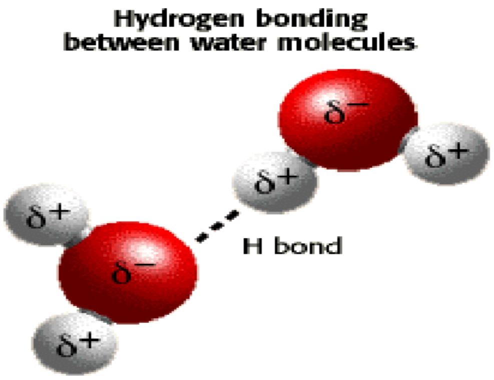

Fig (2) Hydrogen bonding between Water molecules

1.5. 3 Acids and Bases, Ionization of Water

$$H_2O \xrightarrow{Limited} H^+ + OH^-$$

- Acid release H^+

Amphoteric properties of water

- Bases accept H^+

We define the pH of a solution as the negative logarithm of the hydrogen ion concentration.

- at pH 7.0, a solution is neutral
- at lower pH (1-6), a solution is acidic Amphoteric properties of water
- at higher pH (8-14), a solution is basic 2

1.5.4 Physical Properties of Water

1.5.4.1 Odor

Odor can serve as a guide to gross pollution of water. For example, characteristic odors are associated with chlorination plants, untreated sewage and chemical industry effluents. Anaerobic conditions are also indicated by the smell of hydrogen sulphide, especially near boggy areas. It is not practicable to measure odor quantitatively but it is useful as an indicator of particular conditions.

1.5.4 .2 Color

Even pure water is not colorless; in water may be a true color due to dissolved material or an apparent color when suspended material is present (Sawyer 1967). The latter is quite common in natural waters. In the case of drainage waters from peat or humus the brown color may be true or apparent. Similarly an orange color may be present in waters that have passed over iron – rich sediments or mine workings and some colors are associated with various industrial effluents. Color is measured visually against colored glass standard using a comparator or photo metrically with spectrophotometer.

1.5.4.3 Turbidity

May be used as an estimate of undissolved substances in the sample. It is generally measured by visual comparison with standards or photometrically, using a nephelometer or spectrophotometer (Stewart 1989).

1.5.4.4 Density

The density of water is the weight of the water per its unit volume, which depends on the temperature of the water. The usual value used in calculations is 1 gram per milliliter or 1 gram per cubic centimeter. The density of pure water actually. The maximum density of water occurs around 4 degrees Celsius. Ice is less dense than liquid water, so it floats.

1.5.4.5 Temperature

Technically, heat is an indicator of the kinetic energy of water, or energy of motion. Increasing temperature indicates increasing energy, or molecular motion, of water.

Water temperature affects the growth and reproduction of living organisms. Water temperature has a tremendous impact on water density. Differences in water temperature and density cause stratification. Water temperature can be measured with a thermistor, usually expressed in degrees Fahrenheit or Celsius.

1.5.4.6 Conductivity

Conductivity is a property of water governed by the total ionic content. It is often measured because of its value in characterizing waters. It expresses in resistance of $1cm^3$ of water to the passage of a current usually at $25C^{\circ}$. The specific conductance is the reciprocal of the resistance (1/R) in Siemens (S) or more exactly C/R for a given cell expressed as Siemens per cm (Scm^{-1}). The digital readout of modern conductivity meters is in C/R units recorded as microsiemens per cm (μScm^{-1}) for most fresh water but often millisiemens per cm ($mscm^{-1}$) for a brackish sample. Conductivity measures the ability of water to conduct an electrical current and is directly related to the total dissolved salts (ions) in the water (Stewart 1989).

1.5.4.7 Surface Tension

Water has a very high surface tension. In other word, water is sticky and elastic, tend to clump together in drops rather than spread out in thin films. Surface tension is responsible for capillary action which allows water (and in it dissolved substance) to move through the roots of plants and through the tiny blood vessels in our bodies. The highest surface tension 73 dyne /Cm is at 20C0 and 1atmosphere (Sawyer 1967).

1.5.4.8 Radioactivity

Water may contain trace amount of radioactivity caused by naturally occurring radioactive isotopes such as potassium (${}^{40}K$), (Tebbutt 1998).

1.5.4.9 Viscosity

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress. For liquids, it corresponds to the informal concept of "thickness"; example, honey has a much higher viscosity than water. Water has low viscosity.

1.5. 5 Chemical Properties of Water

Chemical characteristic tend to be more specific in nature than some physical parameter and are thus more immediately useful in assessing the properties of sample (Tebbutt 1998).

1.5.5.1 The Water pH

The technical definition of pH is that it is a measure of the activity of the hydrogen ion (H^+) and is reported as the reciprocal of the logarithm of the hydrogen ion activity. Therefore, water with a pH of 7 has 10^{-7}moles per liter of hydrogen ion. The pH ecological significance is wide because the behavior of many ions and 5 organic compounds can be related directly to it. It is measured using a pH selective ion electrode. The pH scale ranges from 0 -14.In general, water with a pH < 7 is considered acidic and corrosive. This water with a low pH could contain elevated levels of toxic metals, cause premature damage to metal piping, and have associated aesthetic problems such as a metallic or sour taste. A water with a pH>7 is considered basic and hard. Hard water does not pose a health risk, but can cause aesthetic problems such as an alkali taste. Water can be softened through the use of ion-exchange or the addition of a lime-soda ash mixture, but both processes increase the sodium content of the water (Driscoll 1986). The normal range for pH in surface water system is 6 to 7.5 and for ground water systems 6.5 to 8.5.

1.5.5.2 Alkalinity

The alkalinity of water is measure of its capacity to neutralize acids; acid neutralization capacity is also sometime used. The alkalinity of natural waters is due primarily to the salt of weak acids, although weak or strong bases may also contribute. Bicarbonate represents the major form of alkalinity since it is formed in considerable amounts from action of carbon dioxide upon the basic materials in the soil. Under certain conditions natural waters may contain appreciable amounts of carbonate and hydroxide alkalinity. This condition is particularly true in surface waters where are algae is flourished (CEES, 2003). Alkalinity is significant in many uses and treatment of natural waters and wastewaters. Because the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate and hydroxide content, it is taken as an indication of concentration of these constituents. The measured values also may include contribution from borates, phosphates, silicates. Alkalinity measurements are used in the interpretation and control of water and wastewater treatment process. Measured values may vary significantly with the end point pH used (APHA, 2005).

1.5.5.3 Hardness

The hardness of water is determined by the concentration of divalent cations in the water, mostly calcium and magnesium and is expressed as mg/l $CaCO_3$. Hardness affects the lather-forming ability of water with soap. Different forms of hardness can be distinguished all expressed as mg/l$CaCO_3$:

- carbonate or temporary hardness, which is caused by calcium and magnesium associated with bicarbonate in the water,
- non-carbonate or permanent hardness, which is caused by calcium and magnesium-m associated with ions other than bicarbonate such as chloride and sulphate,

- calcium hardness, caused by all the calcium ions in solution,
- magnesium hardness, caused by all the magnesium ions in solution, and
- Total hardness, which is the sum of calcium and magnesium hardness.

1.5.5.4 Acidity

Most natural water and domestic sewage are buffered by system. Carbonic acid $H_2CO_3$is not fully neutralized until pH below 4.5 thus CO_2acidity is in pH range 8.2 to 4.5. Mineral acidity, usually due to industrial waste occurs below PH 4.5. (Tebbutt 1998).

1.5.5.5 Chloride

Chloride occurs in all waters in widely varying concentration. Upland and mountain supplies usually are quite low in chloride whereas rivers and ground water usually have considerable amount (CEES, 2003). Chloride in form of chloride (Cl^-) ion is of the major inorganic anion in water and wastewater. The salty taste produced by chloride concentration is variable and dependent on the chemical composition of water. Some waters containing 250mg/L have a detectable salty taste if the cation is sodium. On other hand the typical salty taste may be absent in waters containing as much as 1000 mg/L when the predominant cations are calcium and magnesium (APHA, 2005).

1.5.5.6 Biological oxygen demand (BOD)

Biological oxygen demand (BOD) is usually defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. The decomposable may be interpreted as meaning that the organic matter can serve as food for the bacteria, and energy is derived from its oxidation. BOD test is widely used to determine the pollution strength of the domestic and industrial wastes in terms of the oxygen that they will required if discharge into natural water course in which aerobic condition exist. BOD test a bioassay procedure involving the measurement of oxygen consumed by living organism while utilized the organic matter present in waste, under condition as similar to those that occur in nature (CEES, 2003). BOD measures the molecular oxygen utilized during a specified incubation period for biochemical degradation of organic and oxygen used to oxidize inorganic material such as sulfides and ferrous ion. It is also may measure the amount of oxygen used to oxidized reduced forms of nitrogen unless their oxidation is prevented by an inhibitor (APHA, 2005).

1.5.5.7 Chemical oxygen demand (COD)

Chemical oxygen demand (COD) test is widely used as means of measuring the organic strength of domestic and industrial waste (CEES, 2003). COD is a measure of oxygen equivalent of the organic matter in water that susceptible to oxidation by strong chemical oxidant such as dichromate. The concentration of COD observed in surface waters range from 20 mg/L or less in unpolluted waters to greater than 200 mg/L in waters receiving effluent (Chapman1996). COD often used a measurement of pollutants in wastewaters and natural waters (APHA, 2005).

1.5.5.8 Dissolved oxygen (DO)

Oxygen is essential to all form of aquatic life, including those organisms responsible the self-purification process in natural waters. 7 The oxygen content of natural waters varies with temperature, salinity, turbulence, photosynthetic activity of algae and plants and atmospheric pressure. Variation in DO can occur seasonally, or even over 24 hour periods, in relation to temperature and biological activity. Determination of DO concentration is fundamental part of a water quality assessment since oxygen is involved in, or influences, nearly all chemical and biological process within water bodies. Concentration below 5 mg/L may adversely affect the functioning and survival of biological communities and below 2mg/L may lead to the death of most of fish (Chapman1996). The concentration of DO in natural surface waters is usually less than 10 mg/L (CWQ, 2008).

1.5.5.9 Sodium

All natural waters contain some sodium salt are lightly water soluble and it is one of the most abundant elements on earth. It is found in the ionic form (Na^+) and in plant and animal matter. Increased concentration in surface waters may arise from sewage and industrial effluent (Chapman1996).The concentration of sodium in natural waters varies considerably and may range from below 1mg/L to 105mg/L (CWQ, 2008).

1.5.5.10 Potassium

Potassium (K^+) is found in low concentration in natural waters since rocks which contain potassium are relatively resistance to weathering, however, potassium salt are widely used in industry and fertilizers for agriculture and inter fresh water with industrial discharge and enter fresh waters with industrial discharge and run-off from agricultural land (Chapman1996). Potassium is essential for plant and animal nutrition, and there for is readily accumulated average concentration of potassium in fresh and salt waters are 2.2 and 399 mg/L (CQW, 2008).

1.5.5.11 Calcium

Calcium is present in all waters as (Ca^{+2}) and is readily dissolved from rocks rich in calcium minerals, particularly as carbonates and sulphate, 8 especially limestone and gypsum. Calcium compound are stable in water when dioxide is present. But calcium concentration can fall when calcium carbonates precipitate due to increased water temperature, photosynthetic activity or loss of carbon due to pressure (Chapman, 1996).

1.5.5.12 Magnesium

Magnesium is common in natural waters as Mg^{+2}) and long with calcium is main contributor to water hardness. Magnesium arises principally from the weathering of rocks containing ferromagnesium minerals and from some carbonate rocks (Chapman, 1996). Magnesium is the eight most abundant natural elements. The aqueous chemistry of magnesium is similar to that of calcium, such that carbonates and oxides are formed. Magnesium compounds are in general, more soluble than their calcium counter parts. As result of large amounts of magnesium are rarely precipitated. Magnesium hydroxides precipitate at high pH (<10).Magnesium is considered to be an essential element for all organisms. It may accumulate in calcareous tissue, and has been found in edible vegetables. Magnesium is one of principle cations of the soft tissue (CWQ, 2008).

1.5.5.13 Sulphate

Sulphate is naturally present in surface waters as (SO_4^{-2}). It is arise from the atmospheric decomposition of oceanic aerosols and leaching of sulfur compounds. Either sulfate minerals such as gypsum or sulfide minerals such as pyrite from sedimentary rocks. Industrial discharge and atmospheric precipitation can also add significant amounts of sulfate to surface waters; sulfate can be used as an oxygen source by bacteria which convert it hydrogen sulfide under anaerobic condition (Chapman, 1996). Sulfate concentrations normally vary from 10 to 80 mg/L in surface water (CWQ, 2008).

1.5.5.14 Hydrogen sulphide

Dissolved sulfides exist in water as non-ionized molecules of hydrogen sulfide (H_2S); formation in surface waters is principally through anaerobic bacteria decay of organic substances in bottom sediments and stratified lakes and reservoirs. Traces of sulfide ion occur in unpolluted bottom sediments from the decay of vegetation, but the presence of high concentrations often indicates the occurrence of sewage or industrial wastes (Chapman, 1996).

1.5.5.15 Aluminum

Aluminum is third most abundant element in the earth's crust; however, it doesn't occur in its elemental form in nature. Most natural surface waters contain less than 1000µg/L. Aluminosilicate minerals are abundant in all rock types and most geologic materials, especially clays. Aluminum can be mobilized from soil and sediments by both natural weathering and accelerated acidification processes, resulting in detectable levels in surface waters (CWQ, 2008).

1.5.5.16 Fluoride

Fluoride is abundant in the earth's crust and detectable concentration occurs in almost minerals. The concentration of fluoride in most surface waters is less than 1 mg/L although concentration may exceed 50 mg/L. The highest natural concentrations may exceed 1000 mg/L are found in the lakes of east Africa (CWQ, 2008). Measurement of fluoride content is especially important when a water body is used for drinking water supply. At high concentration fluoride is toxic to human and animals and can cause bone diseases. However a slight increase in natural concentrations can help prevent dental caries although at high concentration (above 1.5- 2.0 mg/L) mottling of teeth can occur (Chapman, 1996).

1.5.5.17 Copper

Copper metal and copper compound have used by humans since prehistoric times copper’s usefulness as a metal is estimated as being 10 secondary to that of iron. Copper is a common metallic element in the rocks and minerals of the earth’s crust. Natural sources of copper in aquatic environments include the weathering or the solution of copper minerals and native copper. Concentration of copper in surface waters is usually below 20 mg/L (CWQ, 2008).

1.5.5.18 Cobalt

Cobalt is used in super alloys where it improve the strength wear it resistance. Cobalt is present in a number of rock types including granite, basalt shale, Limestone and sandstone. Anthropogenic source of cobalt in the environment include acid coal mine drainage and emissions from local burning and other industries. The amount of cobalt in aerobic surface waters generally very small; except where there is gross heavy metal contamination (CWQ, 2008).

1.5.5.19 Chromium

Hexavalent chromium compounds are used in the metallurgical industry for chrome alloy and chromium metal production. Chromium can exist in oxidation states ranging from (-2 to +6) but is present in aqueous system mainly in trivalent, chromate and dichromate state (CWQ, 2008).

1.5.5.20 Iron

Iron is the fourth most abundant element in the earth’s crust. Iron is naturally released into the environment from weathering of sulphide ores. Leaching from sandstone releases iron oxide and iron hydroxide to the environment. Iron is also released into the environment by human activities mainly from burning of coke and coal, acid mine drainage mineral processing, iron industries and corrosion of iron and steel. Concentrations of iron in natural waters are usually less than 0.5 mg/L (CWQ, 2008).

1.5.5.21 Manganese

Manganese is an essential trace element for microorganism, plants and animals, and hence is contained in all or nearly all organism. 11 Manganese may exist in oxidation state ranging from -3 to +7 the divalent and tetravalent state are primary importance in aqueous system. Manganese is similar to iron, its chemical behavior and frequently found in association with iron. Manganese seldom reaches concentration of 1.0 mg/L in natural surface waters and is usually present in quantities of 0.2 mg/L or less (CWQ, 2008).

1.5.5.22 Nickel

Nickel ranks as the third element in order abundant in the earth's crust, and occurs in the nature mainly in combination with sulfur, arsenic and antimony. Nickel enters the environment primarily through the weathering of minerals and rocks and as the result of human activities. Nickel as high as 0.1 mg/L have been found in natural surface waters. Nickel may occur in oxidation state ranging from -1 to +4 in aqueous system (CWQ, 2008).

15.5.23 Ammonia

Ammonia (NH_3) is a colorless at ambient temperature and pressure, and has a distinct pungent odour ; Produced naturally by biological degradation of nitrogenous matter. Natural resources include biological litter, animal waste, forest fire and human breath. If ammonia present in small amount in air, water and soil, it present in large amounts in decomposing of organic matter. Natural waters typically contain ammonia and ammonia compounds in concentration below 0.1 mg/L (CWQ, 2008).

1.5.5.24 Nitrate

The nitrate ion (NO_3^-) is the oxidized form of combined nitrogen found in natural waters. Nitrate may be biologically reduced to nitrite via gentrification, such processes occur in anaerobic environment. Surface waters contain at least trace levels of nitrate, but rarely as much as 5mg/l and often less than 1 mg/L (CWQ, 2008).

1.5.5.25 Nitrite

The nitrite ions (NO_2^-) contain nitrogen in an intermediate relatively unstable oxidation state +3. Nitrite salts are soluble, although they are not as common as nitrate salts. Nitrite concentrations seldom exceed 1mg/L. Nitrite salt is used as corrosion inhibitors in industry. The presence of nitrites in water indicates of biological processes influenced by organic pollution (CWQ, 2008).

1.5.5.26 Zinc

ranks as the 24th most abundant element found in the earth's crust. Zinc is important in biological systems being involved in nucleic acid synthesis and occurring in many enzymes. In natural waters, zinc occurs in both suspended and dissolved forms (CWQ, 2008).

1.6 Water quality

Criteria and standards of water quality are exposure limits for bacteriological, viral and chemical and physical and agent and that have been adopted by government or appropriate authorities therefore have legal force. The purpose to standards is to minimize all known health hazard, since it is obviously impossible prevent all pollution. The WHO has published in 1993vol.1 and in 1996 vol.2 of second Edition of guideline for drinking water quality indented for use by countries as a basis for the development, will ensure the safety of drinking water supplies. In order to define standards, it is necessary to consider these recommendations in the context of prevailing environmental, social, economic and cultural conditions. These guidelines for drinking water.

The guidelines:

A- Acceptability aspects.

B- Microbiological aspect

C- Chemical aspect

D- Radiological aspect

1.7 Water borne diseases

Water borne diseases are among one of the major public health problems in developing countries like Ethiopia. They are the leading causes of morbidity 6 and mortality in all age groups particularly in children under 5 years of age. According to the World Health Organization (WHO) 3 million deaths occur every year from diarrheal diseases worldwide (WHO, 1996). The problem of water borne diseases is especially prevalent where general hygiene and environmental sanitation are poor and where there is a shortage of protected water supply (Abram, 1995; WHO, 1996). It is believed that 80% of all diseases in the world are caused by inadequate sanitation, polluted water or unavailability of water. Poverty, illiteracy, over crowding and low health services are contributing factors that directly or indirectly affect the prevalence of water born diseases. Therefore, an integrated prevention and curative approach with community participation is required in order to tackle this prevalent public health problem. In the United States the Centers for Disease Control and Prevention estimates that 76 million people become ill with food borne disease resulting in about 325,000 hospitalizations and 5000 deaths each year (Abram, 1995). From 1997 to 1998 the Centers for Disease Control and Prevention reported 4,166 illnesses from contaminated drinking water and recreational water exposure in the United States (WHO, 2004). Ground and surface water are exposed to chemical and physical pollutant such as heavy metals (lead, cadmium, iron, phosphorus) and pestisides. Lead is one of the most abundant heavy metals and its toxic effects cause environmental and health problems because of its stability in contaminated site and complexity of mechanism in biological toxicity, particularly dangerous for children leading to mental retardation when exist with abnormal concentration in body fluid. The chronic exposure to Cadmium produces a wide variety of acute and chronic effects in humans. Cadmium accumulates in the human body, especially in the kidneys, resulting in kidney damage (renal tubular damage), which is a critical health effect. Other effects of Cadmium exposure are disturbances in calcium metabolism, hypercalciuria and the formation of kidney stones. High exposure to can Cadmium lead to lung cancer and prostate cancer. Humans have changed 7 the natural phosphate supply radically by addition of phosphate-rich manures to the soil and by the use of phosphate-containing detergents. Too much phosphate can cause health problems, such as kidney damage and osteoporosis. Phosphate shortages can also occur. These are caused by extensive use of medicine, noting that the most from water that is high in iron is that the water may taste metallic. The water may be discolored and appear brownish, and it may even contain sediment. Iron will leave red or orange rust stains in the sink, toilet and bathtub or shower. It can build up in your dishwasher and discolor ceramic dishes. It can also enter into the water heater and can get into the laundry equipment and cause stains on clothing. The EPA cautions that although iron in drinking water is safe to ingest, the iron sediments may contain trace impurities or harbor bacteria that can be harmful. Iron bacteria are naturally occurring organisms that can dissolve iron and some other minerals. These bacteria also form a brown slime that can build up in water pipes. Iron bacteria are most commonly problematic in wells, where water has not been chlorinated (Tiwari and Tripathi; 2012).

1.8 Water pollution

Water pollution can be defined as any chemical, physical or biological change in the quality of water that has a harmful effect on any living organism that drinks or uses or lives in it. Water pollution could be caused by human activities including sewage disposal, fertilizers for agricultural crops containing nutrients such as nitrates and phosphate, also growth of plants and algae might clog water pipes and increase growth of organisms. Another pollution by agricultural activities might be commercial live stock and poultry farming as sources of many organic and inorganic pollutants in surface and ground water. In addition, industrial pollution discharge through pipe lines or sewage into the surface water, organic chemicals such as pesticides, inorganic minerals and chemicals compounds could all be considered as major water pollutants. Furthermore, pollution could come from many sources including untreated 8 sewage, industrial discharges, leakage from oil storage tanks, mine draining and leaking from mine waste and drainage from the residues of agricultural fertilizers and pesticides (Krantz and kifferstein; 1996).

CHAPTER TWO

MATERIALS and MENTHODS

2.1 location of Study Area

The village of Hebika belongs to the locality of Algettina in the state of the White Nile, where the locality of Algettina lies in the north of the state between latitudes 13,20 -15,15 m and longitudes of 32,15 -30,15 BC, and it is bounded on the north by Khartoum state, on the west by Umm Remta locality, and from the south by the locality; of Rabak, from the northwest, North Kordofan state, and from the east, the state of Al-Jazeera.

2.2 Materials

2.2.1 Samplings

Three samples of raw water (well, biara and tap) were collected from the village of Al-Hebika in the White Nile, according to the standard methods. Then each sample was immediately analyzed in the laboratory of Almanara water treatment plant and preserved in a plastic container at room temperature for further working, The experiment was repeated four times at separate intervals to ensure the accuracy of the work, At the beginning of February, for a period of four consecutive weeks, the period between each sample and the following sample is a week.

2.2.2 Chemical and Reagents

- Potassium chromate K_2CrO_4 (Mw= 194.2). (Association chemical Enterprises) (CAS: 7789-00-6).

- Silver nitrate $AgNO_3$ (Mw = 169.87). (Association chemical Enterprises) (CAS: 7761-88-8).

- SPANS reagent for fluoride (HACH, Cat No.444-42).

- Buffer solution buffer10 color code blue (HACH, Cat No.22836-49).

-Buffer solution buffer12

-silecrom

-muroxide

-sulphuric acid (H_2SO_4)(0.01M)

-EDTA(0.01M)

2.2.3 Laboratory glassware

Beakers 1000 ml BORO 3.3, Sample cell 10 ml cat No. 2495402, Sample cell 10 ml. cat No. 2434706, Flask 250 ml. BORO 303. Measuring cylinder 1000 ml, 50 ml, Pyrex vista No.70022, Pipette, 1.0-10 ml, Cat.1970010, Digital Burette 50ml,

2.2.4 Instruments

- 2100P Laboratory TURBIDIMETER, HACH Company, measures turbidity from 0 to 1000 NTU with automatic range selection and decimal point placement. The light source is tungsten filament lamp.
- DR5000 UV- VIS spectrophotometer, HACH LANG Company, includes Power cord 230V, instrument manual, procedure manual, 1-inch matched glass sample cells and multi- cell holder.
- HQ30d Portable Meter Kit with PHC101 pH Electrode and CDC401 Conductivity Cell, HACH, Cat. No. HQ30D53101201.

2.3 Methods

2.3.1 Determination of Turbidity

Turbidity values were determined by nephelometric method:

- Procedure The turbid meter was calibrated using stabilized formazin Primary standard solutions Kit includes sealed vials of each<0.1NTU, 20 NTU, 100 NTU, and 800 NTU. The sample cell was cleaned and rinsed three times with the sample to be analyzed then filled with the sample and the cell was wiped, a thin film of silicon oil was applied and the excess was wiped, the sample cell was inserted in the instrument cell compartment, automatic range mode was selected and signal average was pressed. The 32 NTU values were measured by pressing read button, the turbidity was recorded after the lamp symbol turn off.

2.3.2 Determination of pH values

The pH meter was calibrated with three buffer solutions of pH 4.01, 7.00 and 10.00 at 25C°. The water sample was placed in a glass beaker and the electrode was rinsed with distilled water and placed in the sample. The pH values were recorded after few seconds to allow the pH meter to stabilize.

2.3.3 Determination of temperature, conductivity and total dissolved solid The temperature, EC and TDS of the samples was measured using HACH, HQ30d portable meter kit with IntelliCAL™ CDC401standard conductivity probe, Cat. No. HQ30D53101201. the electrode was immersed in electrode cleaning solution then was rinsed with distilled water. The electrode was calibrated by immersing the electrode in sodium chloride standard solution1000 µS/cm. the water sample was put in a glass beaker and the electrode rinsed in distilled water and lowered into the sample. After the temperature stabilized the EC in µS/cm, TDS in mg/L and temperature in C° of the sample were recorded.

2.3.4 Hardness

taken 50 mL of the sample and put it in a conical flask and added 2mL of the buffer solution 10, add a small amount of reagent silecrom, the color of the solution will turn purple, titrate with EDTA(0.01M) standard solution until the color of the solution became blue, the consumed volume of EDTA was 40 mL.

2.3.5 Alkalinity

sulfuric acid (0.01M) and transfer by pipette (50ml) from the sample to be examined into the conical flask. added 2-3 drops of silecrom to the water and it appears blue. Titrate by sulfuric acid until a pink color appears, then we record the volume of acid used in scaling.

2.3.6 Calcium

Hardness

taken 50 mL of the sample and put it in a conical flask and added 2 mL of the buffer solution 12, add a small amount of reagent muroxide, the color of the solution will turn pink, titrate with EDTA standard solution until the color of the solution became purple, determined the volume of EDTA used in the titration V1

2.3.7 Determination of Chloride

Argent metric Method

♣ **Reagents**

♣ **Preparation of Potassium chromate indicator solution:** prepared by dissolving 50g K_2CrO_4 in a little distilled water, then $AgNO_3$ solution was Added until red precipitate was formed, let stand 12 hours, then filtered and diluted to 1 liter with distilled water.

♣ **Preparation of Standard silver nitrate titrates (0.014 M):** prepared by dissolving 2.395 g $AgNO_3$ in distilled water and diluted to 1000 mL.

♣ Procedure

To 100 mL of water, 1 mL of K_2CrO_4 solution was added then titrated with 0.014 M $AgNO_3$ solution to a pinkish yellow end point. Distilled water was used as a blank, was treated by the same procedure mentioned above.

2.3.8 Determination of Fluoride

Fluoride was determined by spectrophotometer at 580 nm. SPADNS method1 (0.02 to 2.00 mg/L F^-)

- **Reagents**

- SPADNS reagent solution.

- Demonized water.

- Sample preparation: 10mL of sample was poured into a dry, square sample cell, and then 2mL of SPADNS reagent was added and swirled to mix

- **Blank preparation:** 10mL of demonized water was poured into a second dry square sample cell, and then 2mL of SPADNS reagent was added and swirled to mix.
- **Procedure:** The blank and the sample were Let stand for one-minute reaction period, then the blank cell was wiped , dried and placed into the cell holder then zero icon was touched. Immediately the sample cell was wiped, dried and placed into the cell holder, read icon was touched and the result was taken in mg/L F^-.

CHAPTER THREE

Results and Discussion

3.1 Results

The collected water samples from Alhibaka village were analyzed The physical properties such as electrical conductivity (µ\cm), pH and total dissolved solid(TDS)mg/L, turbidity and chemical properties such as concentration (mg/l) of total alkalinity, total hardness, calcium, magnesium, chloride and florid Each samples was analyzed for three replicages. The obtained results are recorded in Tables

Table 3.1 The physical properties Shown in Table below

Parameter	Sample1 well	Sample2 biara	Sample3 Tap	Who
Electrical conductivity(µ/cm)	737	554.25	534	Guide line value set
PH	8.44	8.41	8.05	6---8
Total dissolved solid (TDS) mg \L	406.26	304.77	294.15	1000
Turbidity	0.25	0.15	0.34	5

Table 3.1 presents the statistical summary of physical properties measured in ground water samples collected from well, biara and tap located in Alhbika village, the electrical conductivity (EC) values were found to be 737,554.25,534 µ\cm the pH was measured and was found to be 8.44,8.41 and 8.05.

The total dissolved solid(TDS) ranged from 406.26, 304.77,294.15 mg\L

Table 3.2 The Chemical Properties Shown in Table below

Analyze	Sample 1	Sample 2	Sample 3	WHO(mg/l)
Total alkalinity	249.5	245	209.75	Less than 40 mg \l
Total hardness	12	77.25	59.5	500
Ca^{+2}	0	16	10.4	200
Mg^{+2}	2.88	8.94	8.04	200
Cl^{-}	17.25	13	11.5	250
F^{-}	1.09	0.54	0.917	1.5

3.2. Discussion

This study is done to investigate the quality of drinking water (groundwater) in mining area at Alhbika village in White Nile by determination of the physical properties and the chemical analysis. Three samples were collected from different sources (well, biara and tap). The physical examinations included the electrical conductivity EC, pH, TDS and turbidity and chemicals examinations also applied and the results were compared with international drinking water guidelines. Table (1) presents the statistical summary of physical properties measured in groundwater samples collected from wells located in Alhbika village in White Nile. The electrical conductivity (EC) values are scattered ranging between 737 to 2554.25 µs/cm. the EC values within range 1000 µs/cm, the guide-line value specified by WHO. The total dissolved solid (TDS) ranged from 294.15 mg/L to 406.26 mg/L, within the permissible level of WHO standard. The pH range from 8.05 to 8.44 (Table 1). All the samples had pH values which exceeded the permissible range of 6 – 8(WHO). The turbidity ranges from (0.15 to 0.34) (Table1). All samples had turbidity values within the permissible level of WHO standard. Table (2) statistical summary of concentration (mg/L) of total alkalinity ranged from 209.75 to 249.5 mg/L table (2). All samples had alkalinity value which exceeded the permissible level. The total hardness ranged from 12 to 77.25 mg/L table(2) .All samples had total hardness value within the permissible level of WHO standard, calcium concentration ranging from 0 to 10.4 mg/L .All samples had calcium value within the permissible level of WHO standard, magnesium concentration ranging from 2.88to 8.94 mg/L .All samples had magnesium value within the permissible level of WHO standard, chloride concentration ranging from 11.5to 17.25 mg/L .All samples had chloride value within the permissible level of WHO standard, and floride concentration ranging from 0.054to 1.09 mg/L. All samples had floride value within the permissible level of WHO standard guide line for drink water and set for drinking water, in ground water samples collected from well, biara and tap located in Alhbika village.

Discussion The Three samples among themselves

Table 1

after we compared the three samples (well, biara and tap) we found the highest value for E.C, pH and TDS was for well and the lowest value was for tap whereas the highest value for turbidity was for tap and the lowest value was for biara.

Table 2

after we compared the three samples (well, biara and tap) the highest value of alkalinity was for well and the lowest value was for tap water.

for the total hardness, Ca^{+2} and Mg^{+2} the highest value was for biara water whereas the lowest value was for well.

The highest value of chloride and fluoride were for well water and the lowest value of chloride was for tap water and the lowest value of fluoride was for biara water.

3.3 Conclusion

Based upon the results obtained in this study, the following concluding remarks can be drawn:

- The PH and Alkalinity measurement of the water exceeded the permissible level specified by WHO.
- All values of The Electrical Conductivity (EC), Total Dissolve Solid (TDS), Turbidity, Hardness, Calcium, Magnesium, Chloride and Fluoride were within the acceptable range of WHO.
- The Water of the Well was without Calcium.

3.4 Recommendations

- Further research must consider epidemiological studies as well as setting monitoring program for chemical constituents concentration.
- Proper site selection for the location of domestic water wells and proper well.
- Further research must consider solving the problem of high alkalinity in these waters.

3.5 References

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