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INVESTIGATION OF SURFACE WATER QUALITY IN OWERRI MUNICIPAL, IMO STATE, NIGERIA FOR HUMAN CONSUMPTION

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ABSTRACT

The study was around Owerri Municipal of Imo State, Nigeria to investigate the quality of the surface water for human consumption. The qualities of water from Otamiri River and Nworie River as sources of potable water supply in Owerri Municipal were evaluated by analyzing samples of raw water collected from Otamiri River and Nworie River, which were compared with World Health Organization (WHO) Standards. Water analyses were carried out on the samples for their physicochemical parameters which included, major ions, nutrients and their bacteriological quality. The average values obtained from the analyses are: Ammonia (mg/L) = 0.65, Total iron (Fe) (mg/L) = 0.40, pH = 7.57, Sodium (Na) (mg/L) = 0.95, Nitrate (mg/L) = 0.96, Nitrate (mg/L) = 1.30. The average observed values were compared with standard values of the WHO for potable water. Based on WHO guidelines for drinking water, the results of the analyses indicated that the waters from Otamiri River and Nworie River are not acceptable for human consumption. The two surface waters are unsafe for drinking and they require appropriate treatment before human consumption. Recommendations were made to discourage direct consumption of waters from Otamiri and Nworie Rivers surrounding Owerri Municipal.

Keywords: surface water, Otamiri river, Nworie river, physicochemical parameters, bacteriological quality.

1. INTRODUCTION

Water is a basic necessity for the survival of human beings as well for animals and plants. It is needed for drinking and for the growth of agricultural produce which sustains life on the earth. Water is also used for other various purposes such as for production of hydropower, navigation and recreation. If water is properly harnessed and utilized, it can prove a boon, and of immense value to mankind. In case it is not properly controlled, it may become a curse and cause of misery and destruction to humanity (Arora, 2007; Gupta and Gupta, 2008).

Water is essential for life. Water is very crucial for sustaining human life as well as the lives of other living creatures. The issue of access to potable water is very important especially in the under developed countries. Only three percentage of the earth water is available as fresh water in lakes, rivers and groundwater. However, the requirement for these limited fresh waters is on the increase because of the growth in population and industrialization. The amount of drinking water required is variable and depends on physical activity, age, health issues and environmental conditions (Grandjean, 2004). Water may be naturally potable, as is the case with pristine springs, or it may need to be treated in order to be safe. In either instance, the safety of water is assessed with tests which look for potentially harmful contaminants. There are many areas in Africa and other parts of the world where humans do not have access to sufficient potable water. They could only have access to water sources that are contaminated with pathogens, toxins, disease vectors or suspended solids.

In developed countries, people may not put a great deal of thought into the source of their water. In many first world nations, citizens can turn on a tap for fresh, potable water which may also be enriched with substances for health. In developing countries, however, and especially in Africa, a large proportion of the population does not have access to safe water (WiseGEEK, 2015). Water quality refers to the chemical, physical and biological characteristics of water. The quality of drinking-water is a powerful environmental determinant of health. Water which is not safe to drink can carry diseases and heavy metals. People who consume this water will become ill, and there is a risk of death. Unfortunately, even in areas where the water is known to be unsafe, people may drink it anyway, out of desperation. The lack of potable water is often accompanied by other lapses in sanitation, such as open sewers and limited garbage collection. Many of these public health issues impact the poor more than anyone else.

Access to safe drinking water is essential to human health and survival. But for many people living in high density, low-income areas, the vital services remain out of reach (Akpedeye, 2015). The United Nations (UN) inter-agency mechanism for freshwater and sanitation issues, UN-Water, in her Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS, 2014) report, estimates that: 748 million men, women and children lack access to an improved source of drinking water. From a quoted Nigerian population of about 170 million; 81,000 people died of diarrhea due to inadequate water, sanitation and hygiene (GLAAS, 2014).

1.1 Surface water

Water that flows over the land and run into rivers, lakes, ponds and impounded reservoirs are known as surface water. Surface water is exposed to contamination

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such as organic impurities, inorganic impurities, gases and microorganisms and it must be treated before use. There is need to intensify efforts in the routine monitoring of activities going on within the surface water vicinities. Rivers are the most important freshwater resources for man. Unfortunately, river waters are being polluted by indiscriminate disposal of sewage, industrial waste and plethora of human activities, which affects their physicochemical characteristics and microbiological quality (AIRBDA, 2014). Most of the surface water sources in Nigeria recorded both total coliform and feacal coliform counts high above the limits of WHO Maximum Contamination Levels of drinking water. The high feacal coliform is indication of possible pollution by human excreta. The presence of this indicator bacterium suggests the possible presence of pathogens causing cholera; typhoid and gastroenteritis, thus calling initial disinfection and treatment which renders pathogens ineffective before such water are consumed. Pollution of the aquatic environment is therefore, a serious and growing problem and requires a comprehensive public health survey.

1.1.1 Otamiri river

Otamiri River is one of the main rivers in Imo State that runs through Owerri Municipal City. The river has its source at Egbu from where it runs south past Owerri city and through Nekede, Ihiagwa, Eziobodo, Olokwu, Umuisi, Mgbirichi and Umuagwo to Ozuzu in Etche, Rivers State, from where it flows to the Atlantic Ocean. The Otamiri River has a length of about 105km (Nwachukwu, 1989). The length of Otamiri River from its source to its confluence at Emeabiam with the Uramiriukwa River is 30km. The Otamiri watershed covers about 10,000 km^2 with annual rainfall between 2250mm and 2500mm. The watershed is mostly covered by depleted rain forest vegetation, with mean temperature of 27°C throughout the year (Onweremadu, 2007). The Otamiri River is joined by the Nworie River at Nekede in Owerri. Waste management in Owerri generally is inefficient and contributes to pollution of the Nworie River. Most of the wastes from Owerri municipality are dumped at the Avu landfill in Owerri West on the Port Harcourt highway, which creates a high concentration of phosphate and nitrate that infiltrate into the Otamiri River south of Owerri. Otamiri River (see Figure-1) flows through an alternating sequence of sands, sandstones and clay-shales (Uma and Kehinde, 1992).

1.1.2 Nworie river

Nworie River is a tributary of the Otamiri River. Nworie River is about 9.2 km in length (see Figure-2). The Nworie River is subject to intensive human and industrial activities and is used as a source of drinking water by the poor, when the public water system fails (Acholonu, 2008).

1.2 Objectives of the study

The objectives of the study include:

- To carry out physicochemical and bacteriological analyses of Otamiri River and Nworie River in the study area.
- To examine the quality of Otamiri River and Nworie River and assessed their suitability for human consumption.
- To compare the physicochemical and bacteriological parameters values with World Health Organization (WHO) standard for drinking water.

2. DESCRIPTION OF STUDY AREA

Owerri is the capital and the largest city in Imo State (see Figures 3 and 4). Owerri is located 5º 29´ 0´´ N and 7º 2´ 0´´ E South-East Nigeria. Owerri which is an urban city has a population of about 2.5 million people. The study was carried out on the two rivers in Owerri: Otamiri River and Nworie River.

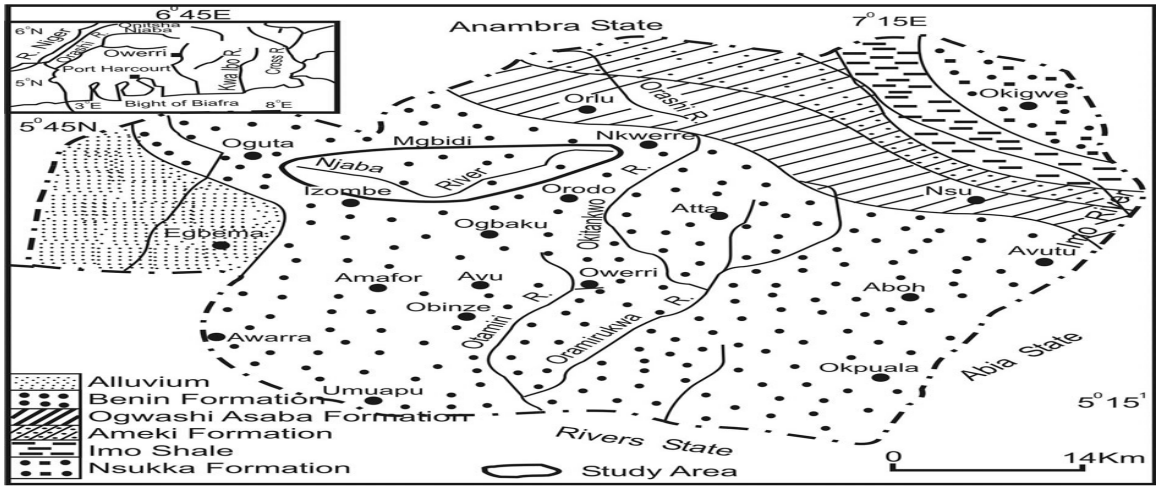

Figure-1. Showing Otamiri river as one of the rivers in Imo State, Nigeria.

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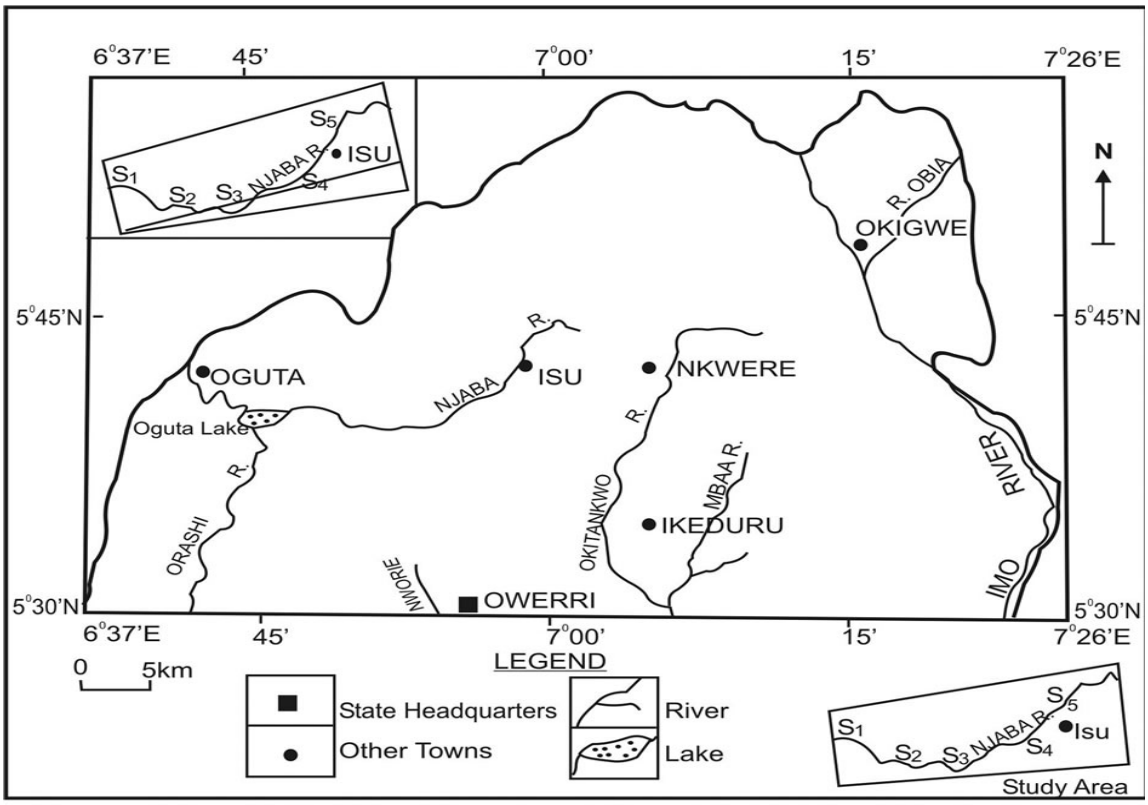

Figure-2. Showing Nworie River as one of the rivers in Imo State, Nigeria.

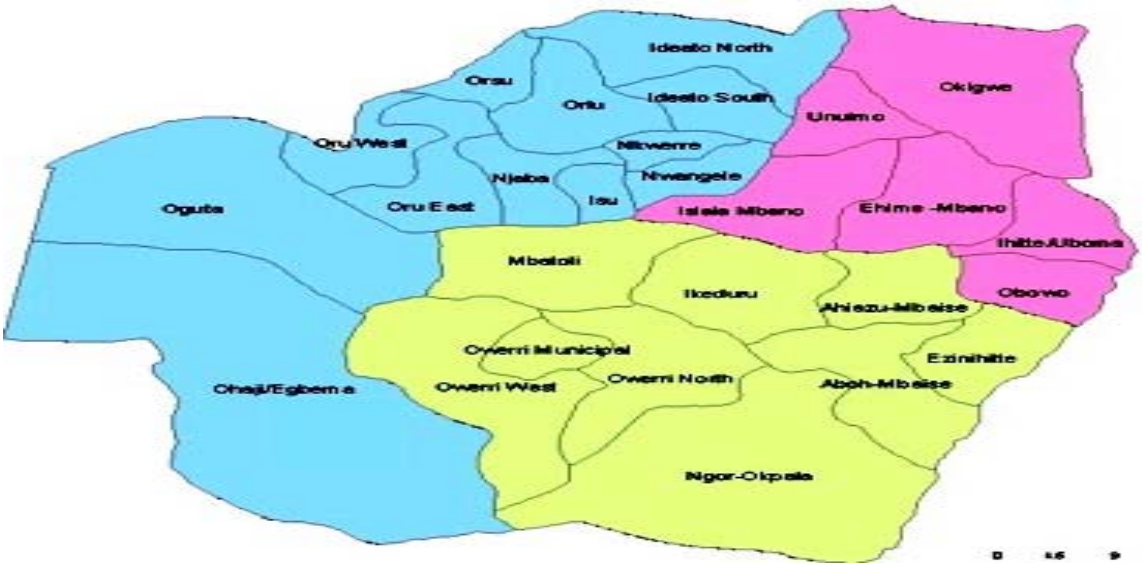

Figure-3. Map of imo state showing the position of Owerri municipal.

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Figure-4. Map of Nigeria showing Owerri.

3. METHODOLOGY

Water samples were collected at the upstream, mainstream and downstream locations at the Egbu road end of Otamiri River and the Orlu road end of Nworie River. The pH, temperature, colour, total dissolved solid, conductivity, magnesium, hardness, total hardness, nitrate, nitrite, phosphate, sulphate, free chlorine, iron, sodium, turbidity and ammonia are water parameters that were analyzed. The results obtained were compared with World Health Organization (WHO) standards for drinking water.

3.1 Physicochemical analyses

(a) pH and temperature

Materials: Suntex pH and temperature meter, beaker, buffer solution; 7.00 pH for alkalinity and 4.00 pH for acidity, and de-ionized water were used for the analysis.

Procedure: The pH meter was calibration with standard buffer solution of pH 4.0 and 7.0. Samples of 500ml each were used to obtain results of pH and temperature.

(b) Total dissolved solids (TDS) and conductivity

Materials: TDS/Conductivity meter, de-ionized water, a beaker and TDS probe were used for the analysis.

Procedure: Samples of 50ml each were used to obtain values of the conductivity in µs/cm and the TDS results in mg/L.

(c) Turbidity, Colour and Total Suspended Solids (TSS)

Materials: To obtain the turbidity, colour and TSS, the following instruments were used: DR2010 data logging spectrophometer, de-ionized water and cell bottle.

Procedure: In the determination of turbidity, colour and TSS, samples of 25ml each were used to obtain the results with the spectrophometer.

(d) Iron and Copper

Materials: The following materials were used to obtain values for Iron and copper: Spectrophometer, Samples cell bottles, Ferrower reagent powder pillow and Cuver 1 reagent powder pillow.

Procedure: Samples of 10ml each were used to obtain results for Iron and copper from the water samples.

(e) Nitrate, Ammonia, Free Chlorine, Phosphorous, Magnesium Hardness and Sulphate

Materials: The following materials were used in the determination of the various parameters: Hi83200 multiparameter bench photometer, de-ionized water, Hi93728-0 reagent powder pillow for Nitrate, Hi93715A-0 reagent powder pillow for Ammonia, Hi93701-0 reagent powder pillow for Free chlorine, Hi93706B-03 Amino acid powder for Phosphorous and Hi93719-01 reagent for Magnesium hardness.

Methods: Cadmium reduction method as specified by American Public Health Association (1998) was used for the determination of nitrate, while Nessler method for ammonia, EPA DPD method for free chlorine, Amino acid method for phosphorous and Calorimeter method for magnesium hardness were used according to the standard methods of American Public Health Association (APHA, 1992) in the determination of the various parameters. For sulphate determination, the turbid meter method was used.

4. RESULTS AND DISCUSSIONS

4.1 Results

The results obtained from physicochemical and bacteriological analyses of Otamiri River and Nworie River water samples were presented in a tabular form as shown in Tables 1 - 6. The results were interpreted and compared with World Health Organization (WHO, 2004) standards for drinking.

Table-1. Major ions in Otamiri river water.

S/No.	Major Ions	Sample 1	Sample 2	Sample 3	WHO Standard
1	Total iron (Fe^{+2}) (mg/L)	0.40	0.25	0.24	0.3
2	Sodium (NA) (mg/L)	0.95	70.20	185.4	200
3	Sulphate (SO_4) (mg/L)	1.10	2.0	3.0	42
4	Chloride (CI) (mg/L)	178.69	185.37	190.70	250
5	Sulphide (SO_4^-) (mg/L)	0.92	3.70	3.5	45

Table-2. Physicochemical parameters of Otamiri river water.

S/No.	Physical Parameter	Sample 1	Sample 2	Sample 3	WHO Standard
1	Appearance	Clear	Clear	Clear	Clear
2	Colour	Slightly brown	Slightly Brownish	Slightly Brownish	Colourless
3	Odour	Inoffensive	Inoffensive	Inoffensive	Inoffensive
4	Temperature	27.0	29.0	28.5	27.0 – 28.0
5	pH	7.57	7.53	7.58	6.5 – 8.5
6	Turbidity (mg/L)	6.20	4.97	5.20	5.0
6	Chloride (mg/L)	2.20	0.90	1.10	250
7	Total Hardness (mg/L)	22.50	11.30	11.90	500
8	Ammonia (mg/L)	0.65	0.58	0.55	0.2 – 0.5

Table-3. Nutrient content of Otamiri river water.

S/No.	Nutrients	Sample 1	Sample 2	Sample 3	WHO Standard
1	Nitrate (mg/L)	0.96	0.27	0.27	3.0
2	Nitrite (mg/L)	1.30	1.28	1.20	1.0
3	Phosphate (mg/L)	1.20	0.31	0.30	3.50

Table-4. Bacteriological quality of Otamiri river water.

S/No.	Nutrients	Sample 1	Sample 2	Sample 3	WHO Standard
1	Total Coliform (mpn/ mL)	30.00	1.0	0.9	0
2	BOD (mg/L)	0.60	0.2	0.2	0
3	COD (mg/L)	1.20	0.5	0.15	0

Table-5. Physiochemical parameters of Nworie Rriver water.

S/No.	Parameters	Sample 4 at Ibada	Sample 5 at F.M.C.	Sample 6 at Old Nekede	WHO Standard
1	Colour (Hazen unit)	8	7	9	5.0 – 15
2	Temperature (^{oC})	28.6	28.8	27.5	27 – 28
3	Turbidity (NTU)	28	61	98	5.0
4	Copper (mg/L)	2.15	2.73	2.28	Nil
5	Iron (mg/L)	0.53	0.9	1.20	0.3
6	Nitrate (mg/L)	25	20	7.2	3.0
7	Nitrite (mg/L)	8.3	2.5	1.0	1.0
8	TDS (mg/L)	22.1	44.8	71.5	500
9	pH	6.8	7.5	7.3	6.5 – 8.5
10	Hardness (mg/L)	1.2	2.4	1.56	500
11	Conductivity (µs/cm)	34	69	110	1000
12	Free Residual Chlorine (mg/L)	0.84	1.02	1.16	0.2 – 5.0

Table-6. Average values of measured parameters of raw water samples from Otamiri and Nworie Rivers with comparison to World Health Organization (WHO) standard.

Parameter	Average values for Otamiri River (1)	Average values for Nworie River (2)	WHO Standard (2004)	Remark
Total Iron (mg/L)	0.29	0.88	0.3	(1) pass, (2) fail
Turbidity (NTU)	5.46	63.33	5.0	(1) and (2) fail
TDS (mg/L)	22.23	46.13	500	Satisfactory
pH	7.56	7.20	6.5 – 8.5	Pass
Temperature (^{o}C)	28	28.3	27 – 28	(1) pass, (2) fail
Hardness (mg/L)	12.23	1.72	500	Pass
Nitrate (mg/L)	1.18	17.4	3.0	(1) pass, (2) fail
Nitrite (mg/L)	0.61	3.9	1.0	(1) pass, (2) fail
Free Residual Chlorine (mg/L)	1.40	1.00	0.2 – 5.0	Satisfactory
Sulphate (mg/L)	2.03	4.17	42	Pass

4.2 DISCUSSIONS

From Tables 2, 4 and 6, it could be observed that turbidity; total coliform and ammonia contents were above the recommended World Health Organization (WHO) standard. From Tables 5 and 6, it could be observed that the turbidity, total iron, nitrate and nitrite of Nworie River are all above the recommended WHO standard. This means that treatment of more unaccepted parameters is required in Nworie River than that of Otamiri River. Table-6 presented a comparison of all the two surface waters in Owerri Municipal and how adequate or acceptable each source is to the WHO standard for drinking water if consumed directly from any of the rivers.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The results obtained from this study showed that Otamiri River does not wholly meet the WHO standard for drinking water. Nevertheless, Otamiri River as a source of potable water requires minimal treatment before use. However, Nworie River is not suitable for drinking as most of the values exceed WHO recommended standards. Besides, Nworie River as a source of drinking water for Owerri Municipal water supply system may require a state of the art water treatment plant which will be very expensive for a private or government agency to embark on without appropriate government allocated funds.

5.2 RECOMMENDATIONS

Based on the study it is recommended that:

- There is need for the government and her appropriate agencies to take up the responsibility of providing potable water to people living both in urban and rural areas within the state, than allow some of her people to consume unwholesome water.
- The Otamiri River water treatment plant should be upgraded and properly funded by the government to ensure that Otamiri River continues to be the source of potable water within Owerri Municipal.

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