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THE PHYSIO-CHEMICAL PARAMETERS OF SOUKA RIVER, IN THE FCT, ABUJA

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Abstract: The Physio-Chemical Analysis of Souka River was studied from April to June, 2014. Three sampling stations were selected and analyzed with APHA, (1996) standard method of analysis. The quality evaluation of Souka river in Amac Area Council, FCT Abuja revealed that the water Temperature, Conductivity, Total dissolve solids, and Chloride contents were found mostly within limits set by both National and International standard regulatory bodies for domestic waters usage (SON, 2007; WHO, 1970, 1971, 1979). Few exceptions were observed in the total solids (station three), pH (station two and three) and total hardness which were found to be a little above the set standards in the samples. Therefore, from the foregoing, it could be concluded that Souka River is not physicochemical suitable. Station 1 shows the lowest mean temperature (29.33°c) while the highest mean temperature of (30.0°C) was recorded in station 3. Station one had pH above the lowest limit set by the standard authority. This study revealed that Chloride obtained was in the range of 22.74mg/L in station three to 48.49 mg/l in station two. The hardness in this study ranged between 173.33 to 223.33ppm. And DO obtained was within the range of 1.05 to 1.98mg/L.

Key Words: Souka River; Conductivity; Dissolve Oxygen

INTRODUCTION

Water, after air, is the most essential commodity to the survival of life. Human life depends to a large extent, on water. It is used for an array of activities; chief among these being for drinking, food preparation, as well as for sanitation purposes. Inasmuch as safe drinking water is essential to health, a community lacking a good quality of this commodity will be saddled with a lot of health problems which could otherwise be avoided (Miller, 1997).

Water is a fundamental resource, integral to all environmental and social processes. Access to adequate safe drinking water is of prime importance to many governmental and international organizations since debatably it is the core component of primary health care and a basic component of human development as well as a precondition for man's success to deal with hunger, poverty and death (SOPAC/WHO, 2005). There is a growing concern everywhere that in the coming century, cities will suffer imbalances in quality water supply, consumption, and population. Many regions of the world are already limited by the amount and quality of available water. According to World Health Organization (WHO, 2002), in the next thirty years alone, accessible water is unlikely to increase more than ten percent (10%) but the earth's population is projected to rise by approximately one-third. Unless the efficiency of water use rises, this imbalance will reduce quality water services, reduce the conditions of health of people and deteriorate the environment and the world.

The growing demands for adequate quality water resources create an urgent need to link research with improved water management, better monitoring, assessment, and forecasting of water resources and sanitation issues with much emphasis on the roles of stakeholders (Yamaguchi and Wesselink, 2000). It must however be emphasized that adequate water quality needs seem to have improved greatly in some regions and countries especially in the developed world but for poor nations this is still a major issue (Stockholm International Water Institute, SIWI, 2001). As observed by WHO-UNICEF (2004), while in 2002, countries like Japan, Australia, Austria, Switzerland and Sweden had achieved hundred percent, others, such as countries in sub Saharan Africa which Nigeria is inclusive are far below 50%.

According to Sarpong (2002), the main source of water in these regions (Nigeria) includes untreated rain water from roofs, polluted rivers and streams, unprotected wells and bore holes. Water related health problems are a growing human tragedy, and according to WHO (2003) it kills more than 5 million people a year with infants being the most affected. This figure seems to be the highest as compared to wars and disasters (UNESCO, 2003). The problems also prevent millions of people from leading healthy lives, and undermine developmental efforts by burdening the society with substantial socio-economic costs for treatment of water-borne diseases.

Increase in human population pose a great pressure on provision of quality water in Nigeria (Okonko *et al.*, 2009). Consequently, water borne diseases such as cholera and typhoid often have their outbreak especially during dry season (Banu and

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Menakuru, 2010; Adekunle *et al*., 2004). High prevalence of diarrhea among children and infants can be due to the use of unsafe water and unhygienic practice (Oladipo *et al.,* 2009; Tortora *et al.,* 2002).

Also, water may contain toxic inorganic chemicals which may cause either acute or chronic health effect. Acute effects include nausea, lung irritation, skin rash, vomiting and dizziness, sometime death usually occurs. Chronic effect, like cancer, birth defects, organs damage, disorder of the nervous system and damage to the immune system are usually more common (Erah *et al*., 2002). This problem of lack of quality water is of great significance to some areas of F. C. T Abuja, Nigeria where polluted water, water shortages, and unsanitary living conditions prevail.

Statement of the Problem

Pathogens as well as life threatening chemicals get to pollute the groundwater system through leaching. When such polluted ground water is sourced for human consumption, the health implications can be overwhelming. Poor sanitation practices, such as locating on-site sanitation systems close to these rivers, are a sure contributing factor in the pollution of the ground water system (ARGOSS, 2001). Within these sites there are various improperly managed sanitation systems, many abnormal activities which could possibly contaminate the water in these rivers, activities like fetching water directly with bathing bucket, using the sites as bathing place and washing and many other unhealthy conditions. Thus the possibility of the physical and chemical components of these rivers increasing to a level that it will not be safe for human consumption and usage cannot be overlooked.

Quality of water from such river needs to be checked periodically in order to ascertain whether they are good for human consumption and other domestic use.

It is therefore important to investigate the water quality of the water sourced from the river. This will help ascertain whether or not these rivers are good for human consumption or not and if not the possible way of making them safe.

Physico-chemical characteristics of Warri river in the Niger Delta region of Nigeria was studied by Aghoghovwia in 2008, the results showed that physicochemical parameters differ significantly in respect to locations. Thermal pollution as well as Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), pH and Total Dissolved Solid (TDS) exceeded stipulated permissible limit by EEC and WHO for drinking water and to protect the health of fish. Physical and Chemical Parameters of Lower Ogun River Akomoje, Ogun State, Nigeria was assessed by Adeosun *et al.,* 2011, the Results showed that temperature ranged between 24. 0-30. 70C, transparency (0. 53-1.00m), depth (1. 0-3. 88m), alkalinity (4. 5-14. 5 mg/l), nitrates (0. 235-5. 445 mg/l), electrical conductivity (140-190 µS/cm), dissolved oxygen (4. 12-5. 32 mg/l), phosphates (0. 02 mg/l-0. 75 mg/l) and total dissolved solids (70-95).

Similar studies carried out in different parts of Nigeria (Yerima *et al.,* 2008; Waziri and Ogugbuaja, 2010; Akan *et al.,* 2010; Muazu *et al.,* 2012) and other parts of Africa (Demeke, 2009; Meseret, 2012) revealed that various sources of drinking water have been contaminated at varying scales.

Water Quality

Water quality is a term used to express the suitability of water to sustain various uses or processes (WHO, 1996). Water quality is affected by anthropogenic activities and natural processes. In order to prevent and reduce the problems associated with water, there are national and international standards or guidelines to be followed for water quality suitable for different purposes (drinking, personal hygiene, irrigation, etc.). Components of water quality include microbial or biological, chemical and physical aspects.

Microbial Aspects: Drinking water should be free of all pathogenic microorganisms. It should also not contain bacteria that would indicate excremental pollution, the primary indicator of which are coliform bacteria that are present in the feces of warm blooded animals (Meseret, 2012). By using specified treatment techniques, the microbial quality of drinking water is controlled and the presence of coliform bacteria is monitored (Muazu, *et al,* 2012). Chlorine is the usual disinfectant as it is readily available and inexpensive

Chemical Aspects: chemical contamination of water sources may be due to certain industries and agricultural practices, municipal solid waste, urban runoff or from natural sources. When toxic chemicals are present in drinking water, there is the potential that they may cause either acute or chronic health effects. After exposure of chemicals in drinking water, for extended years rather than months they become of health concern (WHO, 2006). Chronic health effects are more common than acute effects because levels of chemicals in drinking water are seldom high enough to cause acute health effects. There are many evidences that chemical contaminants created adverse human health problems in urban water sheds (EPA, 2005)

Physical Aspects: water for drinking should be free of objectionable taste, odor, color and suspended materials. These are often called aesthetic parameters. Aesthetic parameters are those detectable by the senses, namely: turbidity, color, taste and odor. They are important in monitoring community water supplies because they may cause the water supply to be rejected and alternative (possibly poorer quality) sources to be adopted, and they are simple and inexpensive to monitor qualitatively in the field.

Physical parameters of water include also such parameters as pH, TDs, salinity and hardness. The chemical quality influences also the physical quality. The appearance, taste, odor and feel of water determine what people experience when they drink or use water and how they rate its quality; other physical characteristics can suggest whether corrosion and encrustation are likely to be significant problems in pipes or fittings. The measurable characteristics that determine these largely subjective qualities are: true color (i. e. the color that remains after any suspended particles have been removed), turbidity (the cloudiness caused by fine suspended matter in the Water, hardness (the reduced ability to get a lather using soap), total dissolved salts (TDs), pH, temperature, taste, odor and dissolved oxygen (ADWG, 2006)

Turbidity should always be low, especially where disinfection is practiced. High turbidity can inhibit the effects of disinfection against microorganisms and enable bacterial growth. Drinking water should be colorless, since drinking water coloration maybe due to the presence of color organic matter or minerals. Organic substances also cause water odor, though odors may result from many factors, including biological activity and industrial pollution.

Brief Description of measured water Quality Parameters

The physio-chemical quality characteristics determine its usefulness for different uses. The physio-chemical characteristics are the result of many environmental factors. Before, addressing in situ and laboratory test results, it is thought essential to briefly describe the major water quality variables. Major ions and cations, physical and biological parameters of water samples have been measured in the laboratory.

Physical parameters

Temperature: In physical analysis of water samples, temperature is generally expressed in ^{0}c. It must be measured in situ or immediately after collecting the water sample. Many of the physical and chemical characteristics of waters are directly influenced by temperature. According to WHO (2006) water temperature should not be greater than 15^{0}c for drinking. Cool water is generally more palatable than warm water, and temperature will impact on the acceptability of a number of other inorganic constituents and chemical contaminants that may affect taste. Temperature is a very important property used to distinguish surface water and ground water. In fact the temperature of the surface and sub-surface waters faithfully reflects the climatic conditions of the environment on which they stop or flow. The temperature of ground water, because it is more or less extensively circulates in the subsurface, tends to assume a near constant value, which roughly corresponds to the mean yearly temperature of the same environment.

Hydrogen ion Activity (pH): The effective concentration (activity) of hydrogen ions could be expressed in the same kinds of units as other dissolved species. But H^+ concentration in milligram per liter or moles per liter is very low for water solutions that are not strongly acid. The activity of hydrogen ions can be most conveniently expressed in logarithmic units and the abbreviation pH represents the negative base 10log of the hydrogen ion activity in moles per liter, or pH= -log H+(Hem, 1971). Water with a pH of less than 4-8 or greater than 9. 2 can be harmful to aquatic life. Most freshwater fish prefer water with a pH range between 6-5 and 8. 4(Hem, 1971).

The pH is also a useful indicator of the chemical balance in water. A high or low pH will adversely affect the availability of certain chemicals or nutrients in the water for use by plants. Acidic waters (those with a low pH) and buffered aggressive waters may also indirectly affect aesthetic quality by promoting corrosion of metal and cement reticulation system pipes and tanks, (Stumm and Morgan, 1981).

pH usually has no direct impact on consumers, but it is one of the most important operational water quality parameters, which is used to get effective treatment, satisfactory clarification and disinfection. The pH of the water entering the distribution system must be controlled to minimize the corrosion of water mains and pipes in household water systems. Alkalinity and calcium management also contribute to the stability of water and control its aggressiveness to pipes and appliance. Failure to minimize corrosion can result in the contamination of drinking water and in adverse effects on its taste and appearance.

The most groundwater has pH value ranging from around 6 to 8. 5 but water having lower pH is not uncommon in thermal springs. River water in areas not influenced by pollution generally has a pH between 6. 5 and 8. 5. pH 7 is said to be neutral: if it is above 7 it is said to be alkaline and if it is less than 7 it is acid. The acidity of natural waters depends on the occurrence of several acidic compounds which may be dissolved and more or less dissociated in the water, as carbonic acid (H_2CO_3), sulphuric acid (H_2SO_4), nitric acid (HNO_3) sulphuric acid (H_2S), hydrochloric acid (HCl) etc. Very acidic waters are named as aggressive waters because of their capacity to itch metallic substances and to accelerate weathering process of rocks. The alkalinity of natural water depends on the total concentration of carbonates, bicarbonates, alkaline and alkaline - earth hydrates which are present in the water sample.

Electrical conductivity (EC): Electrical conductance or conductivity is the ability of a substance to conduct electric current. Specific electrical conductance is the conductivity of a body of unit length and unit cross -section at a specified temperature often expressed in micro Siemens per centimeter (s/cm). Pure liquid water has a very low conductance a few hundredths of micro Siemens per centimeter at 25c. The presence of charged ionic species in solution makes the solution conductive. As ion concentrations increases conductance of the solution increases: Therefore, the conductance measurements provides an indication of ion concentration. Specific electrical conductance of a solution increases as the temperature increases. However, the conductance value to temperature changes is somewhat different for different salts and different concentrations. There is a strong correlation between total dissolved solids and specific conductance. According to Hem (1971) the concentration of dissolved salts can be estimated on the basis of electrical conductivity measurements using the following formula TDs=A. Ec.

Where EC is Electrical conductance in micro Siemens per centimeter. TDs is total dissolved solids in mg/L and A is a conversion factor.

For analysis of natural water the range of A is from 0. 54 to 0. 96(Hem, 1971). For most groundwater the specific conductance multiplied by a factor of 0. 55 to 0. 75 gives reasonable estimates of the dissolved solids. The multiplication factor for saline water is usually higher than 0. 75 and for acidic water it may be much lower.

Turbidity and other Related Parameters -There are also other physical parameters that have to be considered in water quality assessment for specific use. These include turbidity, color, test and odor. Turbidity is very important because it affects both the acceptability of water to consumers, and the selection and efficiency of treatment processes, particularly the efficiency of disinfection with chlorine it exerts a chlorine demand and protects microorganisms and may also stimulate the growth of bacteria. Turbidity is a measure of suspended and colloidal matter in water, such as clay, silt, organic matter and microscopic organisms. The more particles suspended in a sample of water, the more difficult it is for light to travel through it and the higher the waters turbidity or murkiness. Although the suspended particles that reduce clarity can include organic particles (microbes, algae and plant particles and animal detritus) as well as inorganic particles (silt and clay particles) oxygen levels decrease in turbid waters as they become warmer as the result of heat absorption from the sunlight by the suspended particles and with decreased light penetration resulting in decreased photosynthesis (Stumm and Morgan,(1981) in general surface waters are more turbid than ground waters.

Pure water has no color. Color of water is attained due to the existence of mineral organic matter in solution. Taste and odor comes from bacteria, mineral matter and chemical substances, from corrosion or as a result of water treatment (chlorination).

Alkalinity -Alkalinity of water is a measure of its capacity to neutralize acids without significant change in pH. It is caused by the presence of hydroxides, carbonates and bicarbonates (Hem 1971). Presence of carbonates and bicarbonates in water is an interchangeable process, and depends on the pH value of water. At lower values of pH, the carbonates change to bicarbonate. So much so, that at pH less than 8. 3, only bicarbonates are found to occur, since all the carbonates are converted into bicarbonates by the action of Co2 and H20 (Garg, 2008).

Alkalinity is determined by measuring the amount of acid needed to lower the pH in a water sample to a specific end point. The results are usually reported in milligrams caco3 per liter (Weiner and Mathews, 2003). Poorly buffered water may have alkalinities lower than 40mg caco3/L while water sampled from a stream flowing through a limestone region may have alkalinities greater than 200mg caco3/L (Weiner and Mathews, 2003).

Relationship of Environmental factors and Water Composition

There are many natural and man-made factors that influence the composition of natural waters. According to Tenakem and Tamiru (2001) the major factors are the following. Climate -The processes of rock weathering are strongly influenced by Temperature and by amount and distribution of precipitation. Climate patterns tend to produce characteristic plant communities and soil types, and the composition of water of stream draining such areas could be thought of as a product of the ecologic balance.

Certain of the major ionic constituents of natural water are influenced more strongly than others by climate effects. Bicarbonate, for example, tends to predominate in water in areas where vegetation grows abundantly. Biochemical factors -life forms and the chemical processes affect the chemistry of water in many ways. In many cases the study of natural water composition involves concepts of ecology, because a large number of factors and processes are interrelated in bringing about the composition of the water.

The hydrologic cycle -A characteristic property of the free water of the earth is its continual motion, imparted primarily by the input of radiant energy. According to Freeze and Cherry (1979) evaporation and precipitation significantly affect the total ionic concentration of natural waters. Sources of solutes in the atmosphere -Different substances enter into surface and ground water systems from precipitation recharge. These includes different types of gases (S02, NH3, N20, N02, HCL, Co, Co2) produced by burning of fuels, by metallurgical processes and by other anthropogenic activities, and also by biochemical processes in soil and water and by volcanic or geothermal activity. Naturally occurring atmospheric particulate matter consists of terrestrial dust carried aloft by wind or propelled upward by volcanic eruptions and of sodium chloride or other salts picked up as a result of wind agitation of the ocean surface (Hem, 1971).

Influence of humans-A major impact of the environmental factors influencing the composition of water comes from human activities. Solutes may be directly added to water by disposal of wastes or may be directly removed in water treatment or recovery of minerals. The ecology of whole drainage basins may be profoundly affected by bringing forested land into cultivated agriculture. Application of fertilizers, diversion of water courses, urban waste disposal, industrial wastes, mining activities etc. affect the chemistry of water in many ways.

Causes of water Quality Deterioration

The quality of water is influenced by different natural processes and anthropogenic activities. Most of water quality deterioration comes from anthropogenic sources that cause pollution of ground water and surface water. Pollution is an alteration of physical, chemical, bacteriological, or radiological properties of water that result in an impairment of designated uses.

Pollution, in certain circumstances can be caused by nature itself, such as when water flows through soils with high acidities. But more often human actions are responsible for the pollutants that enter the water. Some of these are also common pollutants in Souka area.

1. Biodegradable waste which consists of mainly human and animal wastes are the major pollutants. When biodegradable waste enters a water supply, the waste provides an energy source (organic carbon) for bacteria. If there is a large supply of organic matter in the water, oxygen -consuming (aerobic) bacteria multiply quickly, consume all available oxygen and kill all aquatic life.
2. Nutrients such as phosphate and nitrates, enter the water through sewage, and livestock and fertilizer runoff. Phosphates and nitrates are also found in industrial wastes. Though these chemicals are natural, 80 percent of nitrates and 75 percent of phosphates in water are human added. When there is too much nitrogen or phosphorus in a water supply (0. 3parts per million for nitrogen and 0. 01 parts per million for phosphorus), algae begin to develop. When algae blooms, the water can turn green and cloudy, feel slimy and smell bad.
3. Heat can be a source of pollution in water. As the water temperature increases the amount of dissolved oxygen decreases. Thermal pollution can be natural, in the case of hot springs and shallow ponds in the summer time, or human made through the discharge of water that has been used to cool power plants or other industrial equipment. Fish and plants require certain temperatures and oxygen levels to survive, so thermal pollution often reduces the aquatic life diversity in the water.
4. Sediment is one of the most common sources of water pollution. Sediment consists of mineral or organic solid matter that is washed or blown from land into water sources. Sediment pollution is difficult to identify, because it comes from non-point sources, such as construction, agricultural and livestock operations, logging, flooding and city runoff. Sediment can cause large problems, as it can clog municipal water systems, smother aquatic life and cause water to become increasingly turbid. And turbid water can cause thermal pollution, because cloudy water absorbs more solar radiation.
5. Hazardous and toxic chemicals are usually human made materials that are not used or disposed of properly. Point sources of chemical pollution include industrial discharges and oil spills. Non-point sources of chemical pollution include runoff from paved roads and pesticide runoff. Many people think industries produce the greatest amount of chemical pollution, but domestic and personal use of chemicals can significantly contribute to chemical pollution. Household

cleansers, dyes, paints and solvents are also toxic, and can accumulate when poured down drains or flushed down the toilet. Infact, one drop of used motor oil can pollute 25 liters of water.

6. Radioactive pollutants that include waste water discharges from factories, hospitals and uranium mines. These pollutants can also come from natural isotopes, such as radon. Generally, the pollution of water comes from two main sources: point sources and non-point sources. Point sources include factories, waste water treatment facilities, septic systems and other sources that are clearly discharging pollutants into water sources. Non-point sources are more difficult to identify, because they cannot be traced back to a particular location. Non-point sources include runoff including sediment, fertilizer, chemicals and animal waste from farms, fields, construction sites and mines. Landfills can also be a non-point source of pollution. If substances leach from the landfill into water supplies.

Water Treatment

The objective of municipal water treatment is to provide a potable supply which is chemically and microbiologically safe for human consumption. To fulfill the quality treatment of water for intended use, treatment is necessary. Treatment techniques are prescribed physical and /or chemical processes to ensure the removal of microorganisms or contaminants that are health risk (Mustapha, 2008)

Continuous supply of water that meets drinking water standards needs various treatment processes, in order to get rid off chemicals, organic substances or microorganisms which could affect human health. This is because the source of most urban community's water is collected from natural water body that may not be suitable for drinking. The water is then delivered to the community through a network of mains and pipes or distribution systems (CRC, 2008).

Before releasing the water for use through the distribution system, the raw water is treated. There are different methods of water treatment processes depending on the source of water and the desired water quality. Screening, coagulation /flocculation, sedimentation, filtration and disinfection are the main unit operations used in the treatment of surface water. Water treatment operations have one or more three key tasks: removal of particulate substances such as sand and clay, organic matter, bacteria and algae; removal of dissolved substances such as those causing colour and hardness; removal or destruction of pathogenic bacteria and viruses (Glynn and Gary, 2004).

Water Hardness

Water Hardness is similar to alkalinity but represents different measurements. Hardness is chiefly a measure of calcium and magnesium, but other ions such as aluminum, iron, manganese, strontium, zinc and hydrogen ions are also included when the hardness level is equal to the combined carbonate, bicarbonate alkalinity, it is referred to as carbonate hardness. Hardness values greater than the sum of the carbonate and bicarbonate alkalinity are referred to as non-carbonate hardness. Hardness value of at least 20ppm should be maintained for optimum growth of aquatic organism. Low hardness level can be increased with the addition of ground agriculture lime.

Dissolved Oxygen

Dissolved oxygen (DO) is by far the most important chemical parameter in aquaculture or fish farming low dissolve oxygen levels are responsible for more fish kills, either directly or indirectly than all other problems combined like humans; fish require oxygen for respiration.

The amount of oxygen consumed by the fish is a function of its size, feeding rate, activity level and temperature, small fish consume more oxygen than large fish because of their metabolic rate. Meade (1974) determined that the oxygen consumption of salmon reared at 57°F was 0. 002 pounds per ponds of fish per day. Lewis. (2000) determined that striped bass raised at 77°F consumed 0. 012-0. 0. 020 pounds per pond fish per day, the higher oxygen requirement by striped bass may be attributed to the statement that the metabolic rate double for each 18°F increase in temperature. The amount of oxygen that can be dissolved in water decreases at higher temperature and decreases with increase in altitudes and salinities.

In combining this relationship of decreased solubility with increasing temperature, it can be seen why oxygen depletion are so common in the dry season when higher water temperature occur. Fish farmers in an attempt to maximize production stock great amount of fish in a given body of water than found in nature. At times during dry season it may be necessary to supply supplemental aeration to maintain adequate level of dissolved oxygen, whereas in recirculation system the farmers must supply 100 percent of the oxygen needed for cultured at optimum levels of dissolve d oxygen. A good rule of thumb is to maintain dissolved oxygen level at saturation or at least 5ppm. Dissolved oxygen levels less than 55ppm can place undue stress on the fish, and levels less than 2ppm will result in death (possibly 33ppm for hybrid striped bass and yellow perch). Some warm water species such as Tilapia and carp are better adapted to with stand occasional low DO levels while most cool water species cannot.

Total Solid (TS), Total Dissolved Solid (TDS) and Total Suspended Solid (TSS) in mgl^{-1}

Total solids of the study station ranged from (180-290) mg/l with a mean of 234mg/l, Total dissolved solids indicate the salinity behavior of water, presence of solid particles in water indicate contamination (Goel, 2006). Nwosu and Ogueke (2004), observed that presence of TDS may be as a result of poor filtration method. Total dissolved solids ranged from (120-190)mg/l with a mean value of 151mg/l and Total Suspended Solid ranged from (50-110)mg/l with a man value of 83mg/l. the values all fell below NAFDAC, SON and WHO permissible limits (table 4. 5). In this study there exist a strong positive correlation between Total dissolved solids and the Total solids and permanent hardness, the Total solids hard strong positive correlation with permanent hardness and Total Suspended Solid hard significant correlation with permanent hardness, Total solids and Total dissolved solids (Table 4. 4).

MATERIALS AND METHODS

Souka is a small village found along Airport-Lugbe road in the Amac Area Council, FCT Abuja. Abuja is located in the center of Nigeria with a land area of 8,000 square kilometers. It lies between the latitude of 8° 25 and 9° 25N and longitude 6°45 and 7°45E. It is bounded to the North by Kaduna and Niger State to the South by Kogi state, to the East by Nasarawa State and to the west by Niger state (F. C. D. A, 2006). From its central location, its vegetation combines the savannah grassland type of the north and middle belt with the tropical rain forest type of the south of Nigeria. The overall effect of this is that Abuja has rich soil for agricultural cultivation and enjoys an equable climate that is neither too hot (35°C) nor too cold (22°C) all year round (F. C. D. A., 1979). Meteorological records have shown that rainfall start as late as April in some years and peak between August and September, annual rainfall of about 1000-1600m have been recorded in F. C. T. dry season begins in November and last till March. The season months of December and January are usually cold and dry due to the influence of the North- East winds which usher in the harmattan. There are two main seasons in F. C. T. These are the dry and wet seasons. The wet season begins toward the end of March and ends towards the end of October.

Sample Collection

Water samples were collected in duplicate from each of the three sampling stations in the study site using oxygen and Biological Oxygen Demand (BOD) bottles and plastic bottles of 1L. Each bottle was dipped 5cm below the water level at designated sites. Prior to sample collection, all the sampling bottles were thoroughly washed, sun-dried and rinsed with the same water to be collected in the river. The sampling bottles were labeled with dates and collection sites. Until analysis, the collected water samples were kept in a cool container.

Laboratory Analysis

Procedure for Temperature Determination

Both Atmospheric and Water Temperature was measured using Mercury thermometer and noted in °C.

Procedure for Electrical Conductivity Determination

A Hatch conductivity meter 4600 was used to determine the conductivity of the samples. An electrode connected to a meter was immersed into the sample of water so that the water covered a sensitized electrode. Values on the display kept varying until a stabilized value was obtained and recorded.

Procedure for pH Determination (Electrometric method)

The pH of water sample was measured by electronic portable pH meter. The pH meter was calibrated with phosphate buffer of known pH. It uses electrodes that are free from interference. At constant temperature, a pH change produces a corresponding change in the electrical property of the solution. This change was read by the electrode and the accuracy was the greatest in the middle pH ranges.

Procedure for Dissolved Oxygen (DO) Determination (Winkler's method)

For the estimation of Dissolved Oxygen the water samples were collected with care in BOD bottles without bubble formation. The DO was then fixed at the station itself by adding 1 ml each of Manganese Sulphate (MnSO4) and Alkali-iodate azide (KI) reagents and brought to the laboratory. The precipitates formed were dissolved by adding 2 ml. of concentrated Sulphuric acid (H2SO4). 100ml sample was taken from this and titrated against 0. 1N Sodium thiosulphate. Starch is used as an indicator to estimate iodine generated and the end point is noted as the solution turns from blue to colorless (APHA, 1998). The DO is calculated using following formula,

$$\text{DO mg/l} = \frac{\mathbf{B_1R_1 \times N \times 1000}}{\textbf{Amount of sample taken (ml)}}$$

Where, B. R. = Burette Reading (Amount of titrant used). N = Normality of Sodium thiosulphate

Procedure for Total Hardness Determination (EDTA Titrimetric Method)

For the estimation of total hardness, in 50 ml. of sample, 1 to 2 ml of buffer solution and a pinch of Eriochrome Black-T (used as an indicator) were added. After the appearance of wine red colour, the mixture was titrated against 0. 01M EDTA stirring continuously till end point change of wine red to blue is achieved (APHA, 1998). The total hardness is calculated using following formula.

$$\text{Total hardness expressed as mg } CaCO_3/l = \frac{A \times N \times 1000}{\text{Amount of sample taken (ml)}}$$

Where A = ml of titrant (EDTA) used.
N = Normality of EDTA

Chlorides (Cl^-) (Argentometric Titre metric method, (APHA, 1998)

In 100 ml. of sample, 1 ml. of K_2CrO_4 indicator was added and titrated against 0. 02N $AgNO_3$ till brick red precipitates were formed. The formula used to calculate mg. of Cl-/l is as follows:

$$\text{mg. of } Cl^-/l = \frac{B.\ R. \times N \times 35.\ 45 \times 1000}{\text{volume of sample}}$$

Where, B. R. = Burette reading (Amount of titrant used).
N = Normality of Silver Nitrate.
35. 45 = Equivalent weight of Chloride.

Determination of Total Solid (T. S)

Procedure: Empty beaker was initially weighed, 50ml of the water sample was measured and poured into the weighed beaker and heated gently to dryness at about 70°c, then it was cooled and reweighed. The process was repeated until a constant mass was obtained and the value noted.

$$\text{Total solids in mg/l} = \frac{(A-B) \times 1000}{V}$$

Where, A = Final weight of the dish in gm.
B = Initial weight of the dish in gm.
V = Volume of sample taken in ml.

Determination of Dissolved Solids

Procedure: empty beaker was weighed; 50mls of the water sample was measured and filtered into the beaker. The filtrate was heated to dryness, cooled and reweighed with the beaker, until a constant mass is obtained and the value was recorded.

$$\text{Total solids in mg/l} = \frac{(A-B) \times 1000}{V}$$

Where, A = Final weight of the dish in gm.
B = Initial weight of the dish in gm.
V = Volume of sample taken in ml.

Statistical Analysis

The Statistical Package for Social Scientists (SPPS) version 13. 0 for windows was used for analyzing data in the various statistical relationships between experimental variables (SPSS Data Assess Pack, 2004).

RESULTS

Tables 1 to 3 shows the physio–chemical parameters of the water samples from each of the three sampling stations investigated. Atmospheric temperature in the three sampling stations ranged from 26-27°c with a mean of 26. 67, 26. 33 and 26. 33°c in station one, two and three respectively. The water temperature also varied slightly between the sampling stations, in station one it range from 29-30°c with a mean and standard deviation of 29. 33±0. 58°c, water temperature in station two also had the same range as in station one but with a mean and standard deviation of 29. 67 ±0. 58°c and in station three uniform temperature was maintained throughout the study period at 30°c, one-way analysis of variance (ANOVA) showed that there is no significant difference between the water temperature of the three stations ($p>0.\ 05$, $p = 0.\ 296$). The pH value of Station one ranged from acidic to slightly alkaline (6. 50 to 7. 60) and the mean pH values is 7. 13±0. 57. The pH value for Station two ranged from 6. 20 - 6. 30 and the mean is 6. 23 ± 0. 06. The pH value of Station three ranged from 6. 20 - 6. 35 and the mean pH values is 6. 25±0. 08, one-way analysis of variance (ANOVA) showed that there is a significant difference between the pH of the three stations ($p<0.\ 05$, $p = 0.\ 026$).

The electrical conductivity (EC) of station one samples ranged between 188. 00 and 195. 00 μS/cm with a mean and standard deviation of 192. 00 ± 3. 61. The electrical conductivity (EC) of station two samples ranged between 178. 00 and 180. 00μS/cm with a mean and standard deviation of 179. 00 ± 1. 00. The electrical conductivity (EC) of station three samples ranged between 176. 00 and 183. 00μS/cm with a mean and standard deviation of 179. 33 ±3. 51, one-way analysis of variance (ANOVA) showed that there is a significant difference between the electrical conductivity of the three stations ($p<0.\ 05$, $p = 0.\ 003$). The total solids (TS) and the total dissolved solids (TDS) of station one ranged from (200-400) and (150-180) with mean values of 316. 67 and 163. 33mg/L respectively. The total solids (TS) and the total dissolved solids (TDS) of station two ranged from (300-380) and (120-200) with mean values of 340 and 166. 67mg/L respectively. The total solids (TS) and the total dissolved solids (TDS) of station they ranged from (500-520) and (240-260) with mean values of 510 and 250mg/L respectively, one-way analysis of variance (ANOVA) showed that there is a significant difference between the total solid and total dissolved solid of the three stations (p<0. 05, p = 0. 020; 0. 011). The concentrations for Chloride ranged between 17. 99 and 26. 99mg/L with mean of 24. 24 ±4. 19 in station one and in station two the concentrations for Chloride ranged between 19. 99 and 87. 97mg/L with mean of 48. 49 ±28. 89mg/L and station three chloride ranged from 19. 99 - 25. 99 with a mean of 22. 74 ±2. 75mg/L. the total hardness ranges from 140-200ppm with a mean of 173. 33ppm in station one. Hardness in station two ranges from 180-240 with a mean of 213. 33 and in station three it ranged from 200-250 with a mean 223. 33ppm. one-way analysis of variance (ANOVA) showed that there is no significant difference between the total hardness of the three stations (p>0. 05, p = 0. 161). The dissolved oxygen for station one were found within the range of 0. 95 to 1. 20 mg/L for station two it ranged from 1. 93 to 2. 10 and in station three it ranged from 1. 70-2. 18mg/L. one-way analysis of variance (ANOVA) showed that there is a significant difference between the dissolved oxygen of the three stations (p<0. 05, p = 0. 001). Figure 2: shows the comparison between the values of total solid, dissolved solid, electrical conductivity and total hardness in the three sampling station and the standard set by WHO and NAFDAC. Figure 3: shows the comparison between the values of water temperature, pH, dissolved oxygen and chloride in the three sampling station and the standard set by WHO and NAFDAC.

Table 1: Shows the Descriptive statistics of the physicochemical properties of Station one

	Minimum	Maximum	Mean	±Std. Deviation
Atmospheric Temperature (oc)	26. 00	27. 00	26. 67	0. 58
Water Temperature (oc)	29. 00	30. 00	29. 33	±0. 58
Electrical Conductivity (σ)	188. 00	195. 00	192. 00	±3. 61
pH	6. 50	7. 60	7. 13	±0. 57
Dissolved Oxygen (mg/l)	0. 95	1. 20	1. 05	±0. 13
Chloride (mg/L)	17. 99	26. 99	24. 24	±4. 19
Total Solid (mg/L)	200. 00	400. 00	316. 67	±104. 08
Total Dissolved solid (ppm)	150. 00	180. 00	163. 33	±15. 28
Total Hardness (mg $CaCO_3$/l)	140. 00	200. 00	173. 33	±30. 55

Table 2: Shows the Descriptive statistics of the physicochemical properties of Station two.

	Minimum	Maximum	Mean	±Std. Deviation
Atmospheric Temperature (°c)	26	27	26. 33	±0. 577
Water Temperature (°c)	29. 0	30. 0	29. 67	±0. 58
Electrical Conductivity (σ)	178. 00	180. 00	179. 00	±1. 00
pH	6. 20	6. 30	6. 23	±0. 06
Dissolved Oxygen (mg/l)	1. 93	2. 10	1. 98	±0. 10
Chloride (mg/L)	19. 99	87. 97	48. 49	±28. 89
Total Solid (mg/L)	300. 00	380. 00	340. 00	±40. 00
Total Dissolved solid (ppm)	120. 00	200. 00	166. 67	±41. 63
Total Hardness (mg $CaCO_3$/l)	180. 00	240. 00	213. 33	±30. 55

Table 3: Shows the Descriptive statistics of the physicochemical properties of Station three.

	Minimum	Maximum	Mean	±Std. Deviation
Atmospheric Temperature (°c)	26	27	26. 33	±0. 58
Water Temperature (°c)	30. 0	30. 0	30. 00	±0. 00
Electrical Conductivity (σ)	176. 00	183. 00	179. 33	±3. 51
pH	6. 20	6. 35	6. 25	±0. 08
Dissolved Oxygen (mg/l)	1. 70	2. 18	1. 88	±0. 26
Chloride(mg/L)	19. 99	25. 99	22. 74	±2. 75
Total Solid (mg/L)	500. 00	520. 00	510. 00	±10. 00
Total Dissolved solid (ppm)	240. 00	260. 00	250. 00	±10. 00
Total Hardness (mg $CaCO_3$/l)	200. 00	250. 00	223. 33	±25. 17

Table 4: Correlations for Station I.

	Atmospheric Temperature	Water Temperature	Electrical Conductivity	pH	Dissolved Oxygen	Chloride	Total Solid	Total Dissolved solid	Total Hardness
Atmospheric Temperature (°c)	1								
Water Temperature (°c)	0. 50	1							
Electrical Conductivity (σ)	0. 96	0. 72	1						
ph	-0. 25	0. 71	0. 02	1					
Dissolved Oxygen (mg/l)	0. 33	0. 98	0. 58	0. 83	1				
Chloride(mg/L)	-1. 00**	-0. 50	-0. 96	0. 25	-0. 33	1			
Total Solid (mg/L)	0. 97	0. 28	0. 87	-0. 48	0. 09	-0. 97	1		
Total Dissolved solid (ppm)	-0. 95	-0. 19	-0. 82	0. 56	0. 00	0. 95	-0. 99	1	
Total Hardness (mg $CaCO_3$/l)	0. 95	0. 76	0. 99*	0. 08	0. 62	-0. 95	0. 84	-0. 79	1

Table 5: Correlations for Station II.

	Water Temperature	Electrical Conductivity	pH	Dissolved Oxygen	Chloride	Total Solid	Total Dissolved solid	Total Hardness
Atmospheric Temperature (°c)	1							
Water Temperature (°c)	0. 00	1						
Electrical Conductivity (σ)	-1. 00**	0. 00	1					
pH	0. 50	0. 87	-0. 50	1				
Dissolved Oxygen (mg/l)	-0. 97	0. 23	0. 97	-0. 29	1			
Chloride(mg/L)	0. 87	0. 50	-0. 87	0. 87	-0. 73	1		
Total Solid (mg/L)	-0. 69	0. 72	0. 69	0. 28	0. 84	-0. 24	1	
Total Dissolved solid (ppm)	-0. 19	-0. 98	0. 19	-0. 95	-0. 04	-0. 66	-. 058	1

Table 6: Correlations for Station III.

	Water Temperature	Electrical Conductivity	pH	Dissolved Oxygen	Chloride	Total Solid	Total Dissolved solid	Total Hardness
Atmospheric Temperature (°c)	.[a]							
Water Temperature (°c)	.[a]	1						
Electrical Conductivity (σ)	.[a]	-0. 85	1					
pH	.[a]	0. 86	-0. 47	1				
Dissolved Oxygen (mg/l)	.[a]	-0. 66	0. 17	-0. 95	1			
Chloride	.[a]	0. 99	-0. 89	0. 81	-0. 60	1		
Total Solid (mg/L)	.[a]	-0. 43	0. 84	0. 10	-0. 40	-0. 50	1	
Total Dissolved solid (ppm)	.[a]	-0. 98	0. 94	-0. 74	0. 50	-0. 99	0. 60	1

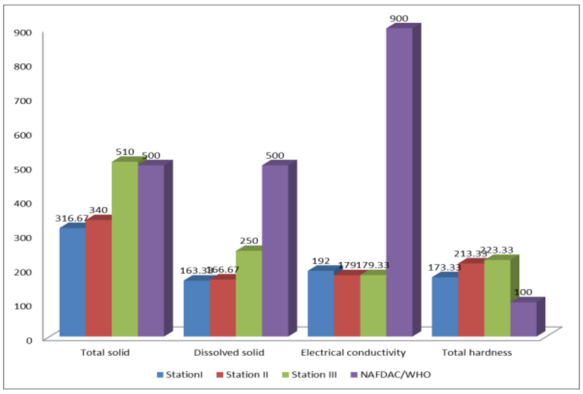

Figure 1: Shows the comparison between the values of total solid, dissolved solid, electrical conductivity and total hardness of the three sampling stations with the standards set by WHO and NAFDAC.

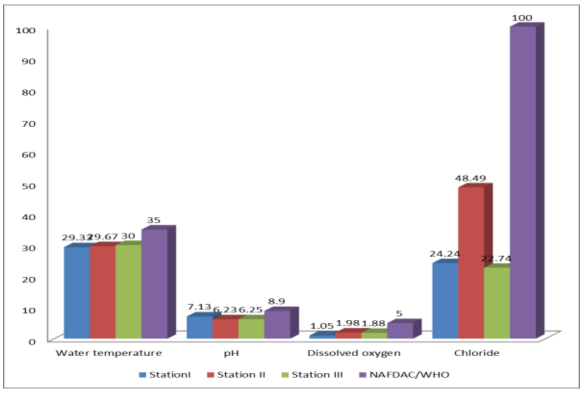

Figure 2: Shows the comparison between the values of water temperature, pH, dissolved oxygen and chloride in the three sampling station with the standard set by WHO and NAFDAC.

DISCUSSION AND CONCLUSION

The results obtained from the analysis of water quality of Souka river showed that some of the measured physical and chemical parameters were below and some were above the permissible limits of World Health Organization (WHO) standards for drinking water. This can be attributed to the fact that there are physical, chemical and biological processes which self-purify and restore streams, lakes, creeks, estuaries, rivers and oceans to their pristine conditions (Ellis *et al.*, 2004), although they are never restored back to their natural conditions thus, some levels of pollution can be observed in this river. These results also indicate that the physico-chemical status of the water is capable of supporting a diverse biota if well monitored and managed. The aesthetics properties of this water are not much in agreement with the stipulations of NAFDAC, SON and WHO, the water was not tasteless, colorless and odorless which makes it not portable and non-drinkable in terms of these properties.

Temperature is an important factor that influences primary production in reservoirs. (Lewis 2000). The result obtained from this study shows that there was no significant difference between the temperatures of the three stations, this similarities in temperature between the three stations could be alluded to the similarity in environmental and climatic conditions. station 1shows the lowest mean temperature (29.33°c) and the highest mean temperature of (30.00°C)was recorded in station 3 The temperature values of these three sampling stations in this study tallies with the recorded values obtained in Oyun reservoir (Mustapha, 2008) and Dankishya and

Chiaha, (2012). These values are below the permissible limit of WHO and NAFDAC.

The result of physicochemical analysis of water shows that the pH of the water samples from station two and three do not comply with standard requirements. Their values are less than the lower limits of the pH (6. 5) recommended by WHO, NAFDAC and NSDWQ, station one had pH above the lowest limit set by the above authority. Even though pH has no direct effect on human health, its indirect action on physiological process cannot be over emphasized (Adekunle et al., 2004; NSDWQ, 2007). These variations may be related to patterns of water use at each sampling station, station one had low contact activities by human followed by station two while station had dense of human activities like bathing, washing of home chores and clothes etc. (Atobatele and Ugwumba, 2008; Oso and Fagbenro, 2008).

Total dissolve solid (TSD) of the water sample from the three sampling stations did not exceed the standard recommended by WHO, NAFDAC and NSDWQ (500 mg/l). The TDS is the term used to describe the inorganic salt and small amount of organic matter present in solution or water. The principal constituents are usually calcium, magnesium, sodium and potassium cation, carbonate, hydrogen carbonate, chloride, Sulphate and nitrate anion (WHO, 1996). The presence of TDS in water may affect its taste (WHO, 1996). It has been reported that drinking water with extremely low concentration of TDS may be unacceptable because of its flat insipid taste (WHO, 1996; Bruvold and Ongerth, 1969). Total dissolved solid concentration, as shown in Fig. 2, was found to be significantly higher ($p<0. 05$) in the water sample from station three when compared with the total dissolved solid concentration in other water samples from both station one and two

Chloride

In present study chloride obtained was in the range of 22. 74mg/L in station three to 48. 49 mg/l in station two. But according to (Trivery and Khatavker, 1986) reported chloride value ranged between 10-25 mg/l in his findings good for fish culture but according to above value, the values which we got in our findings are little more in station two but station one and three are good for aquaculture.

Total hardness

Hard water is water with high mineral content mostly calcium, and magnesium ions. Hardness of water depends on the dissolved solids and pH. Hardness gives a measure of the total concentration of the divalent metallic cations like Calcium, Magnesium and Strontium. Proper liming can rectify the hardness. The ideal value of hardness for fish culture is 30-180ppm (According to Guidelines for Water Quality Management for fish culture in Tripura). The hardness in the present study ranged between 173. 33 to 223. 33ppm. this result does not support guidelines given by Water Quality Management for fish culture in Tripura. But (Wurts and Durbow, 1992) reported hardness ranged between 25-100 mg/l for good fish culture. The value which we got in our findings are more than the above findings of Wurts and Durbow (1992).

Fig. 2 shows no significant difference ($p>0. 05$) in the level of total hardness in the water sample obtained from the sampling stations.

The standards (WHO and NAFDAC) had relatively lower values (100ppm each) of total hardness compared to the test samples. However, when untreated surface and waste water find its way into the water bodies, utilized by man such hard water can lead to dry itchy skin and also influence osmoregulation in fish

Higher conductivity of 192 µs/cm was observed in the water sample collected from station one and lowest obtained in station two (179. 00 µs/cm). Although there is no disease or disorder associated with conductivity of drinking water (NSDWQ, 2007). Conductivity increases as the concentrations of ions in water sample increases. This result serve as an indication of the total dissolved solid content of the water samples in some cases. . .

Dissolved oxygen

Dissolved oxygen is a measure of amount of gaseous oxygen dissolved in an aqueous solution that plays a vital role in the biology of cultured organisms (Dhawan, 2002). Of all the dissolved gases in water, oxygen is the most important for the survival of organism under aquaculture. In present study DO obtained in the range of 1. 05 to 1. 98mg/L. According to Guidelines given by Water Quality Management for fish culture in Tripura, the minimum concentration of DO is 4 mg/l should be maintained in fish ponds at all times. Present study DO values are lower than values set by the guidelines and with those of Saloom and Duncan, (2005) pointed out that the minimum DO should be 5 mg/l for tropical fish.

There was significance difference in the dissolved oxygen concentration of the two stations. The dissolved oxygen of station 2 was slightly higher (1. 98 mg/l) than that of station three (1. 88mg/l). Station two appeared cleaner compared with station three because there were less human activities such as washing, bathing and domestic sewage. This is known to increase the dissolved oxygen of station two. Although the recorded values of dissolved oxygen are lower with the limit for aquatic productivity including fish production as reported by King (1998) and Aguigwo, (1998).

CONCLUSION

The quality evaluation of Souka river in Amac Area Council, FCT Abuja revealed that the water temperature, conductivity, total dissolve solids, and the chloride contents were found mostly within the limits set by both National and International standard regulatory bodies for domestic waters (SON, 2007; WHO, 1970, 1971, 1979).

Few exceptions were observed in the total solids (station three), pH (station two and three) and total hardness which were found to be a little above the set standards in the samples. Therefore, from the foregoing, it could be concluded that Souka river are not physic chemically good for human consumption and aquaculture since not all the physicochemical parameters tested conformed to WHO, SON, and NAFDAC water quality standards, although. It is therefore, observed that the water sources from the studied area have a lot of potentials for wide applications to the people if only they can be subjected to further treatments that will reduce drastically, the concentration of the few identified elements that may pose some danger to health and the society.

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