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DETERMINATION OF HEAVY METALS CONCENTRATION AND SOME PHYSICOCHEMICAL PROPERTIES OF DRINKING WATER SOURCES RABAK AREA WHITE NILE STATE-SUDAN

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ABSTRACT

This study aimed to estimate the concentration of some heavy metals such as (lead, cadmium, chromium and also measure the physicochemical properties). In samples from three sources of drinking water in the region, namely (the White Nile, canals and pools) The study used atomic absorption spectroscopy for the determination of heavy metals, and for physicochemical properties tests, an electrical conductivity meter was used to measure conductivity and pH. As for the total dissolved salts, a physical method was used, which is the evaporation method, The study found that cadmium and lead in all water samples are less than the minimum detectable, Only chromium was found in pool water and canals at a concentration of (0.0003 and 0.0002 mg/L), respectively. The pH value ranged between (6.76, 7.32). Total dissolved salts ranged from (446.72 104.89 mg/liter), electrical conductivity (161.3, 698.0 µs/cm), while nitrate recorded (8.96 -3.92, mg / 1) in each. From the Nile, pool and Canals respectively. The study concluded that the results are generally less than the internationally permissible limit according to the data of the World Health Organization and the specifications of drinking water set by the Sudanese Standards and Metrology Organization, and it was also concluded that there is no pollution in this water.

KEYWARD: heavy metals, atomic absorption spectroscopy, physicochemical properties, White Nile river, canals, pools, pollution.

INTRODUCTION

Water supply in still one of the major challenges in developing countries. The Joint Monitoring Programme (UMP) for Water Supply and Sanitation, implemented by the World Health Organization (WHO) and UNICEF, reports that 783 million people in the world (11% of the total population) have on access to safe water, 84% of whom live in rural areas (WHO, UNICEF 2017) About 187 million people use surface water for drinking purposes, 94% of them are rural inhabitants and they are concentrated in sub-Saharan Africa (WHO, UNICEF, 2012).

Water source

Rain water

Rain is rarely the immediate provenance of municipal water supplies, it is confined to farms and rural settlements usually in semiarid regions devoid of satisfactory ground or surface waters. (Fair, at al, 1966).

Rain water collected from clan house reals can be of better microbiological quality the wane affected from untreated household wells, when rain falls after along dry period. However any nun water collected may carry with it significant amounts of contamination and debris which have accumulated on the roof and in the gutters, it is therefore recommended that the water running off the roof after the first storms should be discarded or used for purpose other than drinking (WHO.1997).

Surface runoff or over land flow it the portion of the rain which is not absorbed by the soil and does not accumulate on the surface but runs while the soil is saturated with water (Hill, 1971). The quantity of runoff depends upon a large number of factors, the most important of which are the amount and intensity of rainfall, the climate, vegetation, the geology and geography of the area. (WHO, 1992).

Rain water harvested with the help of ground catchments will always be polluted by bird droppings, by windblown dust and when left unprotected also by the excrements of animals. (Reid, 1982).

Ground water

Ground water is the water that is found below the surface of the earth, where it occupies all or part of void spaces in geological layers. It is also called subsurface water to distinguish it from surface water, (Encyclopaedia, 1974). It is that portion of the atmospheric precipitation mostly rainfall, which has percolated into the earth to form underground deposits called aquifers (water-bearing formations) .(WHO,1997). Most ground water comes from precipitation, precipitation in filtrates below the ground surface into the soil zone, when the soil zone becomes saturated water percolates down ward.(Encyclopaedia, 1993) It is often sustained and its position determined by the rate of percolation of precipitation or irrigation water through the unsaturated zone. (Hillel, 1971).

Ground water quality is of concern essentially with the various constituents found in water and their relations to water use. In addition, ground water quality data gives important clues to the geological history of rocks and indications of ground water recharge, discharge, movement, and storage(Walton, 1970). The natural quality of ground water varies substantially from place to place (Fetter, 1988)

One form of ground water pollution is chemical pollution, a variety of pollutants from the ground surface or near surface down to underground water occurs continuously from a variety of sources rarely considered and almost never controlled, these sources include (Jewell., and Swan, 1975).

Ground water is normally preferable to surface water because it is purified by the filtering action of the soil through which it flows (WHO, 1993).

Most of it is free of pathogenic organisms and pathogenic bacteria, generally it may be used without further treatment, it is available in many areas, it plays a vital role in the development of arid and semiarid zones, sometimes supporting vast agricultural and industrial enterprises, it is often most practical and economical to obtain and distribute. As some groundwater dissolves substances from rocks and may contain traces of old seawater, it is often high in mineral content. It usually requires pumping, (WHO, 1993, Encyclopaedia, 1993).

The Wells

The wells are vertical openings excavated or drilled from the ground surface to a water bearing stratum or aquifer, pumping a well lowers the water level in it which in turn forces water to now from the aquifer (Encyclopaedia, 1971).1t is used for the extraction of ground water to fill domestic, municipal, industrial and irrigation needs. it is also used to control salt water intrusion, its function to inject fluids into the ground.(Fetter, 1988).

Often one of the first steps in the improvement of the ground water supply is the improvement of existing wells by well protection from surface drainage around the well and covering of the wells and pumps (Reid, 1982). Open or poorly covered wellheads pose the commonest risk to well water quality since the water may then be contaminated by the use of inappropriate water lifting devices by consumers, the most serious source of pollution is contamination by human and animal waste from latrines. (WHO, 1997).

Surface water

This term encompasses all water on the surface of the continents both flowing and stored, a term commonly used to designate the water flowing in stream channels (Encyclopaedia, 1971). In the broadest sense surface water is all the water on the surface of the earth and thus includes the water in lakes, marshes, glaciers, oceans, large rivers, ponds and the small upland streams which may originate from springs and collect the runoff from the water sheds.(Encyclopaedia, 1971). It originates mostly from rainfall, it is a mixture of surface run off, and ground water, it is not infiltrate or percolate into the ground or return to the atmosphere by evaporation or transpiration from plants. (WHO, 1992, 2002)

The quality of surface water is governed by its content of living organisms and by the amounts of mineral and organic matter which it may have picked up in the course of its formation. As rainfalls through the atmosphere it collects dust and absorbs oxygen and carbon dioxide from the air, while flowing over the ground surface water collects silt and particles of organic matter, some of which will ultimately go into solution, it also picks up more carbon dioxide from the vegetation and microorganisms and bacteria from the top soil and from decaying matter.(WHO, 1992), It is subject to pollution and contamination by pathogenic organisms and by contact with human and animal life and cannot be considered safe and always needs treatment before domestic use. (Reid, 1982; WHO, 1992).

The rivers

Rivers are nourished by precipitation by direct over land runoff through sprtops and seepages or from melt water at the edges of snow fields and glaciers (Encyclopaedia, 1993). It is often considered to consist of a base flow fraction made up of ground water that infiltrates into the channel. In addition to mixing of ground water and runoff the natural factors that influence stream composition include reactions of water with mineral solids in the steam bed and in suspension, reactions among solutes, losses of water by evaporation and by transpiration from plants growing in and near the river, and effects of organic matter and water dwelling biota.(Hem, 1992). All of the rivers have broad flood plains subject to annual inundation by rivers carrying heavy sediment loads (Encyclopaedia, 1993). River water may be easily contaminated by disease carriers and by human and animal wastes should be the necessity for thorough treatment and disinfections in order to make such water fit for human consumption. It is virtually impossible to observe complete sanitary control over the entire watershed, furthermore self-purification processes cannot be depended upon to make river water bacteriologically safe (WHO, 1992).

Water Quality

Water quality refers to the chemical, physical and biological characteristics of water. It involves the process of evaluation of the physical, chemical and biological nature in relation to natural quality, human effects and intended uses, particularly uses which may affect human health and aquatic system. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water. Water quality depends on the local geology and ecosystem, as well as human uses such as use of water bodies as sink (Johnson et al., 1997).

The parameters for water quality are determined by the intended use. Water quality tends to be focus on water that is treating for human consumption, water for industrial use, or in the environment. Water contaminants that may be present in untreated water include microorganisms such as viruses and bacteria; inorganic contaminants such as salts and, metals; organic chemical contaminants from industrial processes and petroleum use; pesticides and herbicides; and radioactive contaminants.

Water Quality Standards have been established to regulate substances that potentially affect human health, environment and aesthetic qualities of water. The World Health Organization (WHO) guideline for Drinking Water Standards, United States Specification for Drinking Water and European Union Specification for Drinking Water are among the recognized water quality standards Dissolved minerals may affect suitability of water for a range of industrial and domestic purposes. The most familiar of these is the presence of ions of calcium and magnesium, which interfere with the cleaning action of soap, and can form hard sulphate and soft carbonate deposits in water heaters or boilers. Hard water may be softened by removing these ions.

Environmental water quality, also called ambient water quality, relates to water bodies such as lakes, rivers, and oceans. Water quality standards for surface waters vary significantly due to different environmental conditions, ecosystems, and intended human uses. Toxic substances and high populations of certain microorganisms can present a health hazard for non-drinking purposes such as irrigation, swimming, fishing, rafting, boating and industrial uses. These conditions may also affect wildlife, which use the water for drinking or as a habitat. Modern water quality laws generally specify protection of fisheries especially endangered species and recreational use (Roosbroeck *et al*., 2006).

physicochemical Parameters of water

Physical Parameters of water

Electrical Conductivity (EC)

The electrical conductance of water is a measure of the ability of the water to conduct electricity. It is also an indirect measure of the presence of ions, such as nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron. These substances conduct electricity because they are negatively or positively charged when dissolved in water. The concentration of dissolved solids, or the conductivity, is affected by the bedrock and soil in the watershed. It is also affected by human influences. For example, agricultural runoff can raise conductivity because of the presence of phosphate and nitrate. It is important to measure the conductivity of water because aquatic organisms require a relatively constant concentration of the major dissolved ions in the water. Levels too high or too low may limit survival, growth or reproduction. (Anhwange et al., 2012).

Electrical conductivity is affected by temperature, it is thus important to report temperature data along with conductivity values. In unpolluted waters, conductance increases by 2 to 3% per degree celsius. The international standard temperature to which conductivity measurements are corrected is 25°C. This measurement is expressed in microsiemens per centimeter (uS/cm) at 25 degrees Celsius. Conductivity values can be used to estimate the total concentration of dissolved solids (commonly referred to as total dissolved solids, or TDS). The desired level of conductivity in drinking water according to the WHO (2004a).

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions. The presence of dissolved solids in water may affect its taste.

Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste. Increases in conductivity indicate increased concentrations of TDS and may be attributed to development activities, leaking septic systems, salt run-off from highways, fertilizers, or other pollutants. Rainwater has less than 100 mg/1

TDS, while streams may contain 100 to 2,000 mg/l TDS. The desired level of TDS for public drinking water is 500 mg/l (EPA, 1997) and 1,000 mg/l (WHO, 2004a).

pH

The pH value of a water source is a measure of its acidity or alkalinity. It is a measurement of the activity of the hydrogen ion, because the hydrogen activity is a good representation of the acidity or alkalinity of water. For drinking water, the WHO guidelines set the pH in the range of 6.5-8.5 (WHO, 2008).

pH, is a measure of the concentration of hydrogen ions in the water or a measure of how acidic or basic it is on a scale of 0 to 14, with 7 being neutral (Talling, 2010). Naturally occurring fresh waters have a pH range between 6.5 and 8.5. The pH of the water is important because it affects the solubility and availability of nutrients, and how they can be utilized by aquatic organisms (Stone *et al*., 2013). Surface water pH can be relatively higher in low discharge waters, since water is rich in solutes characteristic of ground water. The pH value can sensitively indicate variations in water quality and is affected by dissolved substances (WHO, 2006).

Chemical Parameters

Total Alkalinity

Alkalinity is a measure of the presence of bicarbonate, carbonate or hydroxide constituents. Concentrations less than 100 ppm are desirable for domestic water supplies. The recommended range for drinking water is 300 to 400 mg $CaCO_3$/1 (Anon., 2006). A minimum level of alkalinity is desirable because it is considered a "buffer" that prevents large variations in pH. Alkalinity is not detrimental to humans. High alkalinity (above 500 mg$CaCO_3$/1) is usually associated with high pH values, hardness and high dissolved solids and has adverse effects on plumbing systems, especially on hot water systems (water heaters, boilers, heat exchangers, etc.) where excessive, scale reduces the transfer of heat to the water, thereby resulting in greater power consumption and increased costs. Water with low alkalinity (less than 75 mg$CaCO_3$/1), especially some surface waters and rainfall, is subject to changes in pH due to dissolved gasses that may be corrosive to metallic fittings. Due to the presence of bicarbonate ($HCO_3^{\,-}$), carbonate ($CO_3^{\,-2}$) or hydroxide (OH^-). Most of the natural alkalinity in water is due to HCO3 produced by the action of groundwater on or chalk. limestone Alkalinity is usually divided into caustic alkalinity above pH 8.2 and total alkalinity above pH 4.5. Alkalinity can exist down to pH of 4.5 because of the fact that HCO_3 is not completely neutralized until this pH is reached. The amount of alkalinity present is expressed in terms of $CaCO_3$.

Total Hardness

Calcium (Ca) and Magnesium (Mg) salts are largely responsible for the Total Hardness (TH) of water (Aher and Deshpande, 2011). TH is the concentration of multivalent metallic cations in a solution. Bicarbonates and carbonates of Ca and Mg impart temporary hardness, while, sulphates, chlorides and other anions produce permanent hardness (Uchchariya and Saksena, 2012). The sources of Ca and Mg in natural water are various types of rocks, industrial waste and sewage. (Gupta *et al*., 2009). Compounds of Ca become stable when CO_2 is present in water, but Ca concentrations are lowered when $CaCO_3$ precipitates due to rise in water temperature. Mg is formed by weathering of rocks having Mg minerals and from some CO_3 rocks (Gupta *et al*., 2009).

Turbidity and Total Suspended Solids

Turbidity and transparency of water is determined by the concentration and nature of Total Suspended Solids (TSS). TSS contains soluble organic compounds as well as fine particles of organic and inorganic matter (Matta, 2014). TSS and turbidity differs with time based on biological activity in the water system and type of sediments carried by surface run-off. Turbidity highly is influenced by rainfall at a particular point. Turbidity can be related to TSS hence turbidity can be used as an indirect measurement for TSS (Chapman, 1996). Turbidity refers to the quantity of suspended material, which interferes with light penetration in the water column. Higher turbidity can cause temperature and dissolved oxygen stratification in water bodies (Tessema *et al*., 2014). High TSS levels in surface water absorb heat from sunlight, which increases water temperature and decreases levels of dissolved oxygen (Iqbal *et al*., 2010). This results with the water body losing its ability to support aquatic life (Jo-Anne *et al*., 2014).

Chloride

Chlorides occur in most fresh waters, as the salts of sodium or calcium. High chloride content in water sample may be due to the pollution from chloride rich effluent of sewage and municipal waste. Chloride in excess imparts salty taste to water and beverages (WHO, 2011). The chloride concentration can be used as an important parameter for detection of contamination by sewage, prior to other test like biochemical oxygen demand (BOD) and chemical oxygen demand (COD) (Verma *et al*.,2013). A maximum of 250 mg/l of Cl is allowable in surface waters as per EPA 2001.

Nitrates and Total Nitrogen

Nitrates and nitrites are nitrogen-oxygen chemical units which combine with various organic and inorganic compounds. Nitrates (NO_3) are essential source of nitrogen (N) for plants. The greatest use of nitrates is as a fertilizer; nitrates taken into the body are converted to nitrites. Nitrate levels in drinking water can also be an indicator of overall water quality. Elevated nitrate levels may suggest the possible presence of other contaminants such as disease-causing organisms from sewage, pesticides, or other inorganic and organic compounds that could cause health problems.

The US Environmental Protection Agency has set the Maximum Contaminant Level (MCL) of nitrate as nitrogen (NO_3-N) at 10 mg/L (or 10 parts per million) for the safety of drinking water. Nitrate levels at or above this level have been known to cause a potentially fatal blood disorder in infants under six months of age called methemoglobinemia or "blue-baby" syndrome (USEPA, 2012).

Sulphates

Sulphates are naturally present in surface waters as sulphate ions (SO_4^{-2}) Sulphates are formed from the leaching of sulphur compounds, sulphate or sulphide minerals such as gypsum and pyrite (Kipngetich *et al*., 2011). Sulphur is readily soluble in water in its stable and oxidized form. Significant amounts of sulphate are added to surface waters through industrial discharges and atmospheric precipitation (Georgieva *et al*, 2010). In natural waters, SO4 levels should range generally between 2 mg/1 to 80 mg/l, though near industrial discharges they may exceed 1,000 mg/l (WHO, 2006).

Water Pollution

Water pollution is any chemical, physical or biological change in the quality of water bodies such as lakes, rivers, oceans, and groundwater due to the direct or indirect activities of humans. Water pollution (surface and ground) may be considered as a naturally induced change in water quality or conditions induced directly or indirectly by man's numerous activities which renders it unsuitable for food, human health, industry, agriculture or leisure pursuit (Dix, 1981; Cifuentes and Rodriguez, 2005).

With the increasing population, industrialization and urbanization, water pollution by agriculture, municipal and industrial sources has become a major concern for the welfare of mankind. The menace of water borne diseases and epidemics still threatens the well-being of population, particularly in developing countries. Thus, the quality as well as the quantity of clean water supply is of vital importance for the welfare of mankind (Owuna, 2012).

Water Pollution by heavy metals

The most common environmental pollutants in the world are heavy metals (DHHS, 2005a). The presence of heavy metals at trace level and essential elements at elevated concentration causes toxic effects if exposed to human population (Somsundaram, 1984). Heavy metals are non-degradable toxic pollutants of natural water sources. Not only they persist within the environment but they also pose serious risks as far as population health is concerned since they can be accumulated by living organisms (DHHS, 2005b).

Arsenic (As)

Is a known human carcinogen by both the inhalation and oral exposure routes. In humans exposed chronically by the oral route, skin tumors are the most common type of cancer. Ingestion also increases the risk of internal tumors, mainly of bladder and lung, and to a lesser extent, liver, kidney, and prostate (DHHS, 2007a).

Cupper

Is toxic when concentrations exceed that of natural concentrations (<0.05 µmol/L; (Stouthart, 1996; Nussey, 1998). Acute poisoning results from ingestion of excessive amount of Cu salt can lead to nausea, vomiting, stomachache and diarrhea and may produce death. At low concentration, Cu can result in anemia, gastrointestinal (GIT) disturbances, bone development abnormalities and death (Lewis and Lewis, 1971).

Lead

The effects of Pb are the same, whether it enters the body through breathing or swallowing. The main target for Pb toxicity is the nervous system (NS). Long-term exposure of adults to Pb at work has resulted in decreased performance in some tests that measure functions of the NS; may also cause weakness in fingers, wrists, or ankles. Pb exposure also causes small increases in blood pressure, particularly in middle-aged and older people, and may also cause anemia. At high levels of exposure, Pb can severely damage the brain and kidneys and ultimately Pb and Pb- compounds are, reasonably anticipated to be human carcinogens, based on limited evidence from studies in humans and sufficient evidence from animal studies, and the US EPA has determined that lead is a probable human carcinogen (DHHS, 2007a).

Zinc

This element is an essential micro nutrient for plants and animals and is associated with many enzymes and with certain other proteins(Allen, 1989). It is an essential component of a number of enzymes present in animal tissues. It is essential for the normal growth, reproduction, and life expectancy of animals (Harper, et al, 1979). It is essential in plant and animal metabolism but water is not a significant source of this element in a dietary sense (Hem, 1992). It occurs in small amounts in almost all igneous rocks. It is found in virtually all food and potable water in the form of salts or organic complexes. The diet is normally have principal source of it. Although levels of zinc in surface and ground water normally do not exceed 0.01 and 0.05 µg/L respectively, concentrations in tap water can be much higher because of dissolution of it from pipes. Drinking water usually makes a negligible contribution to zinc intake unless high concentrations of it occur as a result of the corrosion of piping and fittings. Drinking water containing zinc at levels above 3 mg/1 may not be acceptable to consumers (WHO, 1993, 1996).

Cobalt

When, too much Co is taken into the body harmful health effects can occur. Serious effects on the lungs, including asthma, pneumonia, and wheezing, been found in people exposed to 0.005 mg Co/m³, while working with hard metal, a cobalt-tungsten carbide alloy (DHHS, 2004b). Cr is carcinogenic to humans. Long-term exposure has been associated with lung cancer in workers exposed to levels in air that in the order of 100 to 1000 higher than usually found in the environment (Finkelman, 2005).

Cadmium

Cadmium (Cd) is a major environmental concern and is ranked as the sixth most important toxic substance (ATSDR, 1997). It is released into the aqueous system from metal plating, smelting, mining, cadmium-nickel batteries, phosphate fertilizers, paint industries, pigments, and alloy industries, as well as from sewage (Kadirvalu and Namasivayam, 2003). The nervous system appears to be the most sensitive target of Cd toxicity. Cd exposure can produce a wide variety of acute and chronic effects in humans, such as renal failure, lung insufficiency, bone lesions, and hypertension (Sun and Li, 2011).

Chromium

Chromium typically occurs in two oxidation states in the natural environment, water treatment processes and water distribution systems: trivalent chromium (chromium³, Cr (III), Cr³), and hexavalent chromium (chromium-6, Cr (VI), Cr). Trivalent chromium has been considered an essential human nutrient. Recent studies, however, have shown no deleterious effects from low Cr (III) in the diet and there is no known biological mechanistic function for Cr (III) in cells calling into questions whether Cr (III) is truly an essential nutrient (Di Bona *et al*. 2011).

Hexavalent chromium has been demonstrated to be a human carcinogen when inhaled. The health effects of hexavalent chromium through ingestion-the dominant exposure route for drinking water are currently under review at the federal level by the U.S. Environmental Protection Agency (USEPA, 2011).

Materials and methods

Location

The study area (Rabak city) occupied the part of south of White Nile State on the eastern bank of the White Nile between longitudes 32.73333°E and latitudes 27_370 and 13.16667°N., at an altitude of 362 meters above sea level, 260 kilometers south of Khartoum.

The main sources of water for different purposes in the study area are the White Nile River, canals, and groundwater. The study area contains many industrial zones, agricultural activities, and urban areas.

Water sampling

Three drinking water samples were collected from White Nile River, Canal and pool (Hafeer) which were resources of drinking water in the study area, according to the following procedures.

The cap of the bottles were carefully removed to prevent contamination of the inner surface. The samples were taken by holding the bottles at the bottom and plunging it about 15 cm below the water surface. The bottles were filled leaving about 25 cm of empty space to allow mixing during laboratory analysis. It was then immediately closed and kept in an ice chest.

Analysis for water samples

Determination of physicochemical parameters

Determination of pH

pH of the water samples were determined by Electrometric method using a pH-meter Hanna Digital (H1991405 Hannan, UK). The pH meter was calibrated by the standard buffer solutions of pH 4, 7 and 9 at 25°C, the electrode was washed thoroughly first with distilled water and then with the sample.. The pH of the samples were measured and the readings recorded.

Electrical Conductivity (EC)

Conductivity of the surface water samples were determined using the standard procedure approved by AOAC (1998). The power key and the conductivity key of the conductivity meter were switched on, and the temperature of the meter adjusted; the instrument was calibrated with 0.001 M KCl to give a value of 14.7ms/m at 25°C. The probe was dipped below the surface of both samples. Time was allowed for the reading to be stabilized and the reading was recorded in µS/cm.

Total dissolved solids (TDS)

100 ml of filtered sample was taken in the previously heated, cooled and weighed evaporating dish. Residue was heated at 103-105°c in hot air oven till all the water evaporated. Final weight of dishes was noted, the final weight was taken after cooling in desiccators. Total dissolved solids were calculated by following formula:

Total dissolved solids mg / 1 = (A - B * 1000 * 1000) / V

A final weight of the dish in gm.

B-initial weight of the dish in gm.

V= Volume of sample taken in ml.

Nitrate

The Nitrate of water was determined by chromotropic acid method.

Prepare nitrate standard in the range of 0.10, 5.0, 10, 25, 40 and 50 ml of standard nitrate solution to 100 ml with Distilled water. If appreciable amount of suspended matter is present, filter suitably. Pipette out 2.0 ml portions of the standard nitrate solutions, samples and a water blank into dry 10 ml volumetric flasks. To each flask, add one drop of ammonium sulphite reagent, place flasks in tray with cold water (10 to 20°c) and add 2 ml of antimony reagent. Move flasks during addition of each reagent for 4 minutes. Add concentrated sulphuric acid to bring volume near the 10 ml mark. Stopper the flasks and mix by inverting each flask four times. Let it stand for 45 minutes at room temperature and adjust volume to 10 ml with concentrated sulphuric acid. Read absorbance at 410 nm between 15 minutes and 24 hours after last volume adjustment. Use nitrate free water in the reference cell of the spectrophotometer.

Calculation

$$\text{Nitrate/Nitrogen(as NO3)mg /L} = \frac{\mu\text{g of nitrate /nitrogen in 10 ml final volume}}{\text{Volumein ml of sample taken for test}}$$

Determination of heavy metals

Sample Preparation by digestion method

Samples were shaken gently; 250 ml of each sample were transferred to 500 ml beaker. 25 ml of conc. HNO3 were added to each sample. these mixture were heated gradually on a hot plate until evaporated to the possible lowest volume before precipitation occurs (25-35 ml), beaker walls was washed down with deionized water and filtrated then transferred to 50 ml volumetric flask and completed to the mark with deionized water, then transferred to cleaned 100 ml polyethylene bottles and storied at room temperature for one day before analysis. The blank samples were prepared in a similar way as the study samples.

Preparation of Standard Solutions

Stock standard solutions which already prepared were used, containing 1000 mg/1 of the element under study. For each element a series of standards were prepared by suitable dilutions of stock solution in concentrations that were expected in the sample solution 1.0, 2.0, 4.0, 6.0, and 8.0mg/ml respectively. The instrumental setting was optimized for each element, from the calibration curve of each element the, concentration of the element under investigation was determined see table (1).

Sample Analysis

Prepared samples were analyzed using an Atomic Absorption Spectrophotometer model Buck 210 VGP-2005-janway USA, for the measurement of (Cd,Cr, and Pb)

In drinking water.

RESULT AND DISCUSSION

Table 1: Physicochemical Parameters of drinking water from different sources.

Parameters	River	Pool	Canal
pH	6.76 ± 0.115^{a}	7.32 ± 0.005^{b}	6.78 ± 0.005^{c}
T.D.S (mg/L)	392.32 ± 0.0^{a}	446.72 ± 0.0^{b}	104.89 ± 0.0^{c}
E.C (µs/cm)	161.3 ± 0.0^{a}	698.0 ± 0.0^{b}	163.9 ± 0.001^{ac}
Nitrate(NO_3)(mg/L)	6.72 ± 0.0^{a}	8.96 ± 0.005^{b}	3.92 ± 0.0^{c}
Cadmium(Cd)(mg/L)	ND	ND	ND
Lead (Pb) (mg/L)	ND	ND	ND
Chromium(Cr)(mg/L)	0.0003	0.0002	ND

Data are presented as mean ±SE

$^{a,\,b}$ and ^{c} value with different superscript in the same row and column are significantly different at ($P \leq 0.05$).

ND= not detectable : no content range of these elements.

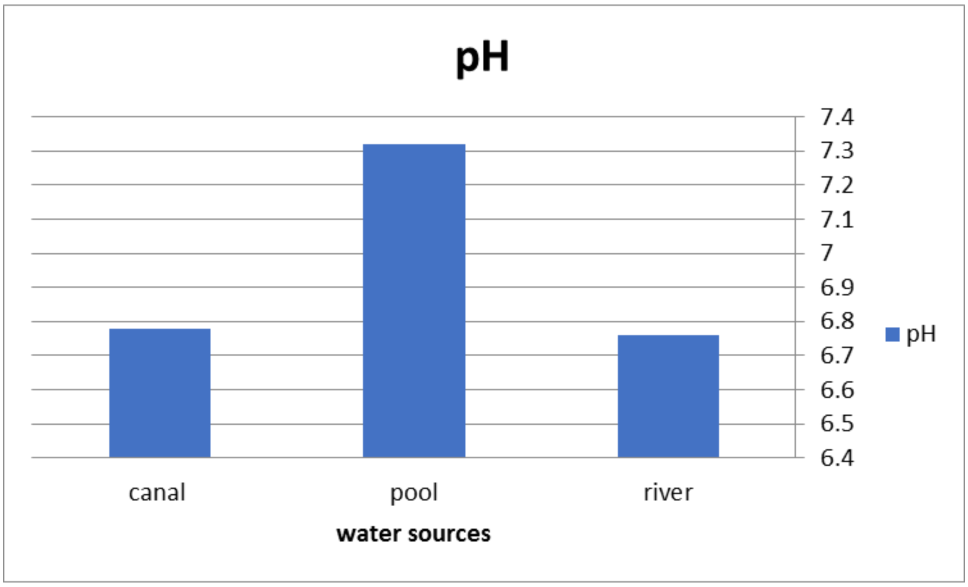

Fig 1: Mean concentration of pH in drinking water sources.

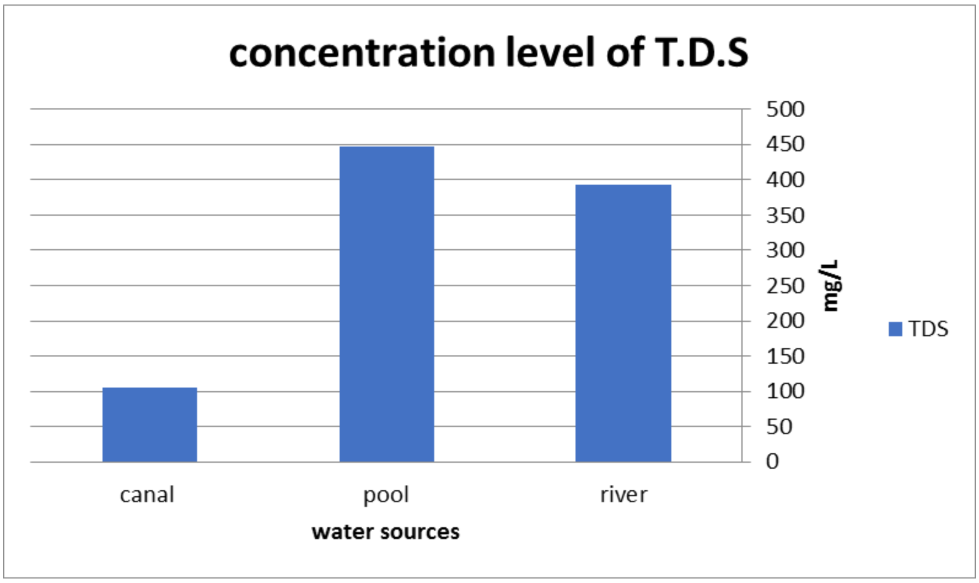

Fig (2) Mean concentration of TDS in drinking water sources

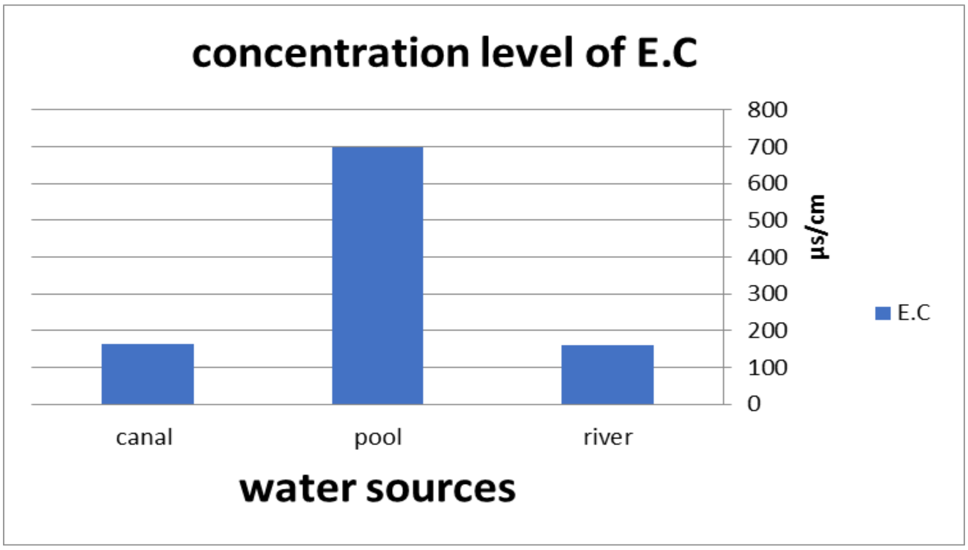

Fig (3) Mean concentration of E.C in drinking water sources

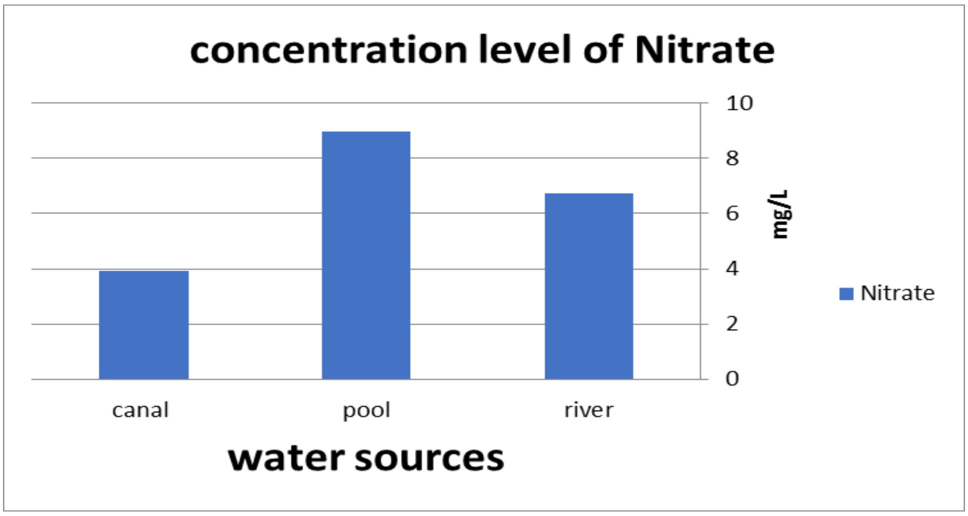

Fig (4) Mean concentration of nitrate in drinking water sources

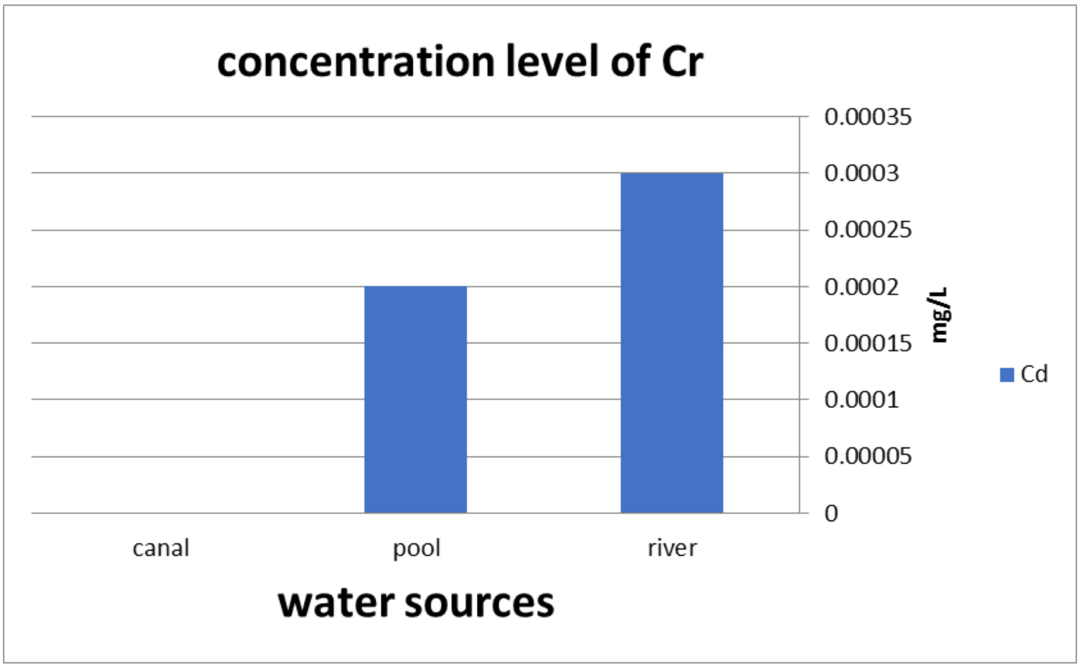

Fig (5): Mean concentration of chromium in drinking water sources.

DISCUSSION

Physicochemical parameters such as pH, TDS, Electrical conductivity, nittute and heavy metals values, has been tested and evaluated, ln accordance with the values of different physiochemical parameters for several drinking water samples (river, pool, and canal).

The pH appear a significant difference between samples, values for all samples from 6.76 ± 0.115, 7.32 ±0.005 and 6.78 ±0.005 (Table 1) for river, pool, and canal respectively, all these value are within the acceptable limit (6.5 to 8.5) of Sudanese standards and as well as that WHO2006).

There is significant difference from the results obtained for TDS which is ranged from 392. 32, 446.72 and 104.89 (mg/L) for river, pool, and canal respectively, the values distributed between high at pool samples and lowest at canal samples table (1) the values of mean is 341.64 mg/L all the values in acceptable limited (1000 mg/L) of Sudanese standard anal as well as that WHO (750 mg/L).

Freshly distilled water has a conductivity of 0.5-2 µS/cm, and this value increases up to about 4 µS/cm due to absorption of carbon dioxide and, to a lesser extent, ammonia from the atmosphere. For surface water, the conductivity is typically within the range 50-1000 µS/cm (Dejlido, and Gerald, 1993). Some industrial waste water may have a conductivity value of several thousand µS/cm (Dojlide, and Gerald. 1993). The recommendation for drinking water quality stipulates maximum allowable value of 1500 µS/cm, whilst the recommended limit for river water for direct abstraction to supply is 1000 µS/cm (Dojlido, and Gerald, 1993). For this study, the conductivity result showed in the range 161.3, 698.0 and 163.9 (us/cm) for river. pool, and canal respectively, all thin values in acceptable limited.

The water samples analyzed for determination heavy metals cadmium, chromium, and lead. The results achieved indicate that the concentration of the elements (cadmium and lead) were mostly below the maximum allowed concentration and cannot be detectable. However, the concentration of chromium detected only in the samples from river, and pool in the range 0.0003 and 0.0002 (mg/L) respectively, in all waters samples were lower, when compared to the Sudanese and WHO values 0.007, ppm. This metals concentration was found to be within the prescribed national and international limit see table (1).

CONCLUSION

The main aim of the this investigation to physicochemical parameters such as pH. TDS, electrical conductivity, nitrate, and heavy metals such as cadmium, chromium, and lead. The result shown that all physicochemical parameter within the permissible values of local and international standards, where the results of heavy metals analysis indicates that concentration was less than detected all waters samples were relatively safe, when compared to the Sudanese and international standard.

Recommendations

The study it could be recommended that:
1. The water station, which are near to residences, must be protected from humans
and animals.
2. Microbial examination of the drinking water should be a routine work.

3. Efforts should be made to minimize heavy metal contamination in aquatic and terrestrial ecosystems to safeguard the biota and the health of their consumers.
4. The public should be educated about the harmful effects of toxic heavy metals and polluted of drinking water on human health and the environment.

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