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Assessment of Pollution Level in the Rivers of Idah Town, Kogi State, North Central Nigeria

*Oluokun, G.O.[1], Salau, O.B.E.[2], Agbede, O.A.[3], Akanbi O.I.[1], and Idenyi, A.A.[2]

[1]Civil Engineering Department,
Adeleke University,
Ede, Nigeria

[2]Civil Engineering Department,
University of Ibadan, Nigeria

[3]Civil Engineering Department,
Abubakar Tafawa Balewa
University, Bauchi, Nigeria

Corresponding Author:
*Oluokun, G.O., as above

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Abstract
Water from river and spring are vulnerable to different kinds of pollutions. Hence, there is need to intensify research on pollution in rivers. This paper presents the pollution level in four major selected rivers in Idah town; Inchalo, Idu – Okoliko, Ofiayi and Ocheche. These rivers are sources of domestic water supply in Idah town, Kogi State. Water samples taken from these rivers were analysed for physical, chemical and bacteriological parameters. Parameters assessed included temperature, colour, turbidity, TDS, pH, Nitrate and Sulphate. Others were Iron, Alkalinity, Chloride, TSS, Hardness and Coliform bacteria. The result of the analyses indicates that the water in the rivers have an ambient temperature of 27°C and are slightly acidic. The colour of the water in Idu – Okoliko and Ocheche were above 50PCU.Inchalo and Ofiayi were slightly turbid whileIdu – Okoliko was the most turbid. Iron content in each of the rivers was in excess of WHO's limit of 0.3mg/l. The results further revealed that Coliform bacteria are present in all the rivers. Even though other parameters fall within the WHO/NIS standards for potable water, the waters were generally unfit for human consumption without treatment. This possibly has a reflection in the water bornediseasespatient records collected from Idah General Hospital. It is therefore recommended that government and other related agencies, sensitize people in Idah town on the treatment of the water before it is used for drinking purpose. Government should also intensify effort on the provision of potable water for the people in this environment.

Évaluation du niveau de pollution dans les rivières de la ville d'Idah, État de Kogi situe au nord-centre du Nigeria

Résumé
L'eau de la rivière et l'eau de source sont vulnérables à différents types de pollutions. Il y a donc, la nécessité d'intensifier la recherche sur la pollution d'eau. Cet article présente le niveau de pollution dans quatre grandes rivières sélectionnées dans la ville d'Idah ; Inchalo, Idu - Okoliko, Ofiayi et Ocheche. Ces rivières sont des sources d'approvisionnement en eau domestique dans la ville d'Idaho, dans l'État de Kogi. Les échantillons d'eau prélevés dans ces rivières ont été analysés pour des

paramètres physiques, chimiques et bactériologiques. Les paramètres évalués comprenaient la température, la couleur, la turbidité, le TDS, le pH, le nitrate et le sulfate. D'autres étaient le fer, l'alcalinité, le chlorure, le TSS, la dureté et les bactéries coliformes. Le résultat des analyses indique que l'eau dans les rivières a une température ambiante de 27oC et sont légèrement acides. La couleur de l'eau à Idu - Okoliko et Ocheche étaient 50PCU. Inchalo et Ofiayi étaient légèrement turbides alors que Idu - Okoliko était le plus turbide. La teneur en fer de chacune des rivières dépassait la limite de 0,3 mg / l fixée par l'OMS. Les résultats ont également révélé que les bactéries coliformes sont présentes dans toutes les rivières. Même si d'autres paramètres relèvent des normes OMS / NIS pour l'eau potable, les eaux étaient généralement impropres à la consommation humaine sans traitement. Cela se montre dans les dossiers des patients de maladies transmises par l'eau recueillies à l'hôpital général d'Idah. Il est donc recommandé que le gouvernement et d'autres organisations, sensibilisent les gens dans la ville d'Idah sur le traitement de l'eau avant qu'elle ne soit utilisée pour boire. Le gouvernement devrait également intensifier ses efforts pour fournir de l'eau potable aux habitants de cet environnement.

Introduction

Water is life (Gideon *et al.,* 2013). All living organisms need water for survival. Water forms a major vital element among other natural resources (Sajid *et al.*, 2012). In fact, no water, no life (Sajid*et al*., 2012). All living organisms need water for survival. About 70% of the human body mass is water (Mckane and Kandel, 1996). Water supports life in diverse ways: it is a necessary requirement for the proper functioning of the human body. Human body needs it for proper food digestion, lubrication of body joints, regulation of body temperature, transportation or evacuation of body wastes and softening of body tissues (Sajid *et al.,* 2012). It has been established that currently, 40% of the world's food supply is grown under irrigation. Infact, several industrial processes cannot be done successfully without water (Manoj *et al.,* 2012). Building and other types of construction cannot be done without water (Kucche *et al.,* 2015). It has also been noted that water had supported the development and sustenance of civilisations around the world (Olatunji *et al.,* 2011). All these and other uses of water are pointers that life cannot be lived on the earth without water. Unfortunately, this water is less conserved by majority of users and government (Gideon *et al.,* 2013).

Water, on daily basis is under the threat of pollution, most especially surface and groundwater that formed major sources of water for human use (Olatunji *et al.,* 2011). Most water available around cannot be regarded as safe or potable. Pollution has made them potential sources of diseases to human being (Nester *et al*., 2002). This is affecting many lives. People are dying gradually on daily basis as a result of accumulated pollution they have unknowingly absorbed from polluted water (Owa, 2013). Water pollutants include any foreign materials that can influence the physical and chemical properties of water from the expected standard values (Sajid *et al*., 2012, Owa, 2013, WHO, 2011). These include untreated industrial effluents, municipal wastewater, runoff from chemical fertilizers and pesticides, oil and lube spillage in the coastal area from the operation of sea and river ports, to list but a few. These pollutants cause great havoc to the body of water once they get in contact with it either directly or indirectly.

This, therefore necessitates that research should be intensified to identify the level of pollution in water bodies around us especially those that members of public depend on as a source of water or that migrate to mix with another water body. Considering the level of activities going on around the rivers that Idah people depend on as source of water, it becomes necessary to study the level of pollution in the rivers. These rivers include Inchalo, Idu –Okoliko, Ofiayi and Ocheche rivers. Children and young adults who come to draw water often defecate around these rivers. Contamination of these rivers with feacal materials cannot be ruled out. Oil spilled from pumping machine used by water tankers flow back to the river. Cattle defecate into these rivers when they come to graze. There are farmlands around the rivers and some agricultural products (mainly cassava) are processed in the rivers. Clothes and other household items are washed at the bank of these rivers. The vulnerability of the Idah townto an outbreak of a water–related epidemic could be possibly attributed to this source of water. The consequence of this could paralyse the social, economic and commercial activities of the town. It would cost a lot of resources to treat victims and control the epidemic; signifying a drawback or stagnation. Agricultural productivity, upon which the nutritional status and economy of the people depend, would also be considerably reduced. Therefore, it is necessary to investigate the pollution level of Inchalo, Idu – Okoliko, Ofiayi and Ocheche rivers. The studywill help to advise members of the public especially people of Idah town on portability of the water from these rivers. It will furnish governmentwith data for possible treatment of these bodies of water. Bioaccumulation of harmful substances in the water can affect the aquatic environment of the river for living organisms which invariably can affect food chain. Hence, the study will also help to properly conserve the animals that use the river as a habitat.

Study Area

This study is focused on Idah-town Rivers. Idah town is located on lat. 6° 36'36" N and long. 6° 45' 13", Kogi State, Northern Central, Nigeria. Idah is located on the eastern bank of River Niger directly south of the Niger/Benue confluence. In Idah town, most rivers take their source from River Niger. These include Inachalo, Ofiayi, Iyoloko springs, Ocheche and Idu-Okoliko rivers. The town has two distinct seasons: the rainy and dry seasons. The rainy season starts in March and lasts till October. The dry season falls between November and February. The annual rainfall ranges from 140cm to 150 cm. Idah town lies within the transition zone between the high forest conditions of the coastal belt and Savannah in the North. The vegetation is largely of the Guinea savannah type. According to 2006 census, Idah's population was seventy–nine thousand, eight hundred and fifteen (79, 815). The town accommodates the following educational institutions: a Federal Polytechnic, the Kogi State School of Health Technology, a Government Technical College, nine Secondary Grammar Schools and numerous nursery/primary schools. Other social and financial institutions in the town include a general Hospital, Health Clinics, two Microfinance banks and three commercial banks – Union Bank Plc, UBA and Zenith Bank. Sadly however, Idah town, headquarters of Idah Local Government Area with all these public institutions has no sustainable system of potable pipe borne water supply. The inhabitants of the town are thus constrained to depend on locally – available surface rivers for their water supplies (Okungbowa, 2003).

Materials and Methods

Thirty-six (36) water samples were collected for this study. This study involved both field sampling and laboratory analyses. Nine (9) samples each were taken for each of the four (4) rivers examined. The samples were taken in three replicates for each river. The samples were labeled as 1A, 1B and 1C for Inachalo River and similar approach was used for other rivers. Table 1 gives the details of the sampling points. Each sample was taken at about 200mm below the river surface as specified by standard methods (Manoj *et al.,* 2012). The samples were stored in separate pre-conditioned and acid rinsed clean polypropylene bottles and acidified with concentrated nitric acid to a pH below 2.0 to minimise precipitation and adsorption on container walls (Manoj *et al.,* 2012). These samples were taken to the laboratory for both physico-chemical and bacteriological analyses. Physical parameters measured include temperature (^oC), turbidity (Nephelometric, NTU), colour, pH and electrical conductivity(EC) while the chemical parameters includetotal iron, nitrate, sulphate and Total Solid(TSS), total hardness, Chloride, total alkalinity, and total and faecal coliforms count. These parameters were determined according to procedures as described in APHA (2005).

Secondary data of the water-borne diseases was also collected from the General Hospital, Idah town. This was collected to check the level of the contribution of pollution in these rivers to the water-borne diseases the people in the town is battling with.

Table 1: Water Sampling Points

River No/Name	Sampling Point	Description of the Sampling Point
1/ Inachalo	A	Located at Iyogbo, a satellite settlement of Idah town along Idah – Anyigba road. The site is located at a point about 150m downstream of the river source.
	B	Located at Aji -akpu , about 2½km downstream of site 1A, Angwa area of the town. It is about 1.0km downstream of site 1B. This river is polluted by the oil from pumping machine used to pump water from the river by commercial water seller. Also, the herdsmen pollute the river through their animals
2/Idu – Okoliko	A	Idu-Okoliko was at Ega. A big market is located close to the river and a huge amount of waste generated in the market is dumped into the river
	B	Located 250m downstream of site 2A. This location is an extension of the market at site 2A. Smoked fish, yams, plantain, and vegetables are the main items on sale around this area. Quite often, wastes generated from the human activities on the bank find their ways into the river. People bath, swim and wash various items at this site.
	C	It is located about 200m downstream of site 2B. The level of hum an activities at this site is lower than those of the preceding sites.
3/Ofiayi	A	It is located at Odogbaghada, a suburb of Idah town – at the North -Western flank. People bath and wash at this site and likewise drink the water.
	B	It is located about 200 m downstream of site 3A. Kogi State Water Board sited her water treatment plant around this site.
	C	It is located about 200m upstream of site 3A. At this sampling point, there is a vast plain of farmland where cattle graze and thereafter drink water from the river, thus polluting it with their feaces.
4/ River Ocheche	A	River Ocheche lies below a dangerouslysteep cliff. Access to the river from the cliff top is risky and therefore water samples were taken along the longitudinal axis of the river. Sample 4A was taken from its bank
	B	This was taken at the middle of the river
	C	The sample was taking at the other side bank of the river

Results and Discussion

Physical, chemical and bacteriological properties examined on the water samples collected are discussed below.

Physical Properties

The physical properties measured include:

Temperature (^oC): The result of the temperature of the water samples is presented in table 2. According to the result, the mean temperature of InachaloRiver is 27.73 while that of Idu – Okoliko, Ofiayi and Ocheche are 27.63, 27.73, and 27.83 respectively. The closeness of these temperatures is the reflection of the ambient temperature of the town which is 27^{o}C. According to the NIS (2007), these temperatures fall within acceptable ambient temperature of a potable water. However, the temperatures are slightly higher than the limit recommended by WHO (2011). This suggests that the temperatures are favourable for the growth of aquatic microorganisms and algae. Secretions by these organisms and the products of dead algae cells may lead to problems of colour, taste, and odour in the water.

Turbidity (NTU): This parameter was measured by Nephalometric Turbidity meter. The value of turbidity obtained for InachaloRiver is 7.33 while that of Idu – Okoliko, Ofiayi and Ocheche are 39.33, 7.33 and 24 respectively. WHO (2011) and NIS (2007) recommend a maximum value of 5NTU as the acceptable limit of turbidity for potable water (table 2.0). Turbidity is a function of suspended materials in water (Gideon *et al.,* 2013). These suspended materials could be colloidal matters such as clay, silt, rock particles and metal oxides, vegetable, fibres, microorganisms, soaps, etc. According to the table, the value of 2NTU recorded at site IA on Inachalo was within specification. This may be as a result of closeness of the site to the river source. At downstream, the water becomes turbid. This is reflected in the values of 10NTU each recorded at sites IB and IC, respectively. On the average, InachaloRiver (7.33NTU) is slightly above the specified limit of turbidity. This statement also equally applies to river Ofiayi which also has a mean turbidity value of 7.33NTU. The table also recorded the highest turbidity value of 39.33NTU for Idu – Okoliko. The high level of storm runoff into the river from the town may be responsible. Another possible contributor is the wastes generated from the market on the river bank. These include vegetable fibres and clayey soils on yam tubers among others. Eventually, they find their ways into the river, thus increasing turbidity. According to Gideon *et al* (2013), high level turbidity in a river could be as a result of high level of nutrients (Nitrogen and Phosphorus) in the river which could cause eutrophication in surface water sources and massive growth of algae, leading the growth of other microorganisms and cause more turbidity in surface water. Gideon *et al* (2013) also noted that high turbidity level can most time linked with some pathogenic microbes which could cause diseases such as diarrhoea, vomiting and abdominal cramps etc. This is also in compliance with Shalom *et al.,* (2011); the more turbid a water is, the greater the chances of water borne diseases.

Table 2: Physicochemical Analysis of the water from Idah Rivers

Physical Properties	Rivers and Sampling Points																	
	1(Inachalo)				2 (Idu – Okoliko)				3(Ofiayi)				4 (River Ocheche)				Standards	
	A	B	C	Mean	A	B	C	Mean	A	B	C	Mean	A	B	C	Mean	WHO	NIS
Temperature (°C)	27.80	27.70	27.70	27.73	27.50	27.70	27.70	27.63	27.70	27.70	27.80	27.73	27.90	27.80	27.80	27.83	**Ambient**	Ambient of 27°C
Turbidity (NTU)	2.00	10.00	10.00	7.33	19.00	28.00	71.00	39.33	8.00	6.00	8.00	7.33	26.00	21.00	25.00	24.00	4	5
Colour PCU	9.0	52.0	55.0	38.7	109.0	159.0	383.0	217.0	45.00	31.00	40.00	38.67	136.0	107.0	129.0	124.0	20	15
Chemical Properties																		
pH	5.55	6.02	5.93	5.83	6.53	6.31	6.69	6.51	5.96	5.82	5.80	5.86	6.15	6.24	6.30	6.23	6.5-8.5	6.5-8.5
Electrical conductivity (µs/cm)	16.00	9.00	10.00	11.67	61.00	44.00	98.00	67.67	20.00	19.00	18.00	19.00	29.00	27.00	29.00	28.33	400 µs/cm	1000
Total Dissolved Solid(mg/l)	8.00	4.50	5.00	5.83	30.50	22.00	49.00	33.83	10.00	9.50	9.00	9.50	14.50	13.50	14.50	14.17	1000	500
Total Suspended Solids (mg/l)	2.00	3.00	5.00	3.33	10.00	15.00	37.00	20.67	4.00	2.00	4.00	3.33	4.00	2.00	4.00	3.33	5	200
Total Iron (mg/l)	0.20	0.45	0.40	0.35	0.70	1.05	0.10	0.62	0.45	0.25	0.25	0.32	0.80	0.65	0.95	0.80	0.2	0.30
Nitrate (mg/l)	8.24	8.91	8.99	8.71	14.04	14.79	15.33	14.72	7.04	7.81	7.90	7.58	10.12	11.03	11.60	10.92	50	45
Sulphate(mg/l)	2.00	2.00	3.00	2.33	8.00	10.00	11.00	9.67	4.00	6.00	6.00	5.33	8.00	8.00	10.00	8.67	250	200
Total Hardness	13.00	11.00	10.00	11.33	25.00	20.00	19.00	21.33	12.00	9.00	8.00	9.67	20.00	16.00	18.00	18.00	500	150
Chloride (mg/l)	1.40	1.40	1.60	1.47	4.10	4.90	8.00	5.67	2.20	1.75	1.82	1.92	2.60	21.00	2.53	2.54	250	250
Total Alkalinity (mg/l)	2.40	3.10	3.90	3.13	6.62	6.80	5.90	6.44	3.80	3.50	2.91	3.40	4.20	4.90	3.10	4.07	500	100
Bacteriological analysis																		
Total Coliform count MPN	141.0	172.0	348.0	141.0	348.0	348.0	345.0	347.0	17.0	4.0	7.0	9.0	542.0	542.0	918.0	667.0	0	1/100ml
Faecal Coliform MPN	9.00	14.00	14.00	17.00	13.00	27.90	22.00	26.00	25.00	4.00	2.00	6.00	4.00	11.00	14.00	13.00	0	0

PCU: - Platinum Cobalt Unit
NTU: - Nephelometric Turbidity Unit
MPN: - Most Probable Number NIS (2007): - Nigerian Industrial Standard for Potable Water

Colour: This parameter is measured in PCU. Colour is among the properties that can be used to determine the state of purity of water. Pure water should be colourless. To the general public therefore, coloured water is aesthetically objectionable. According to table 2, site IA on River Inachalo has the least value of PCU. Sites IB and IC which are further downstream from the source have 52PCU and 55PCU respectively. These give an average value of 38.67PCU, a value below the acceptable maximum of 50PCU by NIS (2007). River Ofiayi also has a mean value of 38.67PCU.It may be deduced that waters from Ofiayi and Inachalo are colourless. However, with mean values of 217PCU and 124PCU, Idu – Okoliko and Ocheche respectively, are highly coloured and therefore aesthetically objectionable.

Chemical Properties

pH: This is the measurement of the level of acid and alkali in the rivers' samples. The acceptable range of pH for potable water is 6.5 to 8.5 (WHO, 2011; NIS, 2007). Water falling above or below the value is not recommended as a drinking water because such water could cause hair to swell and in sensitive individuals, gastrointestinal irritation may occur (Sadji*et al.*, 2012, Khan and Ahmad, 2001). Table 2 indicates that only Idu – Okoliko with a pH value of 6.51 satisfied this requirement. Others are slightly acidic. Hence, the water from these rivers is not recommended for drinking water. Also, from a health point of view, acidic waters are unsuitable for ulcer patients.

Electrical conductivity (EC): According to table 2, Idu-Okoliko had the highest mean value of 67.67.

Total Suspended Solid (TSS): From Table 2, it can be established that Idu – Okoliko had the highest TSS concentration of 20.67 mg/l. Incidentally, the other three rivers, each had a value of 3.33 mg/l. This value of TSS is generally low in all the samples when compared to the maximum acceptable limit of 200 mg/l by the NIS (2007). This suggests that very little effort and money would be needed for the removal of suspended solids if it is required to treat these rivers for consumption.

Total Iron: WHO (2011) and NIS (2007) recommend a maximum iron content of 0.3 mg/l for potable water. Iron concentration (0.32mg/l) in the water at Ofiayi River is bearable because the concentration is marginally above the limit. The concentration at Idu –Okoliko (0.65mg/l), Ocheche (0.80mg/l) and Inachalo Rivers (0.35mg/l) did not fall within the range. Furthermore, the high iron content of these rivers provides a fertile ground for some bacteria that depend on iron compound for an energy source. Any trace of concentration of iron in the water could cause rusting of vessels especially if the vessel is made with uncoated metal (Olatunji *et al.,* 2011). Also, water with high iron concentration

Table 3: Water Classifications

	Total Hardness	**Total Dissolved Solids(TDS)**	
Carbonate Concentration (mg/l)	Water Classification	TDS value(mg/l)	Water Classification
0-50	Soft	greater than 1200	Unacceptable
50-100	Moderately soft	1200 – 900	Poor
100-150	Slightly hard	900 – 600	Fair
150-200	Moderately hard	600 – 300	Good
200-300	Hard	less than 300	Excellent
Over 300	Very hard		

Source: Twort, 1990

could encourage development and growth of slimes which could results in odour (and sometimes, taste problems). Hence, since these waters are susceptible to corrosion problems, it should not be encouraged for drinking.

Nitrate: NIS fixed the maximum limit of Nitrate in potable water at 50mg/l. According to the results of the analysis for the Nitrate in the samples (table 2), Idu-Okoliko had the highest value of 14.72mg/l which is far below the stipulated limit. Although the excess concentration of Nitrate in potable water causes a disease called methaeglobinemia (popularly known as "blue-baby syndrome") in infants below six months. Nevertheless, it should not deviate from the minimum quantity needed by the human body for its metabolism.

Sulphate: The permissible level for sulphate content in a drinking water as recommended by WHO (2011) and NIS (2007) is 250 mg/l and 200 mg/l respectively. The result of this study shows that the sulphate concentration in all the samples is far below both specifications (Table 2).
Inachalo river water sample contains 2.3mg/l sulphate concentration while Idu-okoliko, Ofiayi and Ocheche contain 9.67mg/l, 5.3mg/l and 8.67mg/l respectively. This low sulphate concentrations imply that the rivers have soft waters because sulphate contributes the greater part of non-carbonate (or permanent) hardness to water – in the form of $CaSO_4^{-2}$.

Consequently, the waters of these rivers do not favor the formation of boiler scales nor do they inhibit the effectiveness of soaps.

Total Hardness (TH): According to table 2, Idu-Okoliko has the highest TH value of 21.33 while Ofiayi had the least (9.67). Inachalo and Ocheche had 11.33 and 18.00 respectively. According to Twort (1990) the waters can be classified into soft and hard (Table 3). This classification is based on the concentration of $CaCO_3$ in mg/l. NIS and WHO recommend a maximum limit of 150 and 1000 respectively for potable water. Comparing this with Twort (1990), it suggests that all drinking water in Nigeria is expected to be slightly hard. The values of TH observed in samples water of these rivers suggest that the water is soft. This collaborates the suggestion made about the water as a result of the level of sulphate content in the sample. This requirement may not be unconnected to the beneficial quality of hard water to the human cardiovascular system (Howard *et al.,* 1985). Furthermore, Ibi (2004) established that a statistical connection between the hardness of water and the incidence of cardiovascular disease has been found. The softer, the water consumed by a living being, the higher the chances of cardiovascular disease. The health implication of this is that consumers are susceptible to heart – related diseases. On the economic scale, consumers' soaps would not be wasted and no scales would be formed on boilers and hot water pipes.

Chloride: Excessive chloride in water induces problems of taste, corrosion, and turbidity (Sadji*et al.,* 2012). WHO and NIS specified a maximum limit of 250 mg/l of chloride in potable water. According to the results for chloride presented in table 2, Idu – Okoliko River has the highest value of 5.67 mg/l. This represents only about 2% of the recommended value. Certainly, that value was not enough to produce a distinct taste easily noticeable by consumers.

Total Alkalinity: Alkalinity is a measure of the ability of water to neutralize acid. Table 2 shows the alkalinity results of the water samples. NIS and WHO recommends limiting value of 100 mg/l and 500mg/l respectively. From the table, it can be established that none of the rivers had alkalinity upto the provisions of the two standards. The alkalinity values were extremely low. According to Bangash & Alam (2004) and Sadji *et al.,* 2012, this alkalinity values could cause many problems like the hardness of kidney stone, gas trouble, severe irritation of the eye, skin and mucus membrane. Also, the alkalinity of the rivers implies that it is insufficient for complete coagulation during water treatment. This low alkalinity would have to be improved by adding hydrated lime to the water.

Table 4: Water Related Diseases Reported and Treated at the General Hospital, Idah (2000-2006)

Disease/Year	2000	2001	2002	2003	2004	2005	2006
Enteric fever	914	501	479	821	896	753	725
Typhoid fever	210	670	468	468	568	719	626
Diarrhea	52	123	37	47	78	29	8
Dysentery	62	42	32	19	24	19	63
ABD. Pain	NA	193	157	152	187	153	264
Total	**1238**	**1529**	**1173**	**1507**	**1753**	**1673**	**1686**

Bacteriological Properties

Total and Faecal Coliform Count: Coliforms are the major microbial indicator of monitoring water quality (Olatunji, *et al.,* 2011).These coliforms include total and faecal coliforms. Drinkable water according to WHO (2011) must have zero value for both coliforms. Result of the coliform count in table 2 indicated that none of the rivers satisfied that requirement. Only Ofiayi, with 9, narrowly met the requirement. Ocheche had the heaviest coliform load of 667 (MPN). Idu – Okoliko followed, with 347(MPN) while Inachalo had 141(MPN). Coliform is not really pathogenic (Gideon *et al.,* 2013). However, it is an indicator of faecal pollution. The results therefore indicate that the four rivers analyzed have a high level of faecal pollution. From this point of view, the waters are unfit for human consumption in their untreated raw state.

This calls for concern as these waters provide nearly all the domestic water requirement of the town's population. These people are exposed to risk of water related diseases such as cholera, dysentery, diarrhoea, typhoid fever and others (Gideon *et al.,* 2013). This has a reflection on the water related diseases reported and treated at the town's General Hospital only (Table 4). This does not include those that did not report themselves to this hospital, other hospitals, clinics and those that might have used local treatment as an alternative.

Conclusion

It can be concluded from the results obtained in this study that water from River Inachalo, Idu – Okoliko, Ofiayi and Ocheche is not potable water. Although some of the parameters measured fall within WHO/NIS standard for potable water but the values of major physico-chemical and bacteriological parameters that are above WHO/NIS permissible limit rendered them undrinkable. The presence of *E. coli most especially indicates* that the waters are faecally polluted. This may be accountable for a relatively high number of water disease patients that are treated in the General hospital.

Recommendations

On the basis of the findings of the research, the following recommendations were made:

(i) The Local Government Environmental Health Office and the Kogi State Environmental Protection Agency should collaborate to ensure that the sanitary condition around the immediate area of the rivers, improves.

- Water quality analyses should be conducted on other rivers in the local government area to determine their portability.
- Governments and other related bodies should intensify efforts on awareness creation among the people of this town on the pollution levels in these rivers and should be encouraged to treat the water if it must be used for drinking. Also, governments should intensify efforts at providing potable water in the town. Ofiayi water works project should be given attention.

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*Oluokun, G.O.[1], Salau, O.B.E.[2], Agbede, O.A.[3], Akanbi O.I.[1], and Idenyi, A.A.[2]

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