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DETERMINATION OF PHYSICOCHEMICAL PARAMETERS AND SOME HEAVY METALS LEVELS OF SURFACE AND GROUND WATER OF IBIAKU OSUK COMMUNITY, AKWA IBOM STATE.

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***Abstract*:** The study determined the physicochemical parameters and some heavy metals such as cadmium (Cd), lead (Pb), nickel (Ni), copper (Cu) and iron (Fe) of surface and ground water of Ibiaku Osuk Community. The water samples were collected from two stations. The American Public Health Association (APHA) standard methods were used to analyse the physicochemical parameters and heavy metal content were analysed using atomic absorption spectrophotometer (AAS). The results obtained were as follows; pH (7.03 ± 0.23) for ground water and (7.24 ± 0.09) for surface water, Temperature (27.37 ± 0.06 ºC) for surface water and (27.53 ± 0.06 ºC) for ground water, Electrical Conductivity (16.52 ± 1.95 µS/cm) for surface water and (36.63 ± 2.20 µS/cm) for ground water, Total Dissolved Solid (7.83 ± 0.55 mg/L) for surface water and (16.60 ± 2.61 mg/L) for ground water, Salinity (0.01 ± 0.001 mg/L) for both water samples, Dissolved Oxygen (5.60 ± 0.10 mg/L) for surface water and (6.43 ± 0.30 mg/L) for ground water, Biochemical Oxygen Demand (0.06 ± 0.73 mg/L) for surface water and (1.33 ± 0.21 mg/L) for ground water, Alkalinity (8.06 ± 0.73 mg/L) for ground water and (8.42 ± 0.37 mg/L) for surface water, Total Hardness (18.73 ± 1.17 mg/L) for surface water and (25.57 ± 1.96 mg/L) for ground water, Turbidity was not detected in any of the water samples. Nitrate, chloride and phosphate concentrations were of the range (0.26 ± 0.06 mg/L) for ground water and (1.55 ± 0.47 mg/L) for surface water, (6.63 ± 0.43 mg/L) for ground water and (7.55 ± 0.06 mg/L) for surface water, and (0.04 ± 0.01 mg/L) for surface water and (0.07 ± 0.02 mg/L) for ground water. The heavy metals measured were iron (0.016 ± 0.012 mg/L) for ground water and (0.020 ± 0.001 mg/L) for surface water, nickel (0.003 ± 0.002 mg/L) for ground water and (0.005 ± 0.005 mg/L) for surface water. Copper, Lead and Cadmium were not detected in any of the water samples. The results obtained indicated that all the physicochemical parameters and heavy metals content of the water samples were within the NIS and WHO permissible standard limits. This implies that the surface and ground water of Ibiaku Osuk Community is fit and acceptable for human consumption.

Keywords: Stream, physicochemical parameters, borehole, water quality, heavy metals, contamination.

1.0 INTRODUCTION

Water is one of the most valuable natural resources and is essential for the maintenance of all forms of life. Water plays an important role of the intake of essential element in man (WHO, 2004). Although water is the most important and common chemical on earth, only 2.6 % of global water is freshwater and available as drinking water. Freshwater has remained the major sources of drinking water in most rural and urban cities of the world. The amount of drinking water required by individuals is variable depending on one's age, health condition, physical activity and environmental conditions (Ann, 2004). Water is thus a crucial factor for development and the quality of life in many countries and it has even becomes a survival factor for individual in arid area (Eddy and Ekop, 2007).

There are many trace elements present in virtually all potable water, some of which plays a role in metabolism. For example, sodium, potassium and chloride are common elements found in small quantities in most water and these elements plays a role in body metabolism. Other elemental compounds such as fluorine, which is beneficial in a very low concentration, can cause dental problems and other health issues when present at a high concentration (Miller, 2006). All over the world, water, soil and air composition imparted negatively by human activities which leads to the pollution of the environment (Adesemoye *et al*, 2006). In many countries of the world including Nigeria, good and sufficient amount of drinking water has been a major challenge due to the fact that the supplied drinking water become contaminated with some toxicants which has imparted negatively on human population (EPA, 2009). The contaminants which include heavy metals, bacteria, virus, nitrate, etc. are found in supplied water as a result of improper disposal of wastes, livestock drops, industrial discharges and improper treatment of the water before supply (Sorabjeet and Luke, 2003).

In most communities in the rural areas, stream water is the major source of drinking water. However, in recent, borehole water is sunk in almost all the communities. Water is most often contaminated by organic substances from human activities which causes deterioration of water quality. Water may also be contaminated due to level of toxin or suspended solid in the water. Reduction of water borne disease and development of safe water source is a major public goal in developing countries as reported by United State Center for Disease Control and Prevention (USCDCP, 2006). Due to the enormous importance of water to all categories of life, water quality analysis becomes necessary. Water quality is the physical, biological, chemical and radiological characteristic of any water sample (Diersing, 2009). Water as an essential part of life is used in homes and industries, proper handling and treatment of water before consumption is therefore necessary (NIS, 2015 and WHO, 2011). In many part of Nigeria, especially the rural and remote communities depends on surface water such as rivers, streams, springs and borehole water for consumption and they becomes infected with diseases as a result of consumption of untreated contaminated water. In Akwa Ibom State particularly Ibaku Osuk Community and its environs depends on the surface and ground water as source of drinking and for other domestic purposes.

This study is therefore aimed at determining the physicochemical parameters and some heavy metals of surface and ground water of Ibiaku Osuk Community to determine the extent of contamination

2.0 MATERIALS AND METHODS

2.1 Study Area:

The study was carried out in Ibiaku Osuk Community in Ibiono Ibom Local Government Area of Akwa Ibom State, Nigeria. The sampling location lies between Latitude 05º10'03.5"N and Longitude 007º53'41.3"E for the borehole (ground water) and Latitude 05º09'57.7"N and Longitude 007º53'34.3"E for the stream (surface water) as shown in Fig 1. The stream (surface water) is located downstream of the spring water. It is characterized by moderate flow and a vast flood plain. The activities that take place here include bathing, washing of cloths and farming.

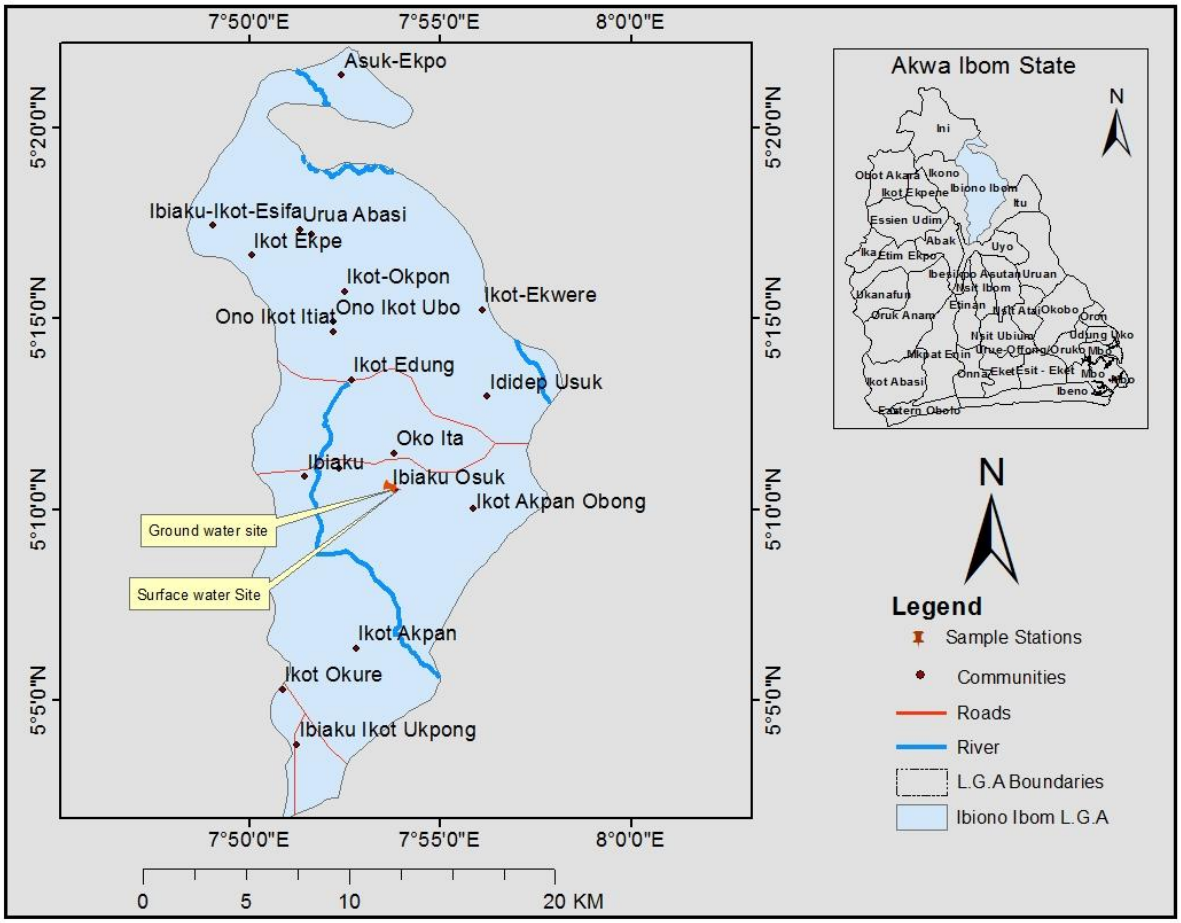

Fig 1: Map of the Study Area showing sampling stations

2.2 Samples Collection

Samples of ground water (borehole) and surface water (stream) were collected during the wet season from Ibiaku Osuk Community for a period of three months (August to October) in duplicate using washed and air dried containers. The samples were collected separately in plastic containers for the physicochemical parameters and heavy metal measurement. Few drops of concentrated nitric acid (HNO_3) were added to the containers containing samples for heavy metals determination to preserve the samples. Amber bottles were used to collect samples for Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD). The water samples were placed in a cooler containing ice blocks and were transported to the laboratory where it would be preserve before analysis.

2.3 Preparation of Water Samples

The water samples were properly labelled, stored in the refrigerator at a temperature below 4 ºC before the analysis. The samples in the amber bottles were stored at a temperature of about 20 ºC for five days before analysing for the biochemical oxygen demand (BOD_5).

2.4 Analysis

Some of the physicochemical parameters of the water samples such as pH, temperature, DO and turbidity were examined in situ. The pH of the water samples was measured immediately at the point of collection using a Digital pH Meter (Model 6 PFCE). The digital pH meter was switched on and allowed to stand for few minutes. It was then standardizes with a buffer solution. The probe of the pH meter was introduced into a beaker containing 100 ml of the water sample and the measurement was taken at a stable reading and recorded. The probe of the meter was rinsed with distilled water after each measurement before taking another measurement. A mercury in-glass thermometer was used to measure the temperature of the water sample at the point of collection. The bulb of the thermometer was immersed in a beaker containing 100 ml of the water samples. The thermometer was held for about 3 – 5 minutes at a stable reading and was recorded in degree centigrade (^oC).

Standard methods of analysis (APHA, 2005) were used to examine all the physicochemical parameters of the water samples at the Centre for Marine Pollution Monitoring and Seafood Safety (CMPMSS), University of Port Harcourt. The concentrations of the heavy metals were determined using atomic absorption spectrophotometer (AAS) in the laboratory.

3.0 RESULTS AND DISCUSSION

The results of the physicochemical parameters and heavy metal concentrations of surface and ground water are presented in Table 1 and Table 2 respectively. The results obtained showed the following concentrations; pH (7.03 ± 0.23) for ground water and (7.24 ± 0.09) for surface water, Temperature (27. 53 ± 0.06 ^oC) for ground water and (27.35 ± 0.06 ^oC) for surface water, Electrical Conductivity (EC) 36.63 ± 2.20 µS/cm for ground water and 16.52 ± 1.95 µS/cm for surface water, Salinity 0.01 ± 0.00 mg/L for both water samples, Total Dissolved Solid (TDS) 16.60 ± 2.16 mg/L for ground water and 7.38 ± 0.55 mg/L for surface water, Dissolved Oxygen (DO) 6.43 ± 0.23 mg/L for ground water and 5.60 ± 0.10 mg/L for surface water, Biochemical Oxygen Demand (BOD) 1.33 ± 0.21 mg/L for ground water and 0.60 ± 0.03 mg/L for surface water, Alkalinity 8.06 ± 0.73 mg/L for ground water and 8.42 ± 0.37 mg/L for surface water, Total Hardness 25.57 ± 1.96 mg/L for ground water and 18. 73 ± 1.17 mg/L for surface water, Turbidity was not detected in any of the water sample. Nitrate (NO_3^2) 0.26 ± 0.06 mg/L for ground water and 1.55 ± 0.47 mg/L for surface water, chloride (Cl^-) 6.63 ± 0.42 mg/L for ground water and 7.55 ± 0.61 mg/L for surface water and phosphate (PO_4^{2-}) 0.07 ± 0.02 mg/L for ground water and 0.04 ± 0.01 mg/L for surface water. The results of the heavy metals are iron (Fe) 0.016 ± 0.012 mg/L for ground water and 0.020 ± 0.001 mg/L for surface water, nickel (Ni) 0.003 ± 0.002 mg/L for ground water and 0.005 ± 0.005 mg/L for surface water, copper (Cu), lead (Pb) and cadmium (Cd) results were 0.001 ± 0.00 mg/L for both water samples.

Table 1: Physicochemical parameters of surface and ground water

Parameters (Unit)	Ground water	Surface water	NIS Standard	WHO Standard
pH	7.03±0.23	7.24±0.09	6.5 – 8.5	6.5 – 8.
Temperature (^oC)	27.53±0.06	27.37±0.06	Ambient	<40
EC (µS/cm)	36.63±2.20	16.52±1.95	1000	1000
TDS (mg/L)	16.60±2.61	7.38±0.55	500	1000
Salinity (mg/L)	0.01±0.01	0.01±0.00	500	250 – 500
DO (mg/L)	6.43±0.23	5.60±0.10	10	5 – 10
BOD (mg/L)	1.33±0.21	0.60±0.10	-	2 – 5
Alkalinity (mg/L)	8.06±0.73	8.42±0.37	-	-
Total Hardness (mg/L)	25.57±1.96	18.73±1.17	150	500
Turbidity (NTU)	0.00±0.00	0.00±0.00	5	5
Nitrate (mg/L)	0.26±0.06	1.55±0.47	50	50
Chloride (mg/L)	6.63±0.42	7.55±0.61	250	250
Phosphate (mg/L)	0.07±0.02	0.04±0.01	-	0.1

Data represented as Mean ± Standard Deviation (SD) of triplicate determination, n=3

The mean pH values of 7.03 ± 0.23 (ground water) and 7.24 ± 0.09 (surface water) were within the National and International Standard limits range of 6.5 to 8.5 (NIS, 2005 and WHO, 2011). The level of pH (7.24 ± 0.09) recorded for surface water in the study was agreed with the pH value of 5.98 – 6.61 as reported by Amacha *et al,* (2019) in the determination of water quality indices of freshwater of Orashi river in Rivers State, Nigeria. The temperature of the sampled water, 27.53 ± 0.06 ^oC for ground water and 27.37 ± 0.06 ^oC for surface water were within the recommended limit by Nigerian Industrial Standard (NIS) and World Health Organisation (WHO). The level of temperature obtained from the study for ground water were high compared with level (26.30 ^oC to 26.50 ^oC) reported by Edori and Kpee, (2016) in the physicochemical assessment of water samples boreholes near Abattoirs in Port Harcourt, Rivers State as well as level (26.57 ^oC) recorded by Eddy and Ekop, (2007) in assessment of the quality of water treated and distributed by the Akwa Ibom State Water Company. The Total Dissolved Solid (TDS) values 16.60 ± 2.61 mg/L for ground water and 7.38 ± 0.55 mg/L for surface water were low compared with the levels (3.50 – 134 0 mg/L) as reported by Musa *et al,* (2014) of the physicochemical characteristics of surface and ground water in Obajana and its environs in Kogi State. Elevated level of TDS also occurred for ground water in the study compared with the level (14.83 ± 0.003 mg/L) reported by Eddy and Ekop, (2007) of assessment of the quality of water treated and distributed by the Akwa Ibom State Water Company. The results of the study revealed that the mean levels of Electrical Conductivity (EC), Alkalinity, Total Hardness and Salinity in the water samples were below the permissible limits (WHO, 2011).

Table 2: Heavy metals concentrations of surface and ground water

Parameters (mg/L)	Ground water	Surface water	NIS Standard	WHO Standard
Iron (Fe)	0.016±0.012	0.020±0.001	0.3	0.03
Lead (Pb)	0.001±0.00	0.001±0.00	0.01	0.01
Cadmium (Cd)	0.001±0.00	0.001±0.00	0.003	0.003
Nickel (Ni)	0.003±0.002	0.005±0.005	0.02	0.02
Copper (Cu)	0.001±0.001	0.001±0.00	1	1

Data represented as Mean ± Standard Deviation (SD) of triplicate determination, n=3.

The zero value of turbidity observed in the study showed the clear nature of the water. Whereas the levels of Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD_5) obtained in the study were within the permissible limit of 5 – 10 mg/L and 2 – 5 mg/L respectively (WHO, 2011). The water samples are less polluted which maybe as a result of low level of biochemical degradation of organic matter in the water by micro-organism. The level of DO and BOD_5 for the ground water were lower compared with levels (5.70 – 6.90 mg/L) and (0.80 – 1.60 mg/L) for DO and BOD respectively as reported by Edori and Kpee, (2016) of the physicochemical assessment of water samples from boreholes near some abattoirs in Port Harcourt.

The mean levels of nitrate concentration 0.26 ± 0.06 mg/L of ground water and 1.55 ± 0.47 mg/L of surface water, phosphate 0.07 ± 0.02 mg/L for ground water and 0.04 ± 0.01 mg/L for surface water and chloride 6.63 ± 0.42 mg/L for ground water and 7.55 ± 0.61 mg/L for surface water were below the permissible limits of 50 mg/L for nitrate, 0.1 mg/L for phosphate and 250 mg/L for chloride respectively NIS, (2015) and WHO, (2011). From the study, the levels of nitrate recorded were high, phosphate and chloride recorded were low for surface water compared with the level of nitrate (0.14 – 0.37 mg/L), phosphate (0.03 – 0.44 mg/L) and chloride (5.46 – 11.81 mg/L) respectively reported by Amacha *et al*, (2019) in determination of water quality indices of freshwater of Orashi River in Rivers State. Whereas copper (Cu), lead (Pb), iron (Fe), cadmium (Cd) and nickel (Ni) levels in the study were all below the National and International standard limits. The levels of metals recorded in the study for surface water were lower compared with the levels of Cu (0.39 – 0.41 mg/L), Fe (2.00 – 2.61 mg/L) and Pb (0.6 – 1.0 mg/L) as reported by Anyanwu, (2012) of the physicochemical and some trace metal analysis of Ogba River in Benin City.

4.0 CONCLUSIONS

The physicochemical parameters and heavy metals concentrations of surface and ground water of Ibiaku Osuk Community were all bellow and within the National and International permissible limits for drinking water. The results showed that the surface and ground water of Ibiaku Osuk Community is fit and suitable for consumption by the inhabitants of the community and its environs. Therefore, regular monitoring of the water is necessary in order to check the quality of the water due to increasing human populations in the community and other activities that may take place in the area.

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