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Studies on the Levels of Heavy Metal Ions in Stream and Borehole Water within Ibiaku Osuk Settlement, Akwa Ibom State, Nigeria

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Abstract: *This study examined the concentration of heavy metals levels in-stream and borehole within Ibiaku Osuk settlement in Ibiono Ibom local government area of Akwa Ibom State, Nigeria. Heavy metals such as copper (Cu), lead (Pb), cadmium (Cd), nickel (Ni) and iron (Fe) were analyzed using atomic absorption spectrophotometer (AAS). The results obtained for stream water were iron (Fe) 0.010 ± 0.001 mg/L, nickel (Ni) 0.001 ± 0.001 mg/L, copper (Cu) 0.001 ± 0.001 mg/L, lead (Pb) 0.001 ± 0.001 mg/L and cadmium (Cd) 0.001 ± 0.001 mg/L. For borehole water; the results were iron (Fe) 0.004 ± 0.001 mg/L, nickel (Ni) 0.003 ± 0.002 mg/L, copper (Cu) 0.001 ± 0.001 mg/L, lead (Pb) 0.001 ± 0.001 mg/L and cadmium (Cd) 0.001 ± 0.001 mg/L. the results indicated that the heavy metals concentrations of the stream and borehole water were within the national and international permissible limits. Therefore, water from streams and boreholes within the studied area is free from heavy metal contamination.*

Keywords: *Water pollution, borehole, contamination, stream, heavy metals*

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1.0 Introduction

The availability of potable water is one of the global greatest environmental challenges (Ann, 2004). However, the volume of wastewater in our environment far outranged the volume of potable water because of increasing contamination of existing water without appropriate remediation measures (USCDCP, 2006). Increases in urbanization accompanied by industrialization have led to increased discharge of contaminants to our aquatic environment (Moss, 2008, West, 2006). The consequence is the pollution of our water bodies especially, our rivers, streams and underground water, over time (EPA, 2009).

In developing countries, the major factors that guide the choice of water in rural areas are not the portability of the water but the available option. Consequently, the choice and acceptability are always based on the colour of the water and some time the taste without recourse to basic quality parameters of the water such as physicochemical, organoleptic, heavy metal content, the content of emergent pollutants and others (Obiri, 2007, Sarabjeet and Luke, 2003). This ignorant is significantly prevalent in rural areas of most countries including Nigeria. Among all forms of water contaminants, heavy metals are one of the most common and easily unnoticed contaminants because they may not affect the physical appearance or characteristics taste of the water (Eddy and Ekop, 2007a). Consequently, most rural dwellers are ignorant of the long-term effect that the accumulation of heavy metals can cause in their systems and other components of the environment (Baroni *et al*, 2007). Also, the utilization of such water for agricultural or other purposes may also increase the levels of

heavy metals in such environment (Eddy and Ekop, 2007b).

Studies on the levels of heavy metals in some Nigerian streams and other water bodies have been reported. For example, Eddy and Ukpong (2005) reported a significant concentration of heavy metal ions in some tributaries of the Calabar River and found that continuous accumulation of heavy metals in the river was remarked by the high concentration of heavy metal ions in the sediment from the river. Eddy *et al*. (2004) also observed a similar trend in water and sediment from the Cross River Estuary at Oron and attributed the accumulation to the continuous and unguarded discharge of anthropogenic and industrial wastes. Ali *et al*. (2016), investigated the levels of heavy metal ions in water and sediment of Karnaphuli River, Bangladesh and found that the metal ions ranged from 13.31-53.87, 46.09-112.43, 2.54-18.34 and 5.29-27.45 µg/L in the water from the river while those in the sediments were 11.56–35.48, 37.23–160.32, 0.63–3.56 and 21.98–73.42 mg/kg for As, Cr, Cd and Pb respectively. They concluded that the level of studied metals in water samples exceeded the safe limits of drinking water, indicating that water from this river is not safe for drinking and/or cooking. Olatunji and Osibanjo (2012) also found high concentrations of heavy metal ions in inland freshwater of lower River Niger drainage in North Central Nigeria and reported significantly high concentrations of heavy metal ions in the water body.

Apart from streams, a borehole is another major source of water in most settlements including the study area. Literature is not scanty on the impact of heavy metal ion accumulation in borehole water. For example, in Ghana, average concentrations of heavy metal ions in borehole water from Dumasi were found to be significantly higher than the recommended limits and included, iron (Fe) - 7.52 ppm, Manganese (Mn) - 1.11 ppm, Arsenic (As) - 4.52 ppm, Chromium (Cr) - 0.026 ppm, Cobalt (Co) - 0.01 ppm, Zinc (Zn) - 0.007 ppm, Cadmium (Cd) - 0.002 ppm and Lead (Pb) - 0.005 ppm (Obiri, 2007). In Kebbi State, Nigeria, mean concentrations of some heavy metal ions in water samples from some boreholes were reported to be above the WHO recommended value distribution profile of the different heavy metal ions in the water samples followed the trend, Cu (0.302 – 0.606mg/l) > Pb (0.047 – 0.245mg/l) > Cr (0.052 – 0.121mg/l) > Ni (0.035 – 0.087mg/l) > Co(0.03 – 0.07mg/l), except for concentration of Fe which was estimated as 1.282mg/l (Elinge *et al*., 2011).

Despite enormous literature on heavy metal concentrations in different sources of drinking water, little has been reported on simultaneous investigations of heavy metal concentrations in Stream and borehole water in most rural areas of Nigeria. Therefore, the present study is aimed at investigating the levels of concentrations of heavy metals in streams and boreholes within Ibiaku-Osuk settlement in Akwa Ibom State, South-South Nigeria.

2.0 Materials and Methods

Water samples were collected from streams and boreholes within the Ibiaku Osuk Settlement in Ibiono Ibom Local Government Area of Akwa Ibom State, Nigeria once monthly for a period of three months (August – October). A clean washed and air-dried plastic containers were used to collect the water samples. Immediately after the sampling, five drops of concentrated HNO_3 were added to each water sample before they were labeled and transported to the laboratory for analysis using atomic absorption spectrophotometer. Before injection into the spectrophotometer, samples were prepared according to APHA (2005) recommended methods.

3.0 Results and Discussion

Measured mean concentrations of heavy metal ions in stream and borehole water, are presented in Table 1. The results indicated that metal concentrations in stream water (SW) were iron (Fe) 0.010 ± 0.001 mg/L, nickel (Ni) 0.001 ± 0.001 mg/L, copper (Cu) 0.001 ± 0.001 mg/L, lead (Pb) 0.001 ± 0.001 mg/L and cadmium (Cd) 0.001 ± 0.001 mg/L. However, the corresponding mean

concentration in borehole water (BW) were iron (Fe) 0.004 ± 0.001 mg/L, nickel (Ni) 0.003 ± 0.002 mg/L, copper (Cu) 0.001 ± 0.001 mg/L, lead (Pb) 0.001 ± 0.001 mg/L and cadmium (Cd) 0.001 ± 0.001 mg/L. This information is also presented in Fig. 1, which reveals relatively similar concentrations in both SW and BW except for iron and nickel ions. This suggests that both sources of water can be used as an index for analyzing the suitability of the water for various purposes.

Table 4.7: Concentration of heavy metals in water from the stream and borehole

Heavy metal ion (mg/L)	BW	SW	NIS Standard	WHO Standard
Lead	0.001±0.001	0.001±0.001	0.01	0.01
Cadmium	0.001±0.001	0.001±0.001	0.003	0.003
Iron	0.004±0.001	0.010±0.001	0.3	0.03
Nickel	0.003±0.002	0.001±0.001	0.02	0.02
Copper	0.001±0.001	0.001±0.001	1	1

Data represented as Mean ± Std of triplicate determinations, n = 3

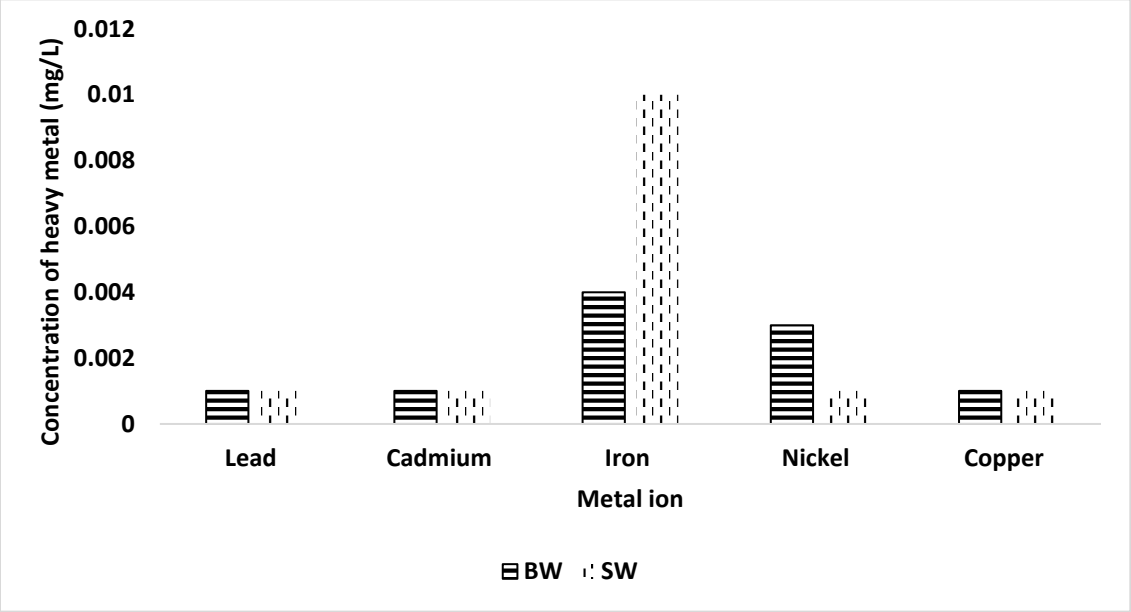

Fig 1: Concentrations of heavy metals of stream and borehole water

The values analyzed for all the heavy metals were below the National and International permissible limits (NIS, 2015 and WHO, 2011). Mean values obtained were 0.001 ± 0.001 mg/L for copper, lead and cadmium in both water samples, 0.001 ± 0.001 mg/L of stream and0.003 ± 0.002 mg/L of borehole water for nickel and0.010 ± 0.001 mg/L of stream water 0.004 ± 0.001mg/L of borehole water for iron. The result recorded for nickel (Ni) in stream water was lower compared with the levels of Ni (0.09 ± 0.00 mg/L) reported by Amacha *et al*, (2019) in the determination of water quality indices of freshwater of Orashi river in Rivers State. Iron (Fe) is a mineral vital to the proper function of hemoglobin, a protein needed to transport oxygen in the blood. Iron also has a role in a variety of other important processes in the body (Abbaspour, 2014).

The levels of heavy metal ions in stream water were lower compared with the levels 0.39 – 0.41 mg/L, 2.00 – 2.61 mg/L and 0.6 – 10 mg/L for copper, iron and lead

respectively reported by Anyanwu (2012) in physicochemical and some trace metals of Ogba river in Benin City. The mean values of lead (Pb) 0.001 ± 0.001 mg/L in water from the various boreholes were low compared with the level (0.1487 ± 0.2531 mg/L) of lead reported by Oko *et al* (2017) in the evaluation of physicochemical and heavy metal content of groundwater sources in Bantaji and Rafin-Kada settlement of Wukari Local Government Area, Taraba State, Nigeria. Copper (Cu) is an essential trace metal that functions in the building of the immune system and the development of the brain. Copper deficiency can cause impaired growth, bone abnormalities, neutropenia, hypo pigment, cytochrome oxidase activity of leucocytes and platelets (Bonham *et al*, 2002). Excess amounts of these heavy metals such as cadmium, nickel, lead, copper and iron are toxic and can harm human health when consumed (NIOSH, 2015).

The mean copper (Cu) and lead (Pb) values of 0.001 ± 0.00 mg/L and 0.001 ± 0.00 mg/L obtained from this study were within the National and International recommended limits for drinking water quality

4.0 Conclusion

All the heavy metals concentrations examined in the water samples from the stream and borehole of Ibiaku Osuk Settlement in Ibiono Ibom Local Government Area of Akwa Ibom State, Nigeria were within the national (NIS) and international (WHO) permissible limits for drinking water. The results also showed that the water from the stream and borehole was suitable for human consumption and other domestic use. Therefore, regular monitoring and proper treatment of the water is required to check the water quality to avoid any health challenges that may arise as a result of consuming the water.

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Conflict of Interest

The authors declared no conflict of interest. All authors took part in analyzing the results, proofreading and effecting all corrections. All authors read and approved the final manuscript