Determination of Physicochemical Parameters and, Total Coliform Studies of Lake Tila in Hawul Local Government Area of Borno State, Nigeria.

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Abstract

This study was carried out to assess the level of physical and chemical parameters of lake Tila in Hawul Local government area of Borno state, Nigeria. Thus, monitoring these compounds is extremely important to ensure that only permitted levels are consumed. In the present study, three samples each of water, fish and plant were collected from Lake Tila in Hawul Local Government Area of Borno state, Nigeria for physicochemical analysis and total coliform studies The laboratory test of the samples was performed for various physicochemical parameters including pH (8.87 ± 0.41), Temperature (25^0C ± 01.16), Total Dissolved Solids (TDS) (736 ± 0.04mg/L), Dissolved Oxygen (DO) (2.04± 0.05mg/L), Alkalinity (13.30 ± 0.5mg/L), Chloride (150.60 ± 0.47mg/L), and Phosphorus (0.71 ± 0.29mg/L). these values fall within the permissible limits of the world health organization. Culture yielded no bacteria growth (water sample) and no significant bacteria growth (fish sample) after 48hours incubation at 37^0c. The culture media were observed and read with the intention of isolating the bacteria Escherichia coli (E coli), which is the pathogenic indicator. Other parameter such as the specific gravity of the water sample, the pH and turbidity of water were also determined in the laboratory. This shows generally that it is not out of place that the water sample yielded no bacteria growth.

Keywords: **Escherichia, Coli, Bacteria, Temperature, Total Dissolved Solids, Dissolved Oxygen, Alkalinity Chloride**

I. Introduction

Due to increasing population growth, human water demand for domestic, industrial and agricultural purposes to supply adequate food for the nation is increasing (UNDP, 2006) and water becoming a scarce commodity in most part of the world. In the world peoples living under water-stressed condition ranges are from 1.4 billion to 2.1 billion (Arnell *et al.*, 2004). Water-stressed condition refers to per capita water availability below 1,000m3 per year or based on the long-term average annual runoff above 0.4 (World Bank, 1992). The quality of water is highly imperative component to understand the healthiness of a water body and it is a critical factor affecting human health and welfare (Al-Gahwari, 2007). Studies showed that approximately3.1% of deaths (1.7 million) and 3.7% of disability adjusted-life-years (DALYs) (54.2 million) worldwide are attributable to unsafe water, poor sanitation and hygiene (WHO, 2005).Public health and socioeconomic development of an area can be enhanced if there is adequate, accessible and safe water supply.

The availability of potable water plays a key role in the realization of health improvement measures in the community. It is an acceptable fact that water supply contributes to reduce the infancy mortality rates and increase the child's life expectancy. This is as a result of reduction in the incidences of water-related diseases. For some disease, water provides the only transmission route, so that improve supplies are the only way to reduce disease incidences. In addition to health benefits, improved water supply produces high productivity and socioeconomic development (Mustafa *et al.*, 2012).

The principal main sources of water are the surface and groundwater. The surface water includes water from streams, artificial reservoirs, rivers, estuary, direct precipitation, etc. the ground water sources are upland springs, artesian springs, infiltration galleries, shallow or deep wells. A sanitary survey of potential drinking water source for a community is very fundamental in the source selection. Information on the suitability of alternative source based on its quantity, quality (physical, chemical and bacteriological), accessibility, service level, treatment level required, transmission, etc., can only be provided based on the sanitary survey. The fact that water source meet the recommended standard does not give assurance that the source was safe for long time continuous consumption. The presence of large scale industrial complex, agricultural practices that uses pesticides and waste landfills in the watershed of a source may introduce new chemicals in a source at only certain times so that analysis may not reveal their presence whereas survey will (Mustafa *et al*., 2012).

In addition to sanitary survey, physical survey is a key element in sourcing suitable water. The survey includes topographic map of the watershed, the recharge area of the ground water supply, land use and agricultural practices, point and nonpoint source of pollution, soil properties, etc. biological will often reveal presence of species of fish and other biota which can cause pollution in a water source (Mustafa *et al*., 2002).

Physicochemical and biological water quality indicators was affected by various ways. The main causes for the water quality deteriorations are anthropogenic and natural agents. Some of the nature and human induced factors which affect the quality of water for various purposes are geology, hydrology, natural hazards, sedimentation/erosion, agricultural activities, industrial, mining, fishing, sewage discharging/disposal, deforestation, and other commercial activities. These activities aggravate the pollution of water body and greatly influence the quality of water (Tamiru, 2006). Ethiopia is one of the sub-Saharan countries, which is gifted with a variety of aquatic ecosystems, especially a number of lakes that are of great scientific interest and economic importance. Lake Hawassa is the prominent lake and it is affected by pollutants from point sources which are released from industries and service rendering centers and diffuse sources like intensive agriculture on the catchment (Ataro *et al.*, 2003).

II. Materials/ Instruments

The assessment and studies of physical, chemical and total coliform parameters and determination of level of pesticides residue in Lake Tila is the focus of this research. It is meant to assess and evaluate the water environment. This is aimed at ascertaining the quality and concentration of these parameters in the water body

Reagents/Chemicals

Hydchloric acid (HCL), hydrofluoric acid (HF), perchloric acid ($HCLO_4$), deionized water, aquaregia, sodium hydroxide (NaOH), calcium hydroxide ($Ca(OH)_2$), EDTA, nitric acid (HNO_3), sulphuric acid (H_2SO_4) and hydrogen peroxide (H_2O_2),

Water Sampling

Samples which are representatives of the entire water body was collected and examined. Water sample was collected by lowering the pre-cleaned plastic bottles into the bottom of the water body, 3m deep, and allow to over flow before withdrawing the bottles. Since changes occur frequently in water sample, analysis was done immediately after collection. Where analysis may not be done immediately, samples were stored with relevant preservatives depending on the parameter to be determined and duration of the preservation as described by AFHA (Maitera, *et al.*, 2010).

III. Method of Analysis

Physical parameters (pH, DO, TDS, BOD and Temperature) determinations was carried out according to UNEPA (2007). All field equipment was checked and calibrated according to the manufactures specifications. The pH meter was calibrated using buffers pH 4.0, 7.0 and 10.0. Total dissolved solid (TDS) and conductivity meter was calibrated using potassium chloride solution provide by the manufacturer. Dissolved oxygen (DO) meter was also calibrated prior to measurement with the appropriate traceable calibration solution of 5% HCl in accordance with the manufacturers instruction. pH, temperature was measured using pH electrode meter. DO was measured with Jenway model 9070 water proof DO meter while TDS and conductivity was determined by using Col. 50 conductivity meter.

To determine the alkalinity, a known volume of water sample is titrated with a standard solution of strong acid to a pH value in the approximate range of 4 to 5. Titrations can distinguish between three types of alkalinity; carbonate, bicarbonate, and total alkalinity. Carbonate alkalinity is determined by titration of the water sample to the phenolphthalein indicator endpoint, or approximately a pH of 8.3. Total alkalinity is determined by titration of the water sample to the endpoint of the methyl orange indicator, or an approximate pH of 4.5. The difference between the two is the bicarbonate alkalinity (Snoeyinka, *et al*.,).

Phosphorus, Nitrate and Chloride were determined by Semi-Automated Colourimetry, as described by EPA, (1993). Total coliform (*Escherichia coli*) was determined by pour plate technique as described by (Monica, 1993) which is usually the method of choice for counting the number of colony-forming bacteria in the fluid (Kass, *et al.*, 1968). And it enables even distribution of cells throughout the media. It is more precise than the strake plate method (A.A. Van Soestbergen, *et al.*, 1996). The water sample for bacteriological analyses was collected into sterile glass bottles and stored in an ice-box, where the temperature did not exceed 7^0C, until they are taken for analysis. The time between sample collection and performance of chemical and bacteriological analysis usually should not exceed 6-8h (Mudryk, *et al*., 2002) and (Albera *et al*., 2011).

Fish and water sample was obtained from Lake Tila. Sample was collected from surface part of the water and fish sample was collected by using fish hook. All sample collected (water, plant and fish) were stored in an ice-chest and transported to the laboratory for analysis. (Mudryk, *et al.*, 2002).

IV. Results and Discussions

Results of Physicochemical Parameters of Lake Tila

pH of the collected water sample

Table 1: Results for Physicochemical Parameters of Water Sample from Lake Tila

		Concentration			
S/N	Parameter	1st	2nd	3rd	Std. Deviation
1	pH	8.87	9.57	8.17	8.87 ± 0.41
3	Temperature	25^0C	27^0C	25^0C	25^0C ± 1.16
4	Specific conductance	736µS/cm	729 µS/cm	730 µS/cm	736±3.79µS/cm

Table 1 shows the recorded pH value in this study to be 8.87 ± 41. It could be observed that the pH is within the maximum permissible limit (MPL) of WHO standard (6.5 – 9.5 mg/L) for drinking water. Most fishes can tolerate pH of 5.0 to 9.00 (Wahabi, 1999) and agreed by (Bassey 2011). Variation in pH can also be caused by constant change in tuberculation and corrosion which produce incrustation in sediments deposition and difficulties in chlorination for disinfections of water (Oyibo *et al.*, 2009). pH is very important in determining the corrosive nature of water. The lower the pH value, the higher the corrosive nature of water. (Gupta *et al.*, 2009).

Alkalinity

The alkalinity of the Lake at the time of this study was 13.30 ± 0.51 mg/l. (Figure 1). This is also within the maximum permissible limit of WHO, NADAC, SON and FEPA. Alkalinity of water is the measure of the capacity water to neutralize acids. Nebraska2011, in his research obtained this values, (59.25 mg/L to 75.25 mg/L.), which is higher than 13.30 ± 0.51 mg/l, but explain that this may be due to salts of weak acids or strong bases. Bicarbonates represent the measured form of alkalinity which is formed in considerable amount from the action of carbon dioxide upon basic materials in soil and other salts of weak acids. (Asante and Ansa-Asare, *2000*).

Temperature

The temperature of the Lake of this study at this summer is 25^0C± 1.16 as shown in Table 1 the recommended value of temperature in water by WHO FEPA are 40^0C and 26^0C respectively. This also matches the result record of Nebraska (2011), which range from 19 – 28^0C. There is a close relationship between atmospheric temperature and water temperature. Air temperature is one of the most important ecological factors which control the physiological behavior of the aquatic system and distribution other microorganisms.

Specific conductance

Specific conductance of the water sample was measured as 736±3.79µS/cm in this study, as shown in Table 1 while the standard values given by NAFDAC and SON is 1000µS/cm. The result obtained is very close to a result obtained by (Nebraska,2011), (656±556µS/cm). Conductivity shows significant correlation with other parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand, and chloride and iron concentration of water. (Kumar *et al.*, 2010) suggested that the underground drinking water quality of study area can be checked effectively by controlling conductivity of water and this may also be applied to water quality management of other study areas. It is measured with the help of EC meter which measures the resistance offered by the water between two platinized electrodes. The instrument is standardized with known values of conductance observed with standard KCl solution.

Dissolved oxygen

Figure 1shows the measured DO to be 2.04± 0.05mg/L. The result is lower than the standard values given by FEPA and WHO: ≥4and ≥6 respectively. This could be due discharges from agricultural runoff and other sources of organic matter entering the water (Maitera *et al*, 2010). (Swati, 2015) and (Wahabi, 1999) reported low DO in upstream and downstream in rating season than dry season. (Lacenda,2014) reported the average DO levels of 590 Paulo shed region ranged from 0.00 to 5.4 mg/l during wet season and 0.05 to 16.06 mg/l in dry season. DO is one of the most important parameter in assessing water quality and understanding the physical and biological process prevailing in the water. The importance of DO was reported by many researchers because DO in aquatic ecosystem brings out various biochemical changes and it influence on metabolic activities on organisms (Efe *et al.*, 2005).

A good quality water should have the solubility of oxygen ≥4 mg/L at 30 0C. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. (Patil *et al*., 2009). In the progress of summer, dissolved oxygen decreased due to increase in temperature and also due to increased microbial activity. DO in sample is measured titrimetrically by Winkler's method after five days' incubation at 293K. The difference in initial and final DO gives the amount of oxygen consumed by the bacteria during this period. This procedure needs special BOD bottles which seal the inside environment from atmospheric oxygen.

Biochemical oxygen demand (BOD)

In Figure 1, the measured BOD of the lake is 9.24±0.168mg/l as expected in relationship with the DO, BOD is high when DO is low. BOD is the measure of organic material contamination in water, specified in mg/L; it is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials (e.g., iron, sulfites). Typically, the test for BOD is conducted over a five-day period (Milacron, 2012).

Total dissolve solids

In Figure4.11, the value of TDS in the collected water samples is 736± 0.04mg/L. The WHO value for TDS is 1000mg/L. It was reported that alkaline ponds were richer in solids than acidic ones. The quantity of TDS was proportional to the degree of pollution (Nasurulla *et al.,* 2006). The TDS recorded was high even though lower than the WHO guide lines of 1000 mg/l. The TDS consist of mainly of Carbonates, bicarbonates, chlorides, iron, phosphates etc. The chemical content of water may be lowered by dilution or raised by the addition of chemical wastes, dissolved Salts, Acids, Alkalis. (Swati, 2015) some physicochemical parameters like PH may have direct influence on the solubility of substances in river water. It was reported that alkaline ponds were richer in solids than acidic ones.

Total phosphorus

The amount of phosphorus in the collected water samples of Lake Tila was found to be0.71± 0.29 mg/L as shown in Figure1.The result is slightly above the environmental protection agency(EPA); 0.05mg/L. This is also measured spectroscopically: Yellow colour is developed from the action of phosphates on molybdate ion under strong acidic conditions. The intensity of colour is directly proportional to the concentration of phosphate in the sample. Phosphate complexes are reduced by weak reducing agents such as ascorbic acid or tartaric acid (potassium antimonyl tartarate) the colour of reduced complex is sky blue (ASTM, 2003). Also in consonant with ASTM, (2003). (0.200 mg/L to 0.308 mg/L).

Nitrate

Nitrate is here measured to be 0.29± 0.25 mg/L. (Figure 1). This is within the permissible limits given by NAFDAC, SON, FEPA and WHO: 10, 10, 20 and 50mg/L respectively. It is another primary form of dissolved nitrogen in natural water. It is a compound of nitrogen in combination with oxygen. Nitrate is highly soluble in water and is stable over a wide range of environmental conditions. It is readily transported in ground water and streams. The levels of nitrate concentrations are of interest for various reasons. Most importantly, high nitrate levels in waters (above 11 mg/dm^{3}N (50 mg/dm^3 NO^{3-})) for drinking purposes will render them hazardous to infants as they induce the "blue baby" syndrome (methaemoglobinaemia). The nitrate itself is not a direct toxicant but is a health hazard because of its conversion to nitrite (WHO, 2013).

Chloride

Figure 1 shows that the chloride value in this study is 150.60± 0. 047 mg/L. this also is not high or low as the guide value given by environmental protection agency (EPA) is 250mg/L. chloride is a negatively charged ion that is formed when chlorine gains electron. It is generally found in the form of salts, which are very soluble in water. (Marianne, 2007). Chlorides are common constituents of all natural waters. Higher value of it imparts a salty taste to water, making it unacceptable for human consumption.

Turbidity

The turbidity of this Lake is 89.2 mg/L as shown in Figure 1. Turbidity is a measure of the clarity of water sample that is affected by suspended matter such as sediment, particulate-organic matter, plankton, and other microscopic organisms (Jason *et al*. 2009). This is a measure of the optical properties of a water sample that cause light to scatter. In most water samples turbidity has been shown to have a strong

correlation to TSS. Therefore, excessive levels of turbidity generally have similar effects on a water body as TSS. Elevated turbidity in water bodies can raise water temperature, lower DO, prevent light from reaching aquatic plants which reduces their ability to photosynthesis and harm fish gills and eggs (Sharon, 1997).

Physicochemical parameter study is very important to get exact idea about the quality of water and we can compare results of different physicochemical parameter values with standard values. Aftab *et al*., (2005) studied various physicochemical parameters and analysis of untreated fertilizer effluent. His result revealed that the parameters like EC, TDS, TSS, BOD, COD and ammonia are high compared to permissible limits of CPCB (Kallol *et al*.,2005) studied various physio-chemical parameters on the samples drawn from the river Koel, Shankha and Brahmani. It was observed that dilution during rainy season decreases the metal concentration level to a considerable extent. However, the enrichment of these metals by bio-magnification and bioaccumulation in edible components produced in water is accepted to produce a remarkable effect on the water of the Lake which is of deep public concern. (Anusha *et al.*,2006) has studied the bore well and dug well water samples from a highly polluted industrial area – Nacharam. Sample were collected and analyzed for physicochemical parameters by adopting the standard methods for examination for water and waste water. The analyzed samples obtained a high value, compared with drinking water standards. The pH of the Lake which is one of the important parameters in the determination of quality of water is 8.87, the alkalinity is 13.30 mg/L, temperature is 25^0C, specific conductance is 736µS/cm, DO is 2.04 mg/L, TDS is 735mg/L similar to that described by (Sawane, 2006).

Total Coliform (E. coli)

Culture yielded no bacteria growth (water sample) and no significant bacteria growth (fish sample) after 48hours incubation at 37^0c. The culture media were observed and read with the intention of isolating the bacteria Escherichia coli (E coli), which is the pathogenic indicator. Other parameter such as the specific gravity of the water sample, the pH and turbidity of water were also determined in the laboratory. This shows generally that it is not out of place that the water sample yielded no bacteria growth. WHO, (2008), and NAFDAC, (2011), in a research explored several alternative coliforms and *E. coli* detection strategies proposed for industrial application especially low-resource settings and less advanced food manufacturers. The colony count using 2 industrial favorites (i.e., Petri film and regular pour plate techniques) were contrasted to 4 alternative low cost strategies. Two modified conventional protocol (i.e., pour and spread plate techniques) in standard mini Petri dishes and two drop plate techniques in micro-titer plate formats (i.e., 24 - and 96-well plate) were applied to count industrial frozen food samples. The colony detection in all treatments was visually facilitated by low-cost digital microscopy technique comparing colony count, the detection time and the colony area in pixels. All experiments except for the Petrifilm*E. coli*/Coliform (EC) Plate utilized MacConkey, blood and CLEAD culture media. The inoculums sizes were varied depending on the cell count technique used; 10 µl and 5 µl for the 24- and 96-well microtiter plates, 50 µl for the mini-plate (both pour and spread plate techniques), and 1000 µl for the full-size Petri dishes. *E. coli*/Coliform (EC) Plate. The incubation temperature was fixed at 37 °C.

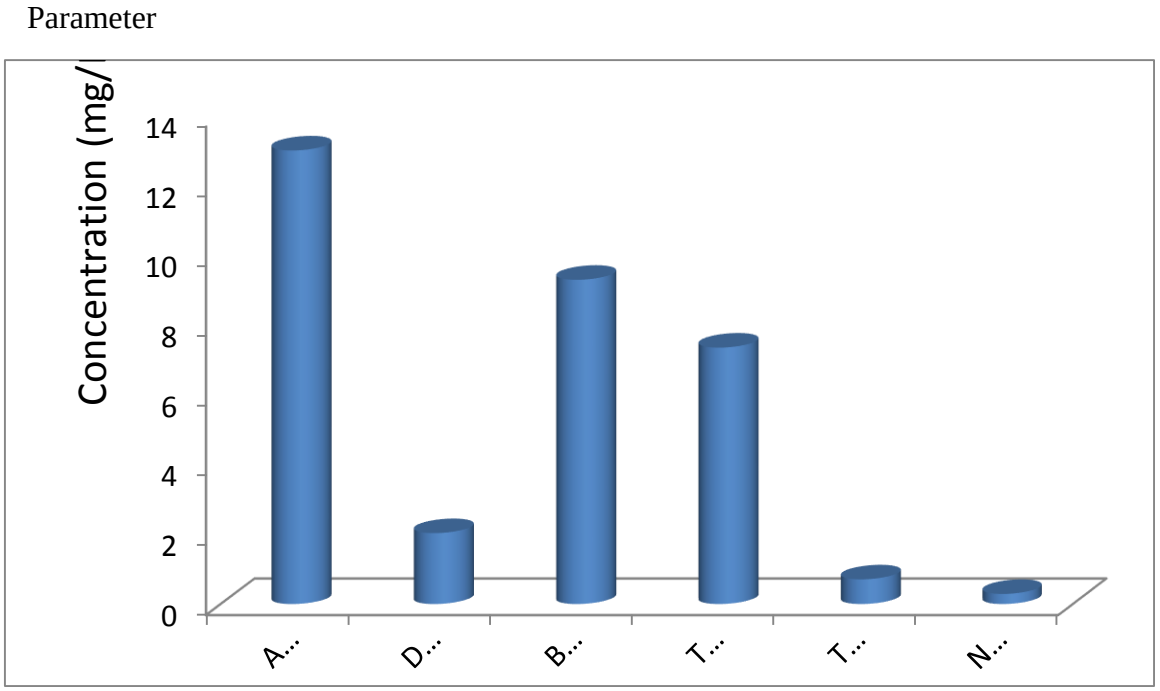

Figure 1: Mean Concentrations Value of BOD, DO, TDS, Total Phosphate, Nitrate and Alkalinity of water sample from Lake Tila

Table 2: Showing the Results for the Isolation of E. Coli

SAMPLE	CULTURE MEDIA		
	Blood	MacConkey	Clead
Water	NBG (0)	NBG(0)	NBG(0)
Fish	NSBG(0)	NSBG(0)	NSBG(0)
plant	NSBG(0)	NSBG(0)	NSBG(0)

NBG = No bacteria growth (E. coli)

NSBG = No significant bacteria growth (E. coli)

V. Conclusion

Many studies have been carried out in Africa and around the world on the knowledge of physical and chemical parameters, its distribution and impacts on the environment. However, faced with the immensity of the areas not yet explored, such as lakes and ponds in local environment, researchers and scientist have the challenge of reaching conclusion regarding the certainty and safety of water bodies. Because of this, it is necessary to respond appropriately for the protection of the environment. Hence, the essence of this work. In addition to this, it is important to create awareness on the impact of physical and chemical parameters on water bodies and the way out.

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