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Assessment of Physicochemical Characteristics of Lower River Niger at Kpata, Adankolo and Gadumo Stations in Kogi State, Nigeria

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ABSTRACT: The present work was conducted to study the physicochemical parameters of lower River Niger at Lokoja and Ajaokuta local government area of Kogi state, with the aims to determine the physical and chemical situation of the River at this point in time, compare the physical and chemical situation of the river with earlier work done on River Niger and other relevant water bodies by relevant authors also to determine its suitability for fish growth and survival at this point in time. Water samples were collected for four month (January to April) at three sampling site (two site from Lokoja and one from Ajaokuta local government area) and analysed for various physicochemical parameter. The mean temperature values ranged from 23.55 - 28.35^{0}C at Kpata station, 24.65- 29.75^{0}C at Adankolo station and 23.90-28.90^{0}C at Gadumo station. The mean pH values ranged from 6.69-8.15 at Kpata station, 6.60-8.30 at Adankolo station and 6.10-8.20 at Gadumo station. The mean electrical conductivity values ranged from 68.50-135.50µS/cm at Kpata station, 68.00-122.50 µS/cm at Adankolo station and 68.00-122.50 µS/cm at Gadumo station. The mean dissolved oxygen (DO) values ranged from 6.10-9.30 mg/l at Kpata station, 5.65-7.78 mg/l at Adankolo station and 6.10-9.30 mg/l at Gadumo station. The mean transparency values ranged from 0.31-0.60m at Kpata station, 0.31-0.60m at Adankolo station and 0.30-0.44m at Gadumo station. The mean biochemical oxygen demand (BOD) values ranged from 2.10-2.95 mg/l at Kpata station, 2.05-3.25 mg/l at Adankolo station and 2.10-4.00 mg/l at Gadumo station. The mean nitrate values ranged from 0.02-0.05 mg/l at Kpata station, 0.02-0.03 mg/l at Adankolo station and 0.02-0.04 mg/l at Gadumo station. The mean phosphate values ranged from 0.48-0.61 mg/l at Kpata station, 0.51-0.65 mg/l at Adankolo station and 0.49-0.64 mg/l at Gadumo station. The study indicated that the mean value of the studied parameters which include pH, temperature, dissolved oxygen, Electrical conductivity, biochemical oxygen demand, nitrate, transparency and phosphate of the River compares slightly favourably with the work of other researchers and within the range that support fish growth and survival. This indicates that the river is in a healthy state and is favourable for fish growth and survival.

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Most of the earth is covered by water, about 70% is occupied by freshwater and oceans. The vast majority of that water, however, is in forms unavailable to land-based or freshwater ecosystems. Less than 3 percent is freshwater, most of which are not potable for drinking, or easily available to irrigate crops. And of that 30%, more than two-thirds is locked in glaciers and ice caps. Freshwater lakes and Rivers hold 100,000 km^3 globally, less than one ten-thousandth of all water on earth (Jackson *et al*., 2001). On earth, water is an essential natural resource for sustaining life and the environment (Dikio, 2010). One of the key sources of water supply is Riverine system, all around the globe, which provide water for agriculture, drinking, industrial and many other purposes (Malik *et al.,* 2012; Ullah *et al.,* 2014b). Rivers are invaluable ecological resources that serves many human needs and therefore, enhance our lives by providing a lot of opportunities. This explain why a large proportion of the Nigeria population lives near water bodies such as Rivers, reservoirs, lakes, swamps and coastal, lagoons. Many depend heavily on the resources of such water bodies as their main source of animal protein and family income (Haruna *et al*., 2006). Water from Rivers have been employed for different purposes in different sectors of human development such as public water supply, aquaculture, transportation, industries, agriculture, cleaning and many other domestic purposes. Therefore owing to its multi uses, it has been felt as necessary to monitor water quality of River ecosystems all around the world in order to assess their capacity of production, potential of utility and for planning restorative and future measures (Das and Sinha, 1993). But unfortunately these resource has been polluted throughout the world and still under further contamination. At source, water is relatively pure, but it is contaminated on account of different reasons including its use, land use, urbanization, industrialization, agricultural runoffs, elevation in the use of chemicals, abstractive utilization of water, household use of chemicals like detergents and soaps etc. (Ullah *et al.,* 2014c). Dams, Wells, Rivers etc. play vital and extraordinary role in agriculture, fishery, and electricity, industries along with its huge use for domestic and drinking purpose. Contamination of water primarily influences its chemical nature and also damages the community alarming the delicate food web. Miscellaneous uses of water reservoirs are

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seriously diminished because of contamination and pollution. Pollution of water is a universal problem, so its active ensuring is required (Altaf *et al,* 2013 and Dhirendra *et al*., 2009). Countless factors are responsible for water pollution, which makes it moderately unbefitting for life. Such factors includes: Emancipation of sewage, which affects the dissolved oxygen and nutrient contents of water leading to destabilization and unbalanced aquatic life. Pollution effortlessly rises and increases with increase in population (Oluyemi *et al*., 2010). It is a communal practice of those people who live near the River catchments to discharge their excreta and domestic wastes into the Rivers. Both wild and domestic animals' use same drinking water and contaminates and pollutes water through direct defecation and urination (Ugwu *et al*., 2012). Both physical and chemical properties of water are frequently changed when it is contaminated with heavy metals and other pollutants, which makes water inappropriate and inconvenient for plant growth and other activities. pH, Organic matter, clay minerals, redox potential, temperature and interrelationships between heavy metals are all themselves physicochemical factors which affect the relationship between microorganisms and toxic metals (Mlitan *et al*., 2015). River Niger is the main source portable water for to a great number of people in the continent of Africa, Nigeria and Kogi state. This study will provide basic information on the physicochemical parameters that promote the growth of phytoplankton and zooplanktons.

MATERIALS AND METHODS

Study area: The study was carried out in the portion of the lower River Niger that falls in Ajaokota (6^0 45'E, 6^0 41'E) and Lokoja (7^0 48'N, 7^0 28'N) (a confluence town of River Niger and Benue) local government areas of Kogi state. The wet season begins mostly in the late April and end in late October. Sampling was carried out in three months (January to April) water sample were obtained from three sampling stations on the lower Niger River which are Kpata, Adankolo and Gadumo station. The sampling station are located few meters away from the bank. The River covers part of Bassa, Igalamela-odolu, Kabba Bunu, Idah, Ajaokuta, Ibaji and Kogi local government area of Kogi State, Nigeria and falls within the humid tropical rain forest of Nigeria (Fig 1).

Water Sample Collection: Water samples were collected twice a month (first and fourth week) from 5^{th} January to 23^{th} April, 2018. A total of 24 samples for the study period. The samples were collected in clean plastic bottles of 2 litre capacity, the bottles were soaked in iodide solution for four days in the laboratory, and the solution was then poured out and rinsed thoroughly with distilled water to sterilize (Haruna, 1992). At the River bank the bottle were rinsed thoroughly with the River water before collecting the samples. One samples was collected at the centre of the River, 10 cm below the surface at each station (i.e. kpata, Adankolo and Gadumo station) on the first and fourth week of the month. All the samples were collected between 6am to 8am.

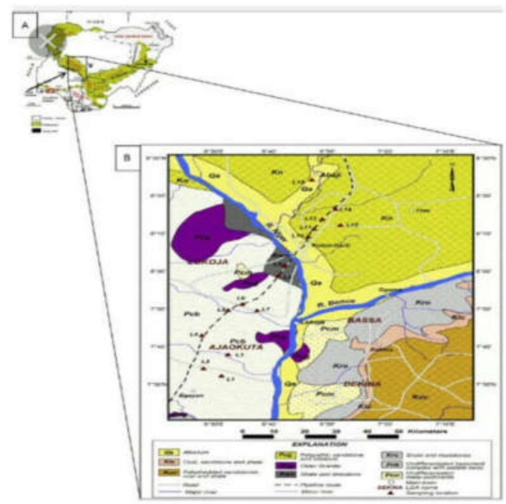

Fig **1**: Map of Kogi state showing Lokoja and the lower River Niger in the state and the three sampling station (kpata, Adankolo and Gadumo station). Source: Sciencedirect.com

Determination of the Physicochemical Parameter of the River: Some parameters (Temperature, dissolved oxygen, pH, electrical conductivity and transparency) were measured on site using automatic readers while others which include phosphate, nitrate, biochemical oxygen demand) were analysed in the lab immediately after collection.

Water Temperature: The temperature of the sampling stations was measured using the mercury in glass thermometer calibrated from 0^0c to 110^0c, the measurement was done by dipping the thermometer into the river at about 5cm below the surface level, and the values were recorded.

pH: The pH was measured using the pH 2606 meter. The probe of the pH meter was dipped into the River. The meter reading came to equilibrium and the reading was recorded.

Electrical Conductivity: The probe of the instrument (conductivity meter DDS-307) was rinsed with distilled water and then dipped into the sample. It was allowed for sometimes for the reading to stabilize and the reading was recorded.

Dissolved Oxygen: The instrument (portable dissolved oxygen analyser model JPB-607) was switched on and the probe was dipped into the water for about 5 minute for the reading to stabilize. The reading was then recorded.

Transparency: A Secchi disc which is about 20cm in diameter painted black and white quadrants and attached to a calibrated line was used. The measurement was achieved by lowering the secchi disc into the water until it disappears; the station was marked with a masking tape on the rope attached to the disc. The secchi disc was then raised until it appeared, the station was also measured and the reading taken by measuring with a tape rule. The average depth of disappearance and reappearance was recorded as the depth of the secchi disc transparency.

Biochemical Oxygen Demand (BOD): BOD measurement requires taking two measurements. One was measured immediately for dissolved oxygen (initial) using dissolved oxygen meter on site, the second is incubated in the lab for 5days by rapping the sample in a black polythene bag, the dissolved oxygen was then measured (final). These represent the amount of oxygen consumed by micro-organisms to break down the organic matter present in the sample during the incubation period.

Phosphate: 50ppm of phosphorus was prepared from 1000ppm, and from it 0.2, 0.4, 0.8 and 1.0ml were pipetted to different standard flasks. 8ml of ascorbic acid solution was added and make up to 50ml with distilled water. 25ml of water samples were pipetted into 50ml with distilled water. 8ml of ascorbic solution was added and made up to 50ml. the solution was allowed to stand for 30 minutes and absorbance was read from spectrophotometer at 660nm. The graph of absorbance was plotted against concentration and samples concentration was evaluated from the graph. The phosphate was obtained by multiplying the reading from the graph by 80mg/l (APHA, 1985).

Nitrate: In determining nitrate concentration, 0.5ml of each sample was pipetted into test tubes; 1ml of 5% salicylic acid solution was added to each test tube and mixed thoroughly. This was allowed to stand for 30minutes, after which 10ml of 4M of NaOH solution was added. It was allowed to stand for one hour for colour development and 12 hours for colour stabilization. The absorptions were read from spectrophotometer at 410 NM. Reading from the graph was multiplied by a factor of $4.6*10^4$ (APHA, 1985).

Statistical Analysis: Data collected were subjected to analysis of variance (ANOVA) and difference between treatments means were separated using Duncan's multiple range test (Steel and Torrie, 1980). Statistical software package- SPSS was used to analyse the data.

RESULTS AND DISCUSSION

Temperature: The mean temperature values ranged from 23.55 - 28.35^{0}C at Kpata station, 24.65- 29.75^{0}C at Adankolo station and 23.90-28.90^{0}C at Gadumo station. The highest temperature mean value of 26.80^{0}C, 27.63 ^{0}C, and 27.20 ^{0}C were recorded in the month of April at Kpata and Adankolo and in the month of March in Gadumo station, while the lowest temperature value of 23.90^{0}C, 24.85^{0}C and 24.85^{0}C were recorded in the month of February at Kpata station and in January at Adankolo and Gadumo station. The total mean value of the three stations was 25.76^{0}C, 26.41^{0}C and 26.51^{0}C.

pH: The mean pH values ranged from 6.69-8.15 at Kpata station, 6.60-8.30 at Adankolo station and 6.10-8.20 at Gadumo station. The highest pH mean value of 7.73, 8.23, and 8.10 were recorded in the month of February at Kpata station and in April at Adankolo and Gadumo stations, while the lowest pH value of 6.73, 7.18 and 6.20 were recorded in the month of March at Kpata and Adankolo stations and in January at Gadumo station. The total mean value of the three stations were 7.21, 7.67 and 6.91.

Electrical Conductivity: The mean electrical conductivity values ranged from 68.50-135.50µS/cm at Kpata station, 68.00-122.50 µS/cm at Adankolo station and 68.00-122.50 µS/cm at Gadumo station. The highest electrical conductivity mean value of 106.75 µS/cm, 95.25 µS/cm, and 104.25 µS/cm were recorded in the month of January at Kpata, Adankolo and Gadumo stations, while the lowest electrical conductivity value of 77.75 µS/cm, 84.00 µS/cm and 81.50 µS/cm were recorded in the month of March at Kpata and Gadumo stations and in April at Adankolo station. The total mean value of the three stations were 88.31 µS/cm, 90.06 µS/cm and 93.75 µS/cm.

Dissolved Oxygen (DO): The mean dissolved oxygen (DO) values ranged from 6.10-9.30 mg/l at Kpata station, 5.65-7.78 mg/l at Adankolo station and 6.10-9.30 mg/l at Gadumo station. The highest dissolved oxygen (DO) mean value of 7.23 mg/l, 7.67 mg/l, and 8.35 mg/l was recorded in the month of April at Kpata, Adankolo and Gadumo stations, while the lowest dissolved oxygen (DO) value of 77.75 mg/l, 84.00 mg/l and 81.50 mg/l were recorded in the month of March at Kpata, Adankolo and Gadumo stations. The total mean value of the three stations were 6.34 mg/l, 6.72 mg/l and 7.36 mg/l.

Transparency: The mean transparency values ranged from 0.31-0.60m at Kpata station, 0.31-0.60m at Adankolo station and 0.30-0.44m at Gadumo station. The highest transparency mean value of 0.55m, 0.60m, and 0.42m were recorded in the month of April at Kpata station, Adankolo station and in April and February at Gadumo station, while the lowest transparency value of 0.31m, 0.32m and 0.33m were recorded in the month of April at Kpata, Adankolo and Gadumo station. The total mean value of the three stations was 0.40m, 0.44m and 0.40m.

Biochemical Oxygen Demand: The mean biochemical oxygen demand (BOD) values ranged from 2.10-2.95 mg/l at Kpata station, 2.05-3.25 mg/l at Adankolo station and 2.10-4.00 mg/l at Gadumo station. The highest biochemical oxygen demand (BOD) mean value of 2.83 mg/l, 2.85 mg/l, and 3.05 mg/l was recorded in the month of April at Kpata, Adankolo and in February at Gadumo station, while the lowest biochemical oxygen demand (BOD) value of 2.15 mg/l, 2.13 mg/l and 2.13 mg/l was recorded in the month of March at Kpata and in march at Adankolo and Gadumo station. The total mean value of the three stations was 2.44 mg/l, 2.44 mg/l and 2.68 mg/l.

Phosphate: The mean phosphate values ranged from 0.48-0.61 mg/l at Kpata station, 0.51-0.65 mg/l at Adankolo station and 0.49-0.64 mg/l at Gadumo station. The highest phosphate mean value of 0.60 mg/l, 0.65 mg/l, and 0.60 mg/l was recorded in the month of January and February at Kpata station, and in march Adankolo and Gadumo station, while the lowest phosphate value of 0.48 mg/l, 0.52 mg/l and 0.51 mg/l were recorded in the month of April at Kpata and Gadumo stations and January and April at Gadumo station. The total mean value of the three stations was 2.44 mg/l, 2.44 mg/l and 2.68 mg/l.

Nitrate: The mean nitrate values ranged from 0.02-0.05 mg/l at Kpata station, 0.02-0.03 mg/l at Adankolo station and 0.02-0.04 mg/l at Gadumo station. The highest nitrate mean value of 0.04 mg/l, 0.18 mg/l, and 0.03 mg/l were recorded in the month of January at Kpata station, and in march at Adankolo station and in February, march and April at Gadumo station, while the lowest phosphate value of 0.02 mg/l, 0.02 mg/l and 0.02 mg/l were recorded in the month of march and April at Kpata station and in April at Adankolo station and January at Gadumo station. The total mean value of the three stations were 0.03 mg/l, 0.02 mg/l and 0.03 mg/lThe results of the mean value of the physicochemical parameters of lower river Niger at Kpata, Adankolo and Gadumo stations are shown in Figure 4.1 to 4.8 below:

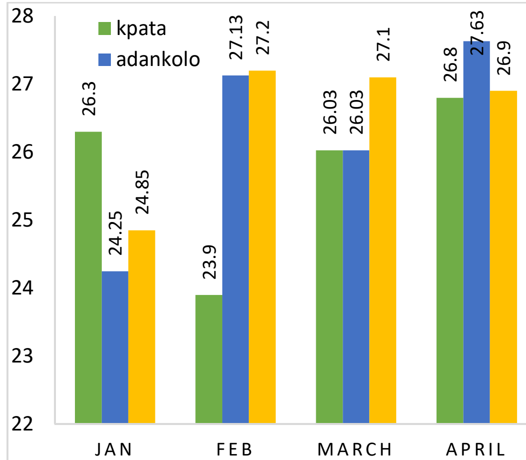

Fig 2: Graph of the mean temperature values

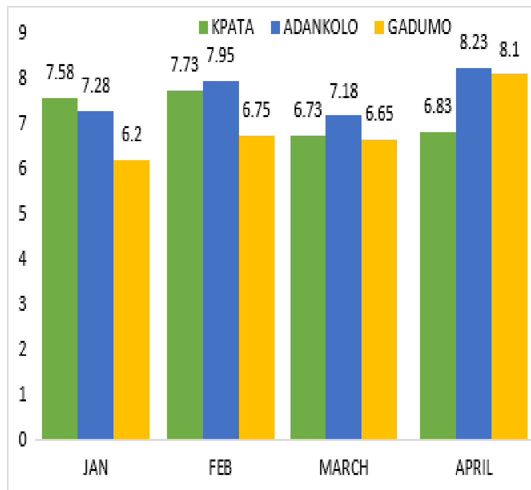

Fig 3: Graph of the mean pH values

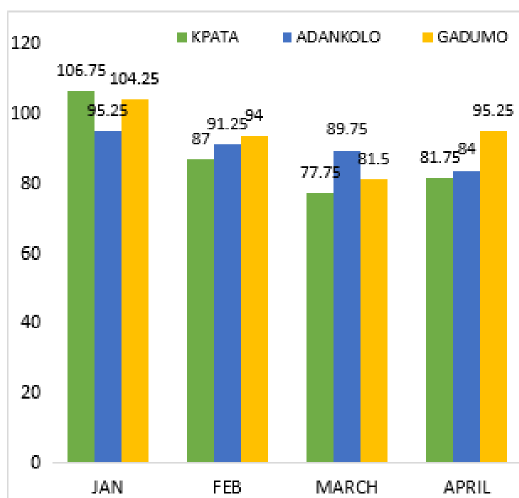

Fig 4: Graph of the mean electrical conductivity values

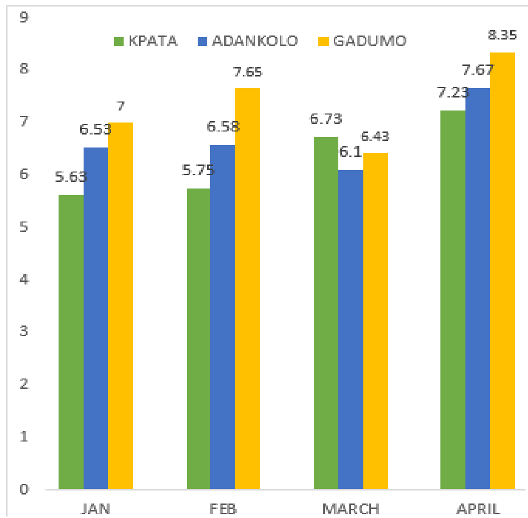

Fig 5: Graph of the mean dissolved oxygen values

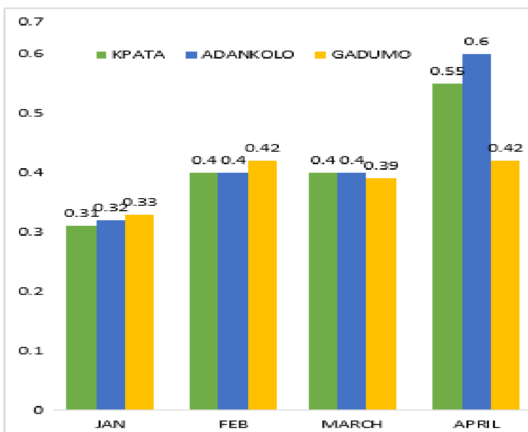

Fig 6: Graph of the mean transparency values

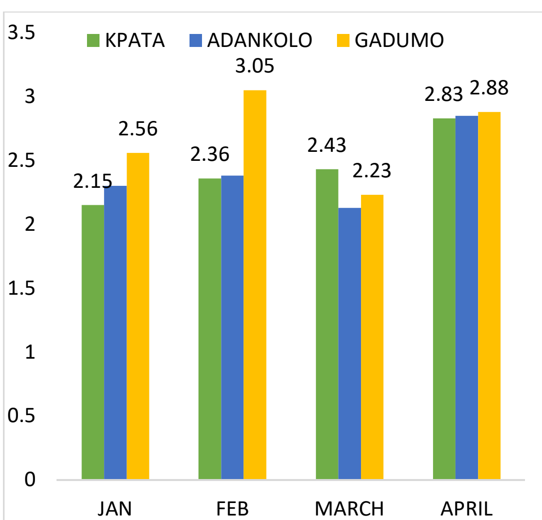

Fig 7: Graph of the mean Biochemical oxygen demand values

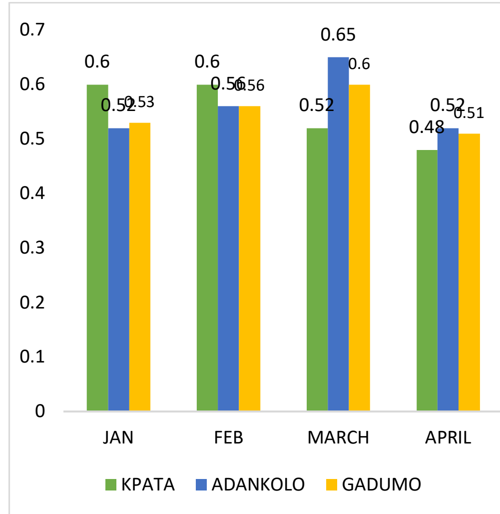

Fig 8: Graph of the mean phosphate values

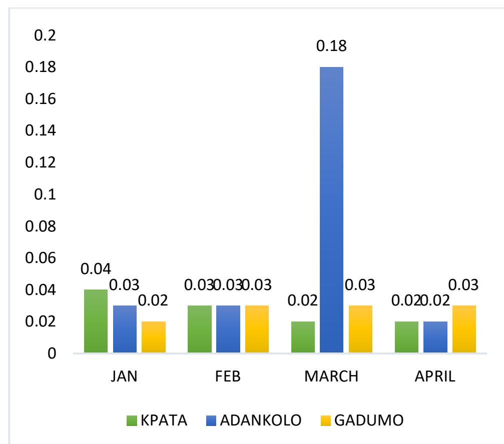

Fig 9: Graph of the mean nitrate values

The mean Water temperature are 25.76^{0}C, 26.41^{0}C and 26.51^{0}C at Kpata, Adankolo and Gadumo station respectively. A slightly similar mean water temperature of 27.60^{0}C was also reported by (Gideon *et al*., 2013 and Ige *et al.*, 2008) while a slightly lower mean water temperature of 18.44^{o}C was reported by (Rauf *et al*., 2015) in River Kabul, Pakistan the mean temperature of the three stations slightly conform to that reported by (Olatunji, 2011).

The pH concentration of the study area ranges from 6.69-8.15 at kpata station, 6.60-8.30 at Adankolo and 6.10-8.20 at Gadumo station and a mean pH of 7.21, 7.67 and 6.91 respectively are circumneutral and thereby suitable for fish growth. This results agree with Ali *et al*., 2013 who reported a mean pH of 7.25, 8.17 reported by Rauf *et al*.,2015 in River Kabul, Pakistan and a range of 6.78-7.50 in Lower River within Lokoja and Ajaokuta local government area.

Ogolo *et al*., 2017 reported a mean pH of 6.51, this value is lower compared to that obtained from Kpata, Adankolo and Gadumo station indicating that the River is more acidic compared to the lower River Niger in this study area. These values conforms to most fresh water pH (Chapman, 1992). The acceptable range for fish culture is normally between pH 6.5-8.5 (Swann, 2007). The mean pH and range of the study area conform to the acceptable range reported by (Swann, 2007). Electrical conductivity of the analysed water samples range from 68.50-135.50 µS/cm, 68.00-122.50 µS/cm and 79.50-112.00 µS/cm this values are slightly lower 99.0 µS/cm and 180.5 µS/cm reported by Dimowo (2013) in River Ogun in the month of February 2012 and December, 2011 respectively, 74.6-510 µS/cm reported by Raji *et al*., (2015) in River Sokoto, 113-287 µS/cm reported by victor *et al*., (2013) in the flooded areas of lower River Niger in Lokoja. Lower value was observed of 6.0 – 17.0µS/cm reported by (Sikoki and Anyanwu 2013).

The mean Dissolved oxygen concentration for Kpata, Adankolo and Gadumo station are 6.34 mg/l, 6.72 mg/l and 7.36 mg/l, while the range are 5.10-7.65mg/l, 5.65-7.78mg/l and 6.10-9.30mg/l respectively. The range compares favourably with 7.20mg/l to 9.25mg/l reported by Ali *et al*., 2013 in lower River Niger, lokoja, 3.22mg/l to 6.42mg/l reported by Adeola *et al*., (2015) in Nwala creek. A transparency of 0.20m to 0.70m was reported by Dimowo, (2013) in River Ogun, this result was slightly below the range observed in the study area which are 0.31m-0.60m, 0.31m-0.60m and 0.30m-0.44m for Kpata, Adankolo and Gadumo station. The highest transparency value of 0.6om was observed at Adankolo station, the high water transparency at this station could be as a result of the low human activities around the River compared to the Kpata stations. While the lowest transparency of 0.31m was recorded at Kpata station due to increase human activities. Boyd (1998) reported 0.30-0.60m as the acceptable range of dissolved oxygen required for the optimum growth and reproduction of freshwater fishes. The range of transparency recorded at the three stations fell within the acceptable range reported Boyd (1998). Thus the River is suitable for fish growth and reproduction. The Biochemical oxygen demand values ranged from 2.10 mg/l-2.95 mg/l, 2.05 mg/l-3.25mg/l and 2.10 mg/l-4.00mg/l for Kpata, Adankolo and Gadumo station, the observed range are slightly similar to 1.27 mg/l-2.57mg/l reported by Ali *et al.,* (2013) in lower River Niger, Lokoja, 3.5mg/l to 3.9mg/l reported by Stanley *et al*., (2017) in new Calabar River. The mean BOD values of Kpata, Adankolo and Gadumo station of the lower Niger River were above 2 mg/L and their statistically difference with the three stations may be attributed to the observed human activities such as washing, dumping of refuse and sewage into the River channel. Based on classification of aquatic bodies, unpolluted (BOD <1.0mg/L), moderately polluted (BOD <10.0mg/L) and heavily polluted (BOD >10.0mg/L) (Maria 1983 and Adakole *et al*., 2002). BOD above 1mg/L is associated with waste water contamination (UNESCO, WHO and UNEP, 1998). Based on the classification of aquatic bodies, the mean BOD of lower River Niger at Kpata, Adankolo and Gadumo station was less than 10mg/l, thus it is moderately polluted and suitable for the growth and survival of aquatic live such as fish. Phosphate concentration in this investigation varied from 0.48 mg/l -0.61mg/l, 0.51 mg/l -0.65mg/l and 0.49-0.64mg/l for Kpata, Adankolo and Gadumo station. The observed range is similar to 0.4 mg/l to 0.6 mg/l reported by Rauf *et al*., (2015) and are lower than 0.33 mg/l -3.30mg/l reported by Ali *et al*., (2013) in lower River Niger at Lokoja and also comparable to the 0.04 mg/l – 0.78mg/l gotten by Wokoma (2010) in the Elechi Creek. 0.11 mg/l – 0.80mg/l,(Wokoma and Njoku, 2017) in the lower Sombreiro River, Niger delta and 0.11-0.59mg/l reported by Raji *et al*., (2015) in River Sokoto, 0.01 mg/l to 0.7mg/l observed in River Ogun between February and March (Dimowo, 2013). The range of phosphate recorded at the three stations fell within the acceptable range reported by Swann (2007). Thus the River is suitable for fish growth and reproduction. But the phosphate level in the study area was low compared to the value reported by Ali *et al*., (2013), this overall low level of phosphate is probably due to the absence or little amount of rainfall to wash fertilizer from farmland into the River as the value obtained by Ali *et al*., (2013) include both the rainy and dry season, in the rainy season large amount of phosphate from fertilizer are wash into the River through runoffs. The nitrate concentration in the study area are lower compared to 6.6 mg/l -19.7mg/l reported by Raji *et al*., 2015, in River Sokoto,1.50 mg/l – 17.5mg/l reported by Ali *et al*., 2013 in lower River Niger, 0.05 mg/l – 7.75 mg/l reported by Wokoma and Njoku *et al*., 2017 and 0.013 mg/l – 0.158 mg/l gotten by Edoghotu and Aleleye – Wokoma (2007), 0.0 – 1.72 mg/l observed by Ogamba *et al*., (2004) and slightly similar to 0.02mg/l in Oji-Aji location reported by Gideon *et al*., (2013) in River Okura, 0.0 – 0.6 mg/l by Sikoki and Anyanwu (2013), 0.24 mg/l - 0.33mg/l reported by (Stanley *et al.,* 2017). The highest nitrate level of 0.05 mg/l was gotten at Kpata station this might be due to human activities such as irrigation near the River, discharge of domestic sewage and other organic waste material into the River at that station. The nitrate in the study area was low, this overall low level of nitrate is probably due to the absence or little amount of rainfall to wash fertilizer from farmland into the River. High nitrate levels greater than 1mg/L are not good for aquatic life (Johnson *et al.,* 2000). The nitrate observed at the three station are less than 1mg/l and good for aquatic life including fish. Boyd (1998) and Swann (2007) reported 0.2-10mg/l and 0.0-30mg/l respectively as the acceptable range of nitrate required for the optimum growth and reproduction of freshwater fishes. The range of nitrate recorded at the three stations fell within the acceptable range reported by Boyd (1998) and Swann (2007). Thus the River is suitable for fish growth and reproduction.

Conclusion: The results showed that water from lower River Niger at Lokoja and Ajaokuta local government area, having passed majority of the water quality criteria for productivity, is a productive water system.

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