INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Comparative Analysis of Trace Metals Content of Rivers Niger and Benue in Lokoja, Kogi State, Nigeria

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Abstract:
The aim of this research is to determine the levels of some heavy metals content of Rivers Niger and Benue at Lokoja and compare these levels with internationally required or permissible standards for aquatic and human consumption. Four sampling stations each were located on Rivers Niger and Benue at Lokoja, Kogi State. Two water samples were collected from each of the sampling stations once during the second week of each month from April 2019 to March 2020 (12 months). The collected water samples were well preserved and immediately transported to the laboratory for their trace metals content analysis. The analyzed results indicated very low levels of Mn, Cu, Zn, Cr, Pb, and Ca in both rivers, despite their comparatively close variations. The two rivers showed variations in their heavy metal levels without significant difference ($P<0.05$) among their stations for K, Mg, Fe and Ca, while variation with significant difference ($P<0.05$) were seen in their Na, Mn, Cu, Pb and Cr concentrations. Most stations in Rivers Benue displayed higher levels of Na, K, and Mg than stations in River Niger. However, both Rivers have high levels of Fe that ranged between 2.33 mg/l to 2.52 mg /l, which are far above the internationally permissible level of 1mg/l (EPA, 1986) for aquatic organisms and human consumption. The research indicated that most aquatic animals in Rivers Niger and Benue at Lokoja are lacking the importance of most trace metals sampled especially Na, K, Mg, Mn, Zn and Ca which are required for bone, teeth development and general growth. Hence, supplementary sources of Na, K, Mg, Mn, Zn, Cu, Mg and Ca are recommended for water from these rivers for fish culturing, breeding and domestic use. Proper and adequate processing methods should also be employed in treating these water contents for drinking and fish culturing because of the high lethal levels of Fe found in both rivers. All forms of water pollution activities should be discourage through public enlightenment campaigns. All laws and regulations concerning environmental sanitation and indiscriminate waste disposals should be adequately enforced.

Keywords: *Trace /heavy metals, Variations, significant difference*

1. Introduction

'Water is vital to life but it is never sufficient' (Kofi, 2001). Yet, we continue to act as if fresh water were perpetually abundant resource.

Fresh water is mostly not abundant for human and livestock because of the various pollution sources mainly from wastes disposal, sewage, industrial wastes and agricultural chemicals such as fertilizers and pesticides which are the main causes of water pollution (USA, EPA, 2006).

Heavy metals sometimes referred to as trace elements are part of the chemical materials resulting from water pollution all over the world.

Some of these elements are actually necessary for humans in minute amounts (Cobalt, Copper, Chrominun, Manganese, Nickel) while others are carcinogenic or toxic, affecting, among others, the central nervous system (Manganese, Mercury, Lead, Arsenic), the kidneys or liver (mercury, lead, cadmium, copper) or skin, bones, or teeth (nickel, cadmium, copper, chromium) (Zevenhoven and Kilpinen, 2001).

Rivers Niger and Benue like other rivers play a major role in assimilation or carrying off the municipal and industrial waste water runoff from agricultural land. 'The river system is most adversely affected due to their dynamic nature and an easy accessibility for the waste water disposal directly or indirectly through drains and tributaries' (Joseph, 1997).

Rivers Niger and Benue are major sources of water supply and economic activities to all towns and villages through which they flow, especially Lokoja. Residents have been observed to engage in farming activities around these rivers and practice indiscriminate dumping of refuse and waste into these rivers at convenience without considering the health implications.

1.1. Problem Statement/Justification

Water, because of its absolute importance to life is classified as one of the first class needs of all living things weather terrestrial or aquatic. It is required for living and for economic activities of which rivers Niger and Benue are notable examples of this fact. The quality and safety level of water these two rivers are been highly contaminated and degraded through agricultural, industrial, sewage and domestic wastes pollution making their water supply hazardous to the community using them and even to their own ecosystem. This research is therefore very important to continually measure and monitor the water quality parameters of these water bodies especially their trace metals contents so that strategies can be put in place for them to provide good, safe and sustainable water for aquatic and domestic activities. Result from this research can also serve as a guide in drawing management plans and policies for commercial fish culturing on Rivers Niger and Benue at Lokoja especially cage culturing in our efforts in solving fish protein shortage.

1.2. Objective (S)

The major objective of this research work is to determine and compare the levels of the selected trace metal contents of Rivers Niger and Benue at Lokoja, Kogi State.

The working objectives are:

- To determine the levels of the major trace metals in Rivers Niger and Benue at Lokoja.
- To compare the level of these trace metals between Rivers Niger and Benue at Lokoja.
- To compare the levels of the selected trace metals in Rivers Niger and Benue at Lokoja with internationally desirable and permissible levels for human and aqua cultural use/activities.

2. Literature Review

According to United Nations Secretary General, (Kofi, 2001) Fresh water is irreplaceable: there are no substitutes for it. But our method and level of using this very important resource determine the quality and quantity of fresh water we can access. 'Natural water, when not tampered with by man, exhibits a closed cycle' (Ojutiku, 2008). The chief drawback of river water is that it is always grossly polluted and is quite unfit for drinking because they are contaminated with hazardous elements / heavy metals without treatment. Pollution of the environment by heavy metals is also common in industrial areas including where constant sewage and waste disposals are not controlled. 'The quality and quantity of trace metals may vary depending on the surrounding parent rock, sediments and water source' (Ronald, 1993). 'Cadmium for example is toxic to both human and fish and seems to be a cumulative toxicant. Small salmon fry has been killed from concentration of 0.03mg/l of cadmium' (Brown, 2003). Clarity of water is no guarantee that the river water is safe for drinking. River water contains dissolved and suspended impurities of all kinds. The bacterial count, including the human intestinal organisms may be very high. 'The impact of pollution discharged into rivers affects the entire environment along the entire course of rivers and water bodies into which they flow' (Allan, 1998). 'The capacity of river self-purification is an important indicator for its health and in regulating the discharge standards' (Shimin, *et al* 2011).

Boyd (1979), defined water quality as its affects the life of fish and other aquatic organisms, that all water quality parameters including trace metal should be assessed as it affect the well-being and performance of fish but these are not enough to be criteria for assessing water for home or domestic use.

The modern researchers are more concerned about the quality and safety of our accessible water for the teeming population, but the major challenge in this area is the challenge of proposing all-encompassing criteria for water quality for specific use (Ajibade *et al,* 2008).

Lloyd (1992) concluded that as long as we cannot derive the maximum benefits from our water sources due to impermissible levels of contamination from human and natural sources, then accepting our water as polluted is unavoidable. 'The primary concern of aqua culturist is usually whether heavy metals occur in potentially lethal concentrations' (Stirling, 1985), which is the core basis for this research on Rivers Niger and Benue at Lokoja, Kogi State.

3. Methodology

This study area is to cover Rivers Niger & Benue areas at Lokoja and Bassa L.G.A. of Kogi State. The location for the research is in the middle belt zone of Nigeria and so enjoys the two major seasons – raining and dry seasons. Lokoja area is known to be generally high in temperature accompanied by hot weather. Sometime temperature can be above 29^0C. However, the vegetation also witness heavy downpour during rainy seasons, comprising of mainly grasses & scattered trees & shrubs.

3.1. Location of Sampling Stations

Four sampling stations were located along the course of the each of the two rivers at Lokoja to give a total of eight sampling stations. The four located sampling stations on River Niger are located at Sarkin–Noma, Old market water side, Pata water side and at NIWA ferry yard (Marine), while that of Benue are at Sheria, Oguma, Gbobe and at Mozum. The distances between each of the stations were about 50 nautical miles. Two samples of water samples were collected in a 50 mls capacity stop cork bottle containers from each of the sampling stations identified above. The first set of water samples from each station were collected at the river bank while the second set of water samples were collected at the pelagic region (open water) with the means of a rented engine boat once during the second week of each month for 12 calendar months from April 2019 to March 2020.

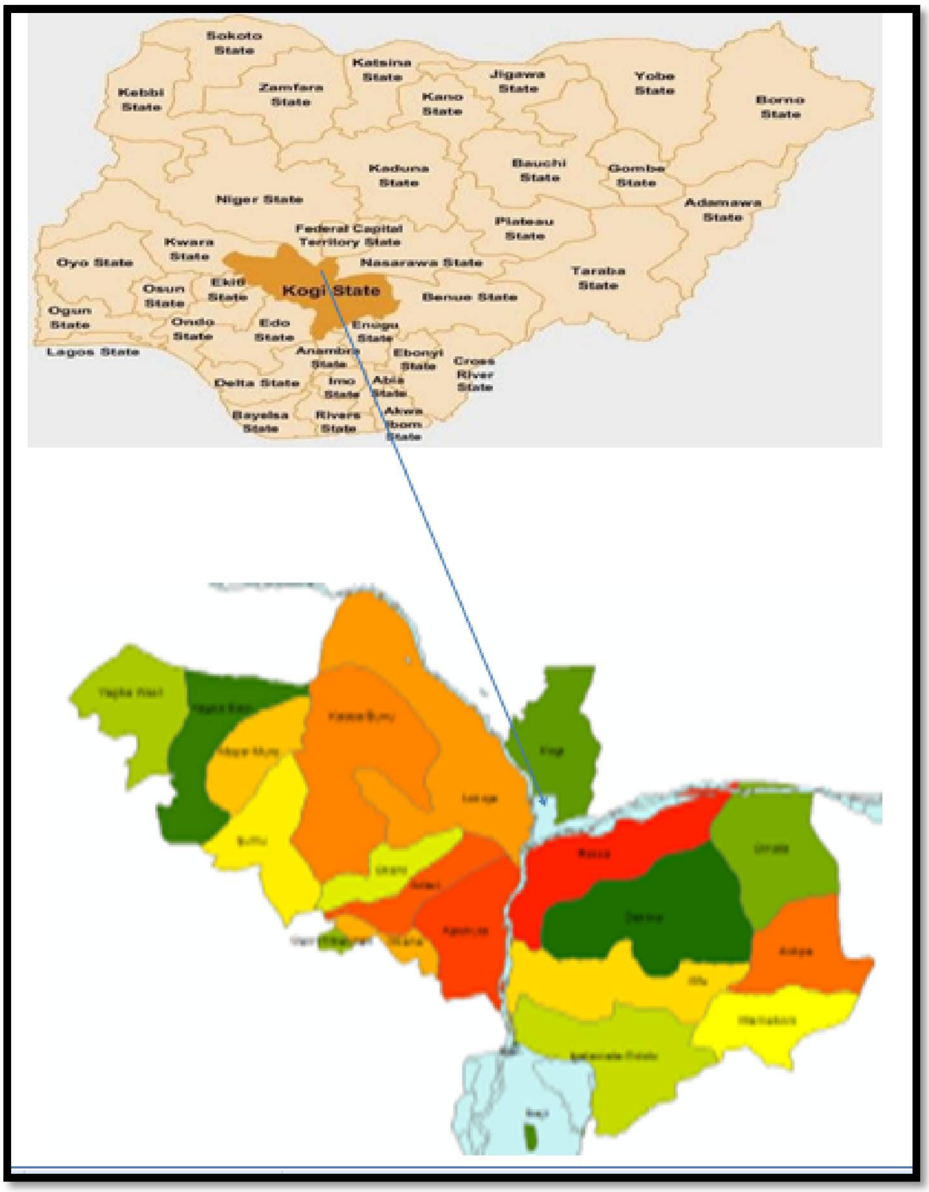

Figure 1: Map of Kogi State Showing Rivers Niger, Benue & the L.G.A.
Scale: 1 Cm = 1895 Km

3.2. Transportation and Laboratory Analysis of Collected Water Samples

The collected water samples were well preserved and transported immediately for analysis at the Department of Water Resources, Aquaculture, and Fisheries Technology and at the Central Laboratory, both of F.U.T., Minna, Niger State. All data obtained were subjected to one-way analysis of variance (ANOVA) MINITAB VERSION 14.0 and the means separated using student new- man keul test for concentration level of each of the selected trace metals per station.

4. Discussion of Results

Parameters	Sarki Noma (ST1)	Old Market (ST2)	Pata Water Side (ST3)	NIWA Ferry Yard (ST4)	Sheria (ST1)	Oguma (ST2)	Gbobe (ST3)	Mozum (ST4)
	Stations							
	River Niger				**River Benue**			
Na (mg/l)	6.80 ±0.02 [a]	6.12±0.12[a]	7.00±1.022[a]	5.1±0.03[b]	6.91±0.13[a]	6.32±1.31[a]	6.42±0.31[a]	6.12±0.12[a]
K (mg/l)	6.72±0.12[a]	6.42±0.17[a]	6.81±0.16[a]	6.92±0.32[a]	6.71±0.34[a]	7.10±1.02[a]	7.21±0.13[a]	6.93±0.31[a]
Mg (mg/l)	7.01±0.31[a]	7.13±0.11[a]	6.98±1.01[a]	6.87±0.01[a]	7.12±1.34[a]	7.21±0.31[a]	7.02±0.46[a]	6.93±0.32[a]
Mn (mg/l)	0.01±0.08[a]	0.01±0.08[a]	0.01±0.08[a]	0.01±0.08[a]	0.01±0.08[a]	0.01±0.08[a]	0.00±0.00[b]	0.00±0.00[b]
Cu (mg/l)	0.01±0.08[a]	0.00±0.00[b]	0.01±0.08[a]	0.01±0.08[a]	0.01±0.08[a]	0.01±0.08[a]	0.00±0.00[b]	0.00±0.00[b]
Zn (mg/l)	0.10±0.18[a]	0.20±0.02[a]	0.10±0.36[a]	0.20±0.34[a]	0.10±0.16[a]	0.30±0.01[a]	0.10±0.21[a]	0.10±0.02[a]
Fe (mg/l)	2.42±0.51[a]	2.42±0.88[a]	2.39±0.01[a]	2.43±0.08[a]	2.33±0.47[a]	2.38±0.24[a]	2.41±0.32[a]	2.52±0.23[a]
Pb (mg/l)	0.00±0.00[b]	0.01±0.08[a]	0.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]	0.01±0.08[a]	0.00±0.00[b]	0.00±0.00[b]
Cr (mg/l)	0.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]	0.01±0.08[a]	0.01±0.08[a]	0.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]
Ca (mg/l)	11.31±0.43 [a]	11.30±0.63[a]	11.23±0.43[a]	12.28±0.13[a]	12.21±0.26[a]	12.24±0.14[a]	12.13±0.43[a]	12.21±0.13[a]

Table 1: Mean Station Values of Trace Metals of Rivers Niger and Benue at Lokoja
Means in the Same Row Having the Same Super Script Do Not Differ Significantly P< (0.05)
Bello, S.O. (2020)

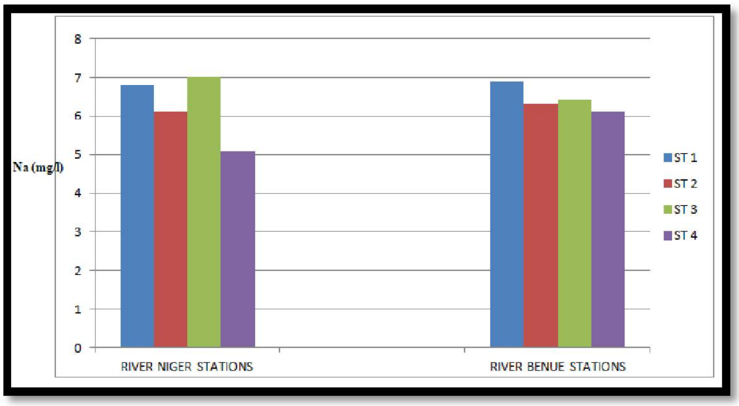

Figure 2: Mean Station Variations of Sodium in River Niger and Benue
Bello, S.O. (2020)

The levels of sodium (Na) concentrations among in all the stations in River Niger indicated variations with slight significant difference. For stations on River Benue, all the stations showed no significant difference in their sodium levels despite their slight variations. Though, station 3 on River Niger had the highest sodium level (7.00 mg/l) among all the observed stations, stations in River Benue still recorded higher sodium values than the stations in River Niger.

Potassium levels in all the stations in Rivers Niger and Benue indicated no significant difference among the stations in the rivers. NIWA ferry yard (station 4) had the highest value of potassium (6.92 mg/l) for River Niger while Gbobe (station 3) on River Benue shows the highest potassium level (7.21 mg/l) for all the observed stations on both rivers. However, Stations in River Benue indicated more potassium levels than stations in River Niger. Many salts of sodium like chlorides and sulphates are easily soluble in water as their sodium is washed away by the action of water. 'The high levels of sodium and potassium without significant differences recorded may have resulted from alloctthonous input from flood and run–off from the catchment area' (Mbanaso, 2010), especially that of River Benue from Adamawa plateau. However, their concentrations are still below the recommended levels for fish production.

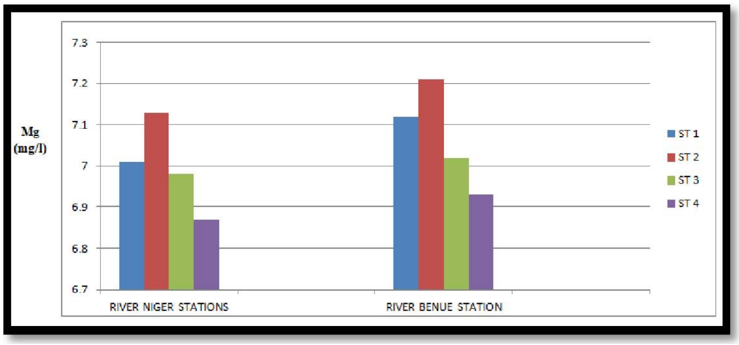

Figure 3: Mean Station Variations of Magnesium in River Niger and Benue
Bello, S.O. (2020)

Station 2 at old market station had the highest magnesium concentration of (7.13 mg/l) for River Niger, while Oguma (station 2) in River Benue recorded (7.21 mg/l) to be the highest magnesium concentration station in both Rivers. The two rivers showed variations in their magnesium concentrations without significant difference. There was also a close range of magnesium levels among both Rivers as River Niger and Benue had 0.26 mg/l range and 0.28 mg/l range respectively among their stations. The magnesium concentrations in the two water bodies may be due to the cumulative effects of its deposits and other pollutants from upper parts of the rivers of flooded soluble trace metals carried by the water bodies.

Most of the stations in Rivers Niger and Benue recorded 0.01mg/l as their values for manganese levels while some stations in River Benue indicated 0.00 mg/l. There was no significant difference for all the stations observed on River Niger for manganese levels but slight significant difference were observed among stations in River Benue. These low levels of Manganese recorded is an indication of poor potentials for phytoplankton production in the two rivers as manganese is an essential constituent for photosynthesis process in green plants.

Rivers Niger and Benue separately displayed significant differences with slight variations in their recorded values for copper despite its general low concentration levels observed in all the stations been studied. The highest copper value recorded from the two rivers is 0.01 mg/l while some stations in both rivers had 0.00 mg/l concentration.

Goel, (2001) reported the danger of copper pollution on algae emphasizing that copper values of even less than 0.5 mg/l can be lethal to their existence. So the copper levels in the studied areas are far below the permissible/required level for domestic and aqua cultural purposes.

There were variations in all the observed stations without significant difference for zinc level recorded in the two rivers. Rivers Niger had 0.20 mg/l as its highest zinc value in station 3-old market, which is less than the 0.30 mg/l recorded in station 2 on River Benue. The mean values for zinc levels were generally low in the two rivers displaying a range of 0.20 mg/l. 'Therefore, all the zinc concentrations recorded from both rivers were not up to the desirable and permissible levels of 5 mg/l and 15 mg/l respectively as stated' by EPA (1986). This is an indication that the zinc levels in these water bodies poses no threat to aquatic life but the aquatic organisms inherent areas well lacking the essential importance of zinc.

Slight variations without significant difference in iron concentrations were observed among all the stations on Rivers Niger and Benue during the research period. Station 4-Mozum on River Benue displayed the highest value of 2.52 mg/l for iron among all the observed stations in the two rivers. River Niger also displayed its highest value of 2.43mg/l for iron in station 4-NIWA ferry yard while its lowest recorded value 2.39 mg/l for iron was observed in station 3-Pata water side.

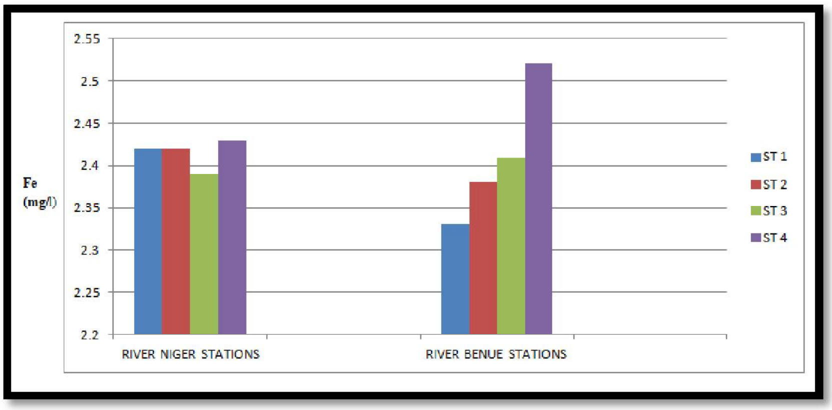

Figure 4: Mean Station Variations of Iron in Rivers Niger and Benue
Bello, S.O. (2020)

'All the stations showed more than 2 mg/l iron concentration levels which are above the recommended level of 1.0 mg/l' by EPA, (1986). This means that these water habitats are not conducive for aquatic and domestic life as iron concentrations of these magnitudes are hazardous to living organisms particularly fish.

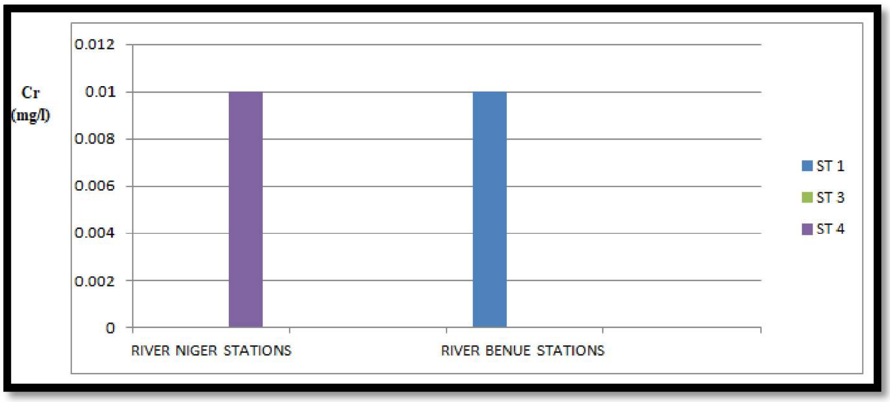

Figure 5: Mean Station Variations of Chromium in River Niger and Benue
Bello, S.O. (2020)

Slight variations of low level concentrations with significant differences were observed in all the stations in Rivers Niger and Benue for lead and chromium concentrations. The highest value recorded for lead in both rivers was 0.01 mg/l in station 2-old market on River Niger and in station 2- Oguma in River Benue. Chromium values were also generally very low with 0.0 mg/l concentrations in all the stations observed except for station 4 in River Niger and station 1 in River Benue that both recorded 0.01 mg/l values as the highest values for chromium in both Rivers.
Though lead and chromium are classified as dangerous elements to fishes and humans, their concentration in the studied areas is negligible and of no threat to the aquatic animals and other domestic users of these water bodies.

Station 4- NIWA ferry yard station in River Niger displayed a calcium value of 12.28 mg/l as the highest concentration recorded in both rivers. However, there were no significant differences among stations in the two rivers despite the slight variations observed in their calcium levels. Individual stations in River Benue stations still recorded higher calcium levels than stations River Niger. These general results of poor calcium levels is indicating cases of poor teeth and bone formation in the fish and other aquatic organisms habituating in these water bodies. Calcium values from all the stations fall below the recommended level of 100 mg/l for drinking water for livestock. This condition could result from low sedimentary rock presence along the course of the rivers and poor mineralization process.

5. Conclusion and Recommendation

The result from this work showed slight variations without significant difference among the stations in their concentration levels for most metals observed, though variations with significant differences were observed for Mn, Cu, Pb and Cr readings. Stations in River Benue recorded higher levels of Na, K and mg than stations in River Niger. Majority of the metals indicated low concentration levels far below the required levels in the two rivers except for Fe that displayed more than permissible level in all the stations observed. It can be concluded that most aquatic animals in Rivers Niger and Benue at Lokoja are lacking the importance of most trace metals sampled especially Na, K, Mg, Mn, Zn and Ca which are necessary for bone, teeth development and general growth.

Hence, supplementary sources of Na, K, Mg, Mn, Zn, Cu, Mg and Ca are recommended for water from these rivers for fish culturing and breeding. Proper and adequate processing methods should also be employed in treating these water contents for drinking and fish culturing medium source because of the high levels of Fe and indiscriminate waste disposal found in and around both rivers. All forms of water pollution activities like uncontrolled farm chemicals and sewage disposal should be discourage through public enlightenment campaigns. All laws and regulations concerning environmental sanitation and indiscriminate waste disposals should be adequately enforced.

6. References

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