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Assessment of heavy metals and physico-chemical parameters in water from Kpata River, Lokoja, Nigeria

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Abstract
Water as a universal solvent has the capability to dissolve many substances including organic and inorganic compounds. This study was aimed at assessing the levels of some heavy metals (Iron, Manganese, Zinc and Nickel) and some physicochemical parameters of the river water, namely: temperature, pH, conductivity, nitrate, biochemical oxygen demand (BOD) and total dissolved solids (TDS). Temperature, pH, Conductivity and TDS were measured onsite using field instruments. The nitrate and biochemical oxygen demand were measured in the Laboratory following the standard procedures. Heavy metal composition of the river water was also studied using atomic absorption spectrophotometer (AAS). Data obtained were subjected (mean and standard deviation) and inferential (ANOVA) statistics. Statistical Analysis System (SAS) version 9.0 portable was used. Results of physico-chemical analysis revealed that values were within acceptable limit set by World Health Organization. Results of the heavy metal analysis showed that iron, manganese and nickel were above acceptable limit of drinking water set by World Health Organization. The accumulation of these pollutants poses a dangerous threat to both aquatic and human lives.

Keywords: Water quality, physico-chemical, heavy metals, Kpata River, Lokoja

1. Introduction

Water is an important component of the environment and all living organisms depend on water for their survival (Smitha *et al*., 2007) [18]. Contaminants such as nitrates, salts and heavy metals have polluted water supplies as a result of inadequate treatment and disposal of waste from humans, livestock, industrial discharges, domestic discharge and extensive use of limited water resources (Onwughara *et al*., 2013) [12].

For many decades, the pollution of aquatic environment with heavy metals has become a worldwide problem because of their potential toxic effect and also most of them accumulate in tissues and organs of aquatic organism (Gledhill *et al.*, 1997) [5]. However, the amount of absorption and bioaccumulation of the heavy metals depends on ecological, physical, chemical and biological condition and the kind of element and physiology of organisms (Jaffer *et al.*, 1988) [18].

Research on heavy metals alongside monitoring programmes in aquatic environment have become important due to concerns of over accumulation and toxic effects to aquatic organisms and to humans through the food chain since contaminants can persist for many years in sediments where they hold the potential to affect human health and the environment (Otchere, 2003) [13]. It has been reported that contaminated water kills more people than cancer, AIDS, wars, terrorism or accidents (Uduma, 2014) [21].

Physico-chemical properties of water are some of the important factors that play a vital role for the growth of living organisms in the water body. The aim of this study was to determine the levels of some elemental components and physicochemical parameters in water collected from Kpata River, Lokoja, Kogi State.

2. Materials and Methods

2.1 Description of the Study Area

Kpata River is a river that flows into the river Niger within Lokoja metropolis. For many years, it has been a major source of water for Kogi State Water Board, Lokoja. This river is located close to a market in Lokoja. Toxic wastes are most often times washed into this water body.

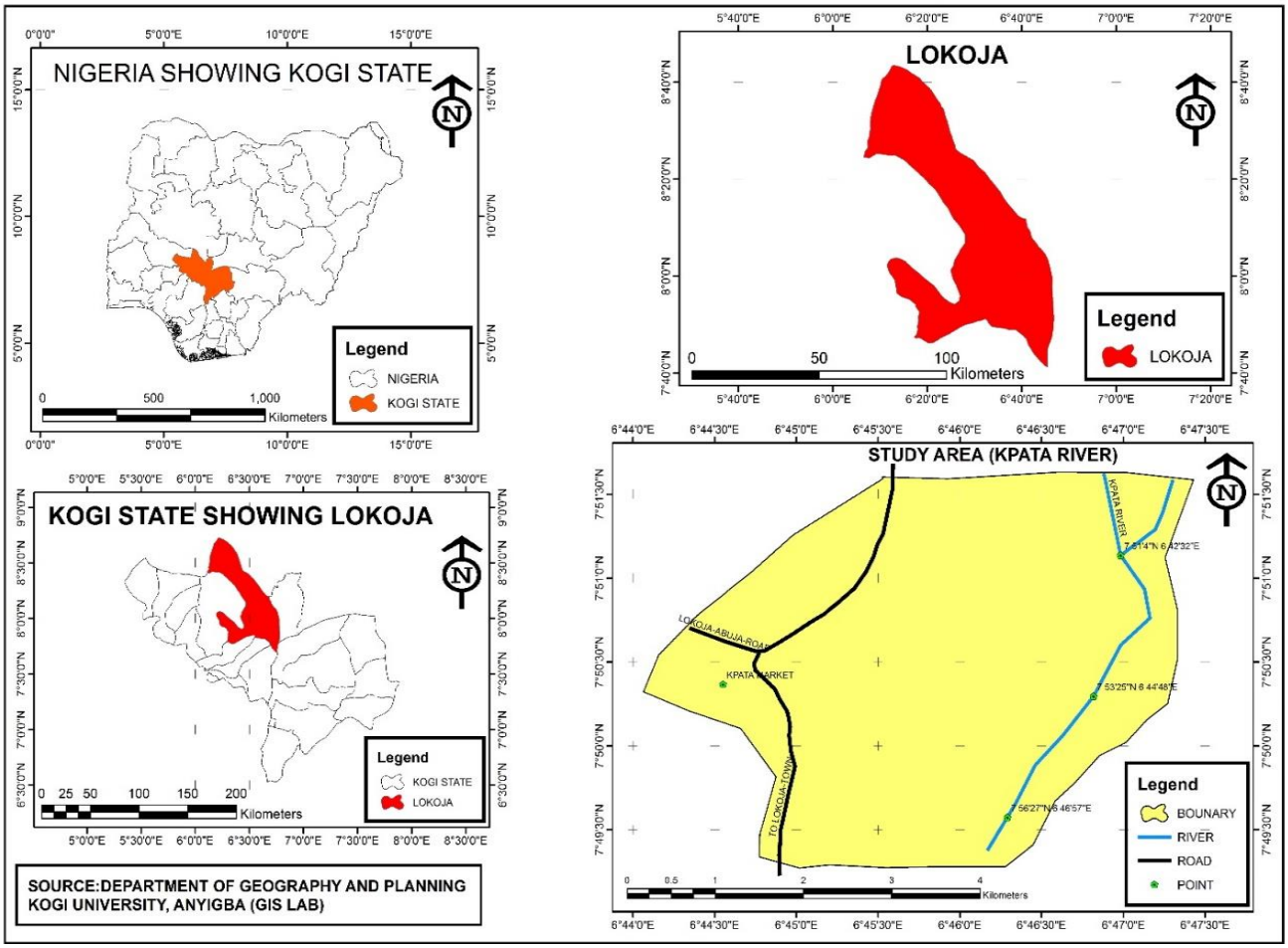

Fig 1: Map showing study area

2.2 Water Samples Collection

Water samples were collected using plastic containers to fetch water below the surface of designated points, mixed properly and stored in a plastic container rinsed with 0.01N nitric acid and kept in deep freezer prior to the time of analysis (Aremu *et al*., 2007) [3].

2.3 Physicochemical Analysis

The surface water pH, Temperature, EC, and TDS were determined using HANNA pH/EC/Temp/TDS meter model 210. The meter was turned on and then the meter probe was inserted into the water at the point of collection as described by (APHA, 1999) [2]. The values were recorded as displayed on the meter. Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Dissolved Solids (TDS) and Nitrates in the study were done according to (APHA 1999) [2]. All parameters of water quality monitoring and their analytical methods were summarized in Table 1. The measurement was done in three replicates and the mean value was taken.

2.4 Determination of Elemental Composition

Ten millilitre (10 ml) each of water samples were measured into a beaker and 10 ml mixture of $HNO_3 – H_2O_2$ (1:1) was added and digested for 2 hours at 160°C. The digest was cooled, filtered and transferred to 100 ml volumetric flask and filled up to the level with de-ionized water (Olaifa *et al*., 2004) [11]. Digested water samples were analysed using flame Atomic Absorption Spectrophotometer (model AA240FS, Varian), at the University of Ibadan Central Laboratory. The dilution factor of the sample was used to determine the final concentration of the various elements in water. The elements determined were cobalt (Co), iron (Fe), manganese (Mn), zinc (Zn) and nickel (Ni),

2.5 Statistical analysis

Data obtained were subjected to descriptive (mean and standard deviation) and inferential (ANOVA) statistics. Means were separated using Duncan Multiple Range Test (DMRT). Statistical Analysis System (SAS) software version 9.0 portable was used.

3. Results and Discussion

3.1 Results and Discussions

The physico-chemical parameters such as temperature, pH, electric conductivity, turbidity, alkalinity, dissolved oxygen, total dissolved solid, biological oxygen demand and nitrate (Table 1) and elemental composition were analyzed in the water samples collected from Kpata River, Lokoja. These parameters were taken in the month of April, 2019. The mean metal concentrations of water collected from Kpata River were presented in Table 2. The mean concentration of metal determined in the water samples ranged from 0.16 to

30.17 mgL^{-1}. The metals determined were Fe, Mn, Zn and Ni with mean concentrations of 30.17, 0.60, 1.32 and 0.16 (mgL^{-1}) in water respectively.

3.1.1 Temperature
Temperature plays a significant role in regulating the biological and physico-chemical parameters of water and is considered as one among the most important factors in the aquatic environment (Singh and Mathur, 2005) [17]. The temperature of the river was observed to be 29 °C during the study period (Table 1). This could be as a result of low water level, high atmosphere temperature and clear atmosphere (Qureshimatva and Solanki, 2015) [14]. The temperature value was within the standards for drinking water (WHO, 1998) [23].

3.1.2 pH
pH is the intensity of the acidic or basic character of a solution at a given temperature **(**Qureshimatva *et al*., 2015) [14]. The pH of the river sampled was observed to be 7.20 (Table 1). The pH of water is important for the biotic communities as most of the plant and animal species can survive in narrow range of pH from slightly acidic to slightly alkaline condition (Goher, 2002) [6]. Qureshimatva *et al.* (2015) [14] in an earlier study reported a similar range of temperature, although from a different water body. The pH value was within the standards for drinking water (WHO, 1998) [23].

3.1.3 Electrical conductivity
The ability of water to transmit electric current is known as electrical conductivity and it could serve as tool to assess the purity of water (Murugesan *et al*., 2006) [10]. This capability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement (Shinde *et al*., 2011) [16]. The electrical conductivity observed in this study was 85.70 µS/cm. The conductivity value was within the standards for drinking water (WHO, 1998) [23].

3.1.4 Dissolved oxygen
Dissolved oxygen is a factor, which is used to determine whether the biological changes are brought about by aerobic or anaerobic organism. The DO observed in this study was 7.2 mg/L indicate relatively mild organic pollution that might have resulted from sewage wastes from human settlement (Igbal *et al*., 2006) [7]. These results also agree with those of other researchers (Ashish *et al*. 2009; Yogendra *et al*., 2013) [23, 25]. The dissolved oxygen value was within the standards for drinking water (WHO, 1998) [23].

3.1.5 Nitrates
Nitrates reach freshwater through discharge of sewage and industrial wastes and run off from agricultural fields (Solanki, 2012) [19]. The amount of nitrate recorded in the water of Kpata River was 6.0 mg/L. The low level of nitrate reported in this study could be because of their utilization by plankton and aquatic plants for metabolic activities (Verma *et al*., 2012) [19]. The nitrate value was within the standards for drinking water (WHO, 1998) [23].

3.1.6 Total dissolved solids
Solids refer to the suspended and dissolved matter in water. They are very useful parameters describing the chemical constituents of the water and can be considered as edaphically relation that contributes to productivity within the water body (Goher, 2002) [6]. The total dissolved solid in the sampled water from Kpata River was 40.25 mg/L. This could be due to the addition of organic matter and solid waste into the river (Moss, 1973) [9]. The total dissolved solid value was within the standards for drinking water (WHO, 1998) [23].

3.1.7 Biochemical oxygen demand
The biochemical oxygen demand may be defined as the oxygen required for the microorganism to performed biological decomposition of dissolved solids or organic matter in the wastewater under aerobic conditions ((Solanki and Pandit 2006) [20]. The biochemical oxygen demand in the sampled water from Kpata River was 1.30 mg/L. The low level of BOD recorded in this study could be as a result of less vegetation in the study area (Reddy *et al*., 2009) [15]. The biochemical oxygen demand value was within the standards for drinking water (WHO, 1998) [23].

3.1.8 Iron
The water concentration of Fe in Kpata River was 30.17 mg kg^{-1} (Table 2). This value exceeded the permissible limit set by the WHO for drinking water (WHO, 2011). These high Fe values might be due to the run-off from domestic and urban wastes. This could lead to toxicity. Though excessive iron is not stored in the body, impaired ability to regulate iron absorption may result in siderosis in liver, pancreas, adrenals, thyroid, pituitary and heart and which could manifest as cirrhosis, adrenal insufficiency, heart failure or diabetics (Abdulmalik *et al*., 2018) [1].

3.2. Zinc
Zinc is a ubiquitous metal present in the environment. The water concentration of Zn in Kpata River was 1.32 mg kg^{-1} (Table 2). This value was within the acceptable limit recommended by WHO for drinking water (WHO, 2011) [24]. This finding is similar to the observation of Abdulmalik *et al*. (2018) [1], although from a different River.

3.2.1 Manganese
The water concentration of Mn in Kpata River was 0.60 mg kg^{-1} (Table 2). This value exceeded the permissible limit of standard of drinking water prescribed by WHO (WHO, 2011) [24]. The higher Mn concentration may be attributed to the addition of agricultural run-off, sewage and domestic wastes in the River. Abdulmalik *et al*. (2018) [1] in a related experiment reported higher values of Mn from River Lavun, Bida, Northern Nigeria.

3.2.2 Nickel
Nickel is a moderately toxic element and consumption of water or food with high Ni content may cause serious health problems (Osibanjo *et al*., 2011). The water concentration of Ni in Kpata River was 0.16 mg kg^{-1} (Table 2). The water concentration of Ni exceeded the permissible limit set by the WHO for drinking water (WHO, 2011) [24].

4. Conclusion
The study revealed that all the physico-chemical parameters determined were within the permissible limits as prescribed by World Health Organization but the presence of some heavy metals such as Fe, Mn and Ni above the allowable limit makes the River water unsafe for domestic use and consumption.

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