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Advanced Journal of Microbiology Research ISSN 2241-9837 Vol. 13 (5), pp. 001-006, May, 2019. Available online at www.internationalscholarsjournals.org © International Scholars Journals



*Full Length Research Paper*

# The impact of industrial effluent discharge on physico-chemical and microbial parameters of Orogodo River, Agbor, Nigeria

**Idise, Okiemute Emmanuel* and Maduka, Kate**

Department of Microbiology, Delta State University, Abraka, Nigeria.

Accepted 25 March, 2019

**The microbiological and physico-chemical analyses of water samples obtained from the Orogodo River, Agbor, at point of industrial effluent discharge (Location 2) and at 100 m before (Location 1) and 100 m after (Location 3), were carried out using standard methods to determine the impact of the discharge on the water quality. While the temperature, conductivity, biological oxygen demand, and coliform counts increased from Stations 1 to 3 and pH, hardness, alkalinity and dissolved oxygen decreased from Stations 1 to 3, the solids (total, suspended and dissolved) and nitrates increased from Station 1 to 2 and decreased thereafter to Station 3 while heterotrophic bacterial counts increased from Station 1 to 2 and 3 and sulphate, which was equal for Stations 1 and 2, decreased in Station 3. Most of the parameters were above set limits by regulatory bodies. Thus, the industrial effluents contained much solids and oxygen-demanding materials with deleterious effects on the water quality, to the extent that it may not be potable without treatment. There is the paramount need to treat these industrial effluents prior to discharge into the River Orogodo.**

**Key words:** Water, analyses, effluent, treatment, discharge, potable.

## INTRODUCTION

Water is one of the most important chemical substances for the maintenance of life. It constitutes about 70% of the earth surface. Water is indispensable for man's activities hence many ancient cities and towns were built around water bodies (Ukpong, 2008). Orogodo River is located between latitudes 5° 43'N and 5° 30'N and longitudes 6° 20'E and 6° 12'E, and takes its source from Mbiri village at an elevation of 150 m above sea level. It joins the River Ethiope at Urhuoka near Abraka in Delta State. It covers a total distance of about 75 km. The climate of the area is marked by two distinct season- the rainy season (May to October) and dry season (November to April). The river serves as a major source of water for drinking, bathing, fishing, washing, Orogodo River, aside being a source of drinking water, serves other purposes which include fishing, swimming or bathing, washing of vehicles, cloths, and household utensils at various locations. Some of these activities, including abattoir effluent discharges, could result in contamination and subsequent pollution of the water (Okonkwo and Odeyemi, 1985; Okokoyo and Rim-Rukeh, 2003; Ukpong, 2008). The Agbor and Owa communities, through which the Orogodo River traverses, are mainly peasant farmers whose products include food stuff such as yams, corn, vegetables, cassava, plantain and fruits. Agricultural activities in the area are mostly carried out along the bank of the Orogodo River, and agricultural wastes are discharged directly into the river or as runoffs into the river after rainfalls (Puyate et al., 2007).

In Agbor metropolis, and many of the communities along the river Bank, proper waste disposal methods are lacking such that many of the inhabitants pass their wastes directly into the surrounding bushes, a practice common in many developing counties (Edema et al., 2006). Consequently, during the rainy season, feces with its load of bacteria, viruses and helminthes of public health importance are washed into the river. At Agbor, there are chemical industries that discharge their effluents, albeit without treatment, into the river. These

*Corresponding author. E-mail: emmaidise@yahoo.com. Tel: +2348057592441, +2348136506553.

may alter the bacteriological and physico-chemical qualities of the river (Okonkwo and Odeyemi, 1985; Edema et al., 2006). The aim of this research was to determine the physico–chemical quality and microbial load of Orogodo River at Agbor town at three locations – point of impact of industrial effluents and at 100 m before and after this location.

## MATERIALS AND METHODS

### Collection of samples

Samples were collected using clean 2 L plastic container that were washed with soap and allowed to air dry. The plastic containers were rinsed thrice with river water before the samples were collected. The samples were stored in ice pack and transported immediately to the laboratory for analysis.

### Determination of temperature

This was carried out using a 0 to 100°C thermometer.

### Determination of pH and conductivity

The pH of the water sample was determined using a pre-standardized pocket-size pH and conductivity meters, Hanna Instruments, (Made in Italy) in accordance with the manufacturer's instructions.

### Determination of solids (TSS, TDS, SS and TS)

These were carried out in accordance with the procedures reported in America Public Health Association (APHA, 2002). These were determined with the Rotary method using HACH DR/2010 Spectrophotometer (Made in Germany). The dry weights of two 100 ml beakers – A and B were determined. 20 ml of the unfiltered sample was added to beaker A and 20 ml of the filtered sample was added to beaker B. The weights of the two beakers were then determined. Both beakers were gently heated until completely dried, allowed to cool in a desiccator and their weights were further determined.

Total Suspended Solids (TSS) = Weight of residue/Weight of sample x $10^6$ of the unfiltered sample.

Total Dissolved Solids (TDS) = Weight of residue/Weight of sample x $10^6$ of the filtered sample.

(Volatile) Suspended Solids (SS) = TSS – TDS; and

Total Solids (TS) = TSS + TDS.

### Determination of alkalinity

This was carried out in accordance with the procedures reported in the titration method of WHO, 2002). Total alkalinity was determined using the procedure of Test method A – Electrometric method of ASTM (2002). 100 ml of the sample was measured into a clean 250 ml conical flask, added either the content of one phenolphthalein indicator powder or 4 drops of phenolphthalein indicator solution, swirled to mix to form a pink color and titrated with concentrated 95% Sulphuric acid ($H_2SO_4$) until solution became colorless.

Alkalinity (mg/L) = titer x 0.1.

### Determination of biochemical oxygen demand ($BOD^5$)

This was carried out in accordance with the procedures reported in ASTM (2002). The reduction of the DO in a water sample, which has been kept for 5 days at a constant temperature in a totally closed vessel after sampling, was measured and calculated thus: The diluents water (aeration water) was prepared by measuring 1 L of distilled water in a Winchester bottle and aerating it for 1 h. To the aerated water in the bottle were added 1 ml each of Solution A (Phosphate buffer solution), Solution B ($MgSO_4$ solution), Solution C ($CaCl_2$ solution) and Solution D ($FeCl_2$ solution). The aerated water was then used for the determination of the DO before and after incubation by titrating 0.25 N Sodium Thiosulphate ($Na_2S_2O_3$) solution against the sample in a 400 ml beaker until a faint yellow or pale yellow color was obtained. Added 2 ml of starch indicator to obtain a blue color and continued the titration until color disappeared. The procedure was used for both pre- and post-incubation samples. The DO was obtained using the following calculation:

1 ml of 0.025 N $Na_2S_2O_3$ = 0.2 g of oxygen (or 0.2 g of DO).

$$DO\ (mg/L) = \frac{T \times 0.2 \times 1000}{\text{Volume of Winchester bottle}}$$

$$BOD^5\ \text{in mg/L} = \frac{(D_1 - D_2)}{V} \times T$$

Where T = titer value, $D_1$ = DO of the sample before incubation in mg/L, $D_2$ = DO of the sample after incubation in mg/L

### Determination of total aerobic and coliform counts

These were carried out in accordance with the methods of Cowan and Steel (2004). Pour plate technique using nutrient agar and MacConkey agar was used for the determination of total aerobic and coliform counts respectively. Inoculated nutrient agar and MacConkey plates were incubated at 37°C for aerobic and coliform counts respectively. Plates with 30 to 300 colonies were used for the determination of the microbial counts.

## RESULTS AND DISCUSSION

The changes in pH values of the sampling locations are presented in Figure 1. It was observed that pH decreased from 6.44 (Station 1) to 6.18 (Station 2) and 6.17 (Station 3). The reduction in the pH of the Orogodo River water reduced from 6.44 in Station 1 to 6.17 in Station 3, a 4.19% reduction, could have been due to the discharged paint effluent which had a pH value of 6.24. This result agrees with the reports by previous scientists on many Nigerian and other African water bodies (Edema et al., 2006; Rim-Rukeh et al., 2004; 2006). The variation in surface water temperature is presented in Figure 2. It was observed that the surface water temperature

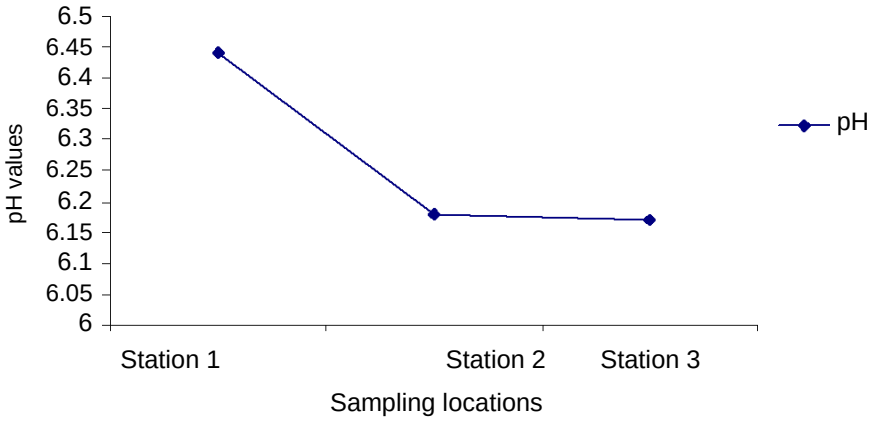


**Figure 1.** Changes in pH of the sampling locations.

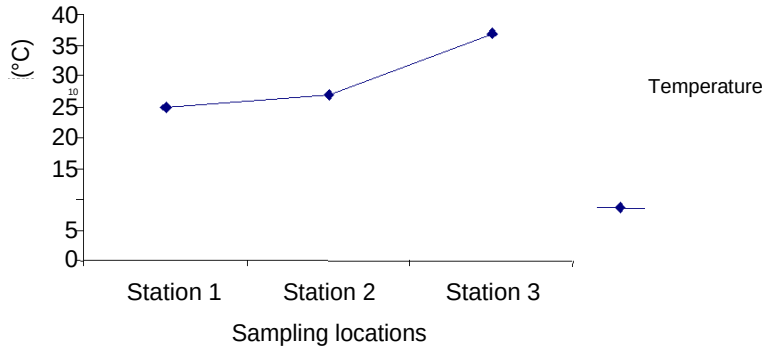


**Figure 2.** Changes in temperature of the sampling locations.

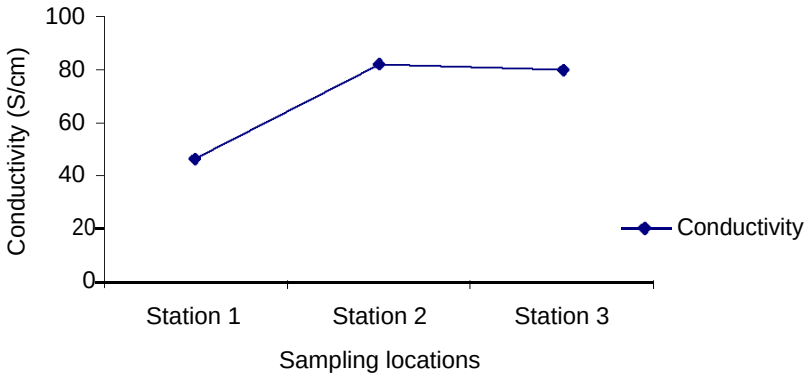


**Figure 3.** Changes in conductivity of the sampling locations.

increased from 25.83°C (Station 1) to 26.58°C (Station 2) and 36.93°C (Station 3). The temperature increased by 4.3%, after the water received the part effluent (28°C) at Station 2. The increase in temperature could be due to the paint effluent and this has effects on the quality of the water. However, the water temperature values obtained during the sampling period were all within the set standard of 10 to 50°C (WHO, 2002; Anon, 2010a).

The changes in conductivity of the sample locations are presented in Figure 3. It was observed that the conductivity increased from 46.44 µs/cm at Station 1 to 81.83 µs/cm (Station 2) and decreased to 79.83 µs/cm at Station 3. The conductivity of the Orogodo River increased from Station 1 to 2 and decreased thereafter to Station 3. This could have been due to the paint effluent discharged in Station 2. The values for Station 3 are

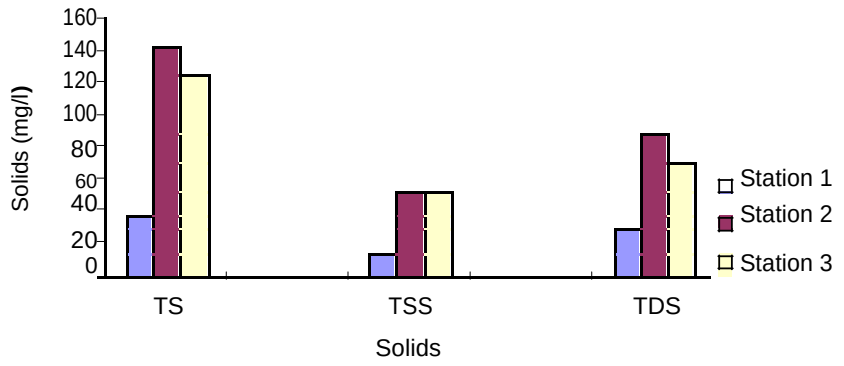


**Figure 4.** Changes in solids (TS, TDS, TSS) of the sampling locations.

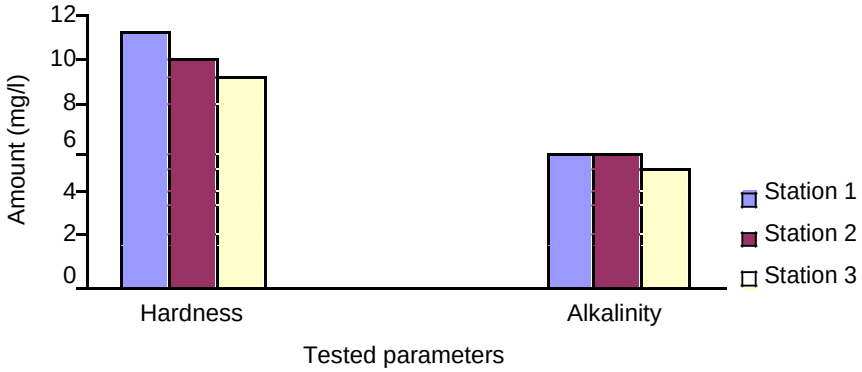


**Figure 5.** Changes in hardness and alkalinity of the sampling locations.

above the set standards by regulatory bodies for river water. This result agrees with reports on some polluted rivers in Nigeria and Africa by previous researchers (Rim-Rukeh et al., 2006; Puyate et al., 2007; Ukpong, 2008). The changes in solids of the sampling location are presented in Figure 4. The TSS values were lower than the TDS and TS value in all the sampling stations. It was observed that the TSS increased from 12.59 (Station 1) to 54.88 (Station 2) and 50.43 (Station 3). The values for TDS that increased from Station 1 to 2 and decreased to Station 3, with the value in Station 1 being lowest, were within the set standards. The higher values of TDS at the downstream Stations 2 and 3 may be responsible for lower concentrations of DO at these downstream stations with the corresponding effects on aquatic lives. This result agrees with reports by other scientists (Puyate et al., 2007; Ukpong, 2008; Anon, 2010a, b).

The change in hardness and alkalinity of the sampling locations is presented in Figure 5. It was observed that the alkalinity values were lower than the total hardness values. The alkalinity values decreased from 6.35 mg/L (Station 1) to 5.64 mg/L (Station 2) to 5.12 mg/L (Station 3). The hardness of the Orogodo River reduced from 11.27 (Station 1) to 9.21 (Station 3) after receiving the part effluent, a 8.46% reduction. There was also a corresponding reduction in alkalinity from 6.35 (Station 1) to 5.01 (Station 3) amounting to a 14.17% reduction. However, the values were all within the acceptable set standards of 100 mg/L. The results agree with the reports of Egborge (1994) who reported ranges of 0.2 to 98 mg/L and 0.1 to 16.4 mg/L for magnesium and calcium respectively for Warri River. The changes in BOD and DO of the sampling locations are presented in Figure 6. It was observed that the BOD increased from 2.24 mg/L (Station 1) to 3.28 mg/L (Station 2) and 3.64 mg/L (Station 3). The values of Dissolved Oxygen (DO) obtained decreased from Station 1 to 3. This may be attributed to increased waste industrial effluents from industries in Station 2. The values at Station 3 were above set standards by regulatory bodies. The decrease in DO along the course of a river has detrimental effects on the aerobic aquatic organisms. This result agrees with the reports of Benta-Coker and Olimani (1995) who examined the Ikpoba River and reported high concentration of organic matter which led to a reduction in oxygen concentration due to decomposition by anaerobic bacteria.

The values of $BOD^5$ increased from 2.23 mg/L at Station 1 to 3.64 mg/L at Station 3 after receiving the paint effluent at Station 2. The concentration of $BOD^5$ in this study falls within both the minimum allowable limit (6 mg/L) and maximum acceptable limit (240 mg/L) (WHO, 2002). The change in nitrate and sulphate of the

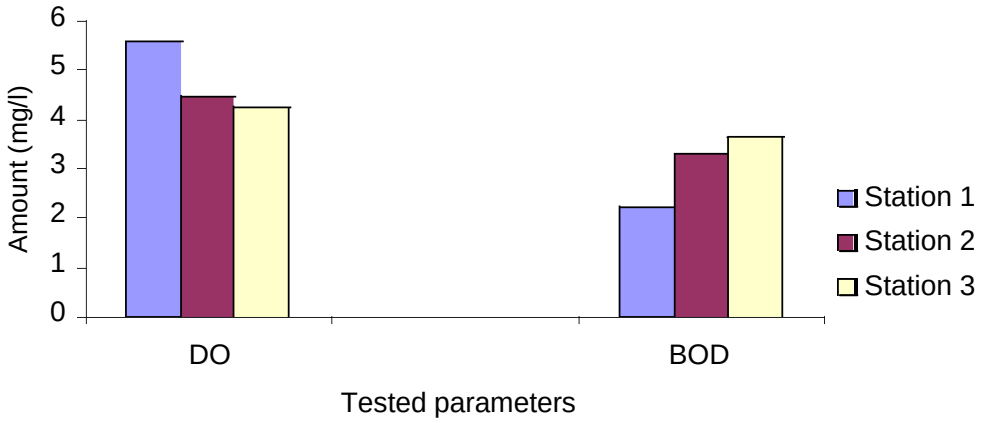


**Figure 6.** Changes in BOD and DO of the sampling locations.

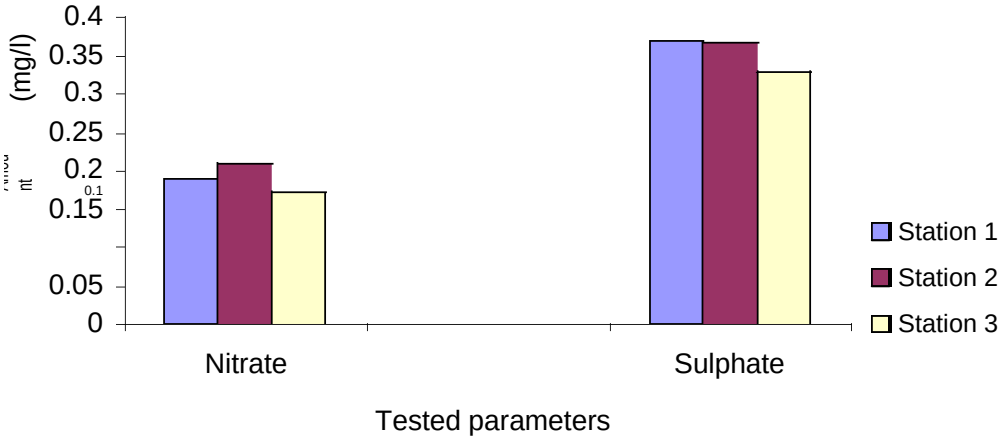


**Figure 7.** Changes in nitrate and sulphate of the sampling locations.

sampling locations is presented in Figure 7. Nitrate in the surface water sampled increased from 0.19 mg/L (Station 1) to 0.208 mg/L (Station 2) and decreased to 0.17 mg/L (Station 3). The values of nitrate and sulphate for this study decreased from 0.19 mg/L at Station 1 to 0.17 mg/L at Station 3 corresponding to 9.52% decrease and 0.37 mg/L at Station 1 to 0.33 mg/L at Station 3 corresponding to 10.9% decrease respectively. This result agrees with the reports of Okonkwo and Odeyemi, (1985) who observed changes in nitrate and Sulphate concentrations in the receiving stream of the University of Ife sewage effluent and Ukpong (2008) reported similar observations in drinking water sources in Uyo Local Government Area in Cross River State, Nigeria.

The changes in Heterotrophic bacterial and coliforms counts are presented in Figure 8. It was observed that the THB increased from 5.4 cfu/ml (Station 1) to 8.05 cfu/ml (Station 2) and 8.05 cfu/ml (Station 3). The coliform counts increased from 1.6 cfu/ml (Station 1) to 2.7 cfu/ml (Station 2) and decreased to 1.7 cfu/ml (Station 3).

The values of heterotrophic bacterial counts (HBC) increased from 5.4 cfu/ml (Station 1) to 8.05 cfu/ml (Station 3) which corresponded to 32.9% increase. This agrees with the reports of Ogan and Nwika (1993) who reported the presence of *Salmonella* sp at different locations on the Calabar River and Benka-coker and Ohimain (1995) who reported the increased microbial load due to impact of slaughter house effluent on the water quality of Ikpoba River. The higher counts obtained in Station 2 for coliforms agree with the findings of Benka-coker and Ohimain (1995), and Rim-Rukeh (2004, 2006). The detection of coliforms at these Stations indicates the presence of man and animal fecal contamination. The presence of these organisms has been used as indicators of fecal pollution of water (APHA, 2002; FEPA, 1990).

While the values obtained in Station 1 were within set acceptable standards, those obtained at Stations 2 and 3 were not. Thus, the water from the Orogodo River may not be acceptable for consumption and domestic needs at the Stations sampled without treatment as it does not

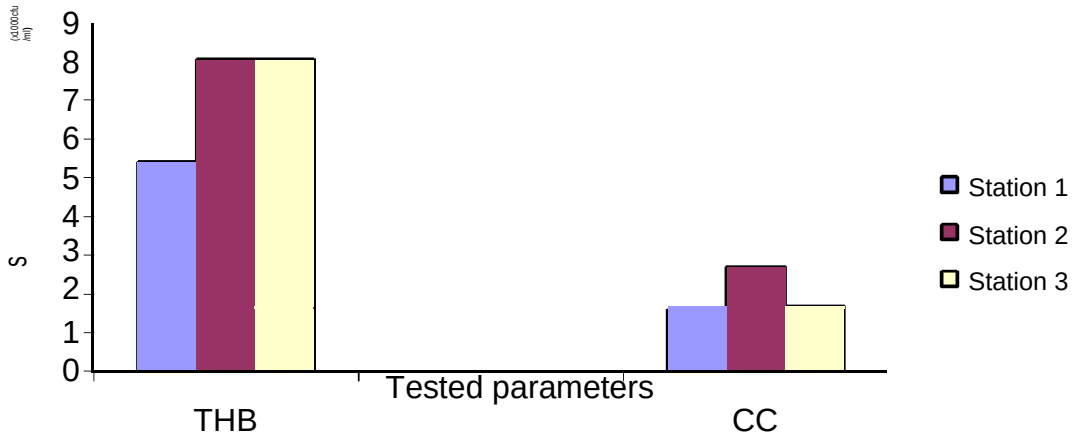


**Figure 8.** Changes in bacterial and coliform counts of the sampling locations.

meet the set standards for potable water.

## Conclusion

This study revealed that the discharge of industrial effluents into the Orogodo River had negative impacts on the microbiological and physico-chemical parameters of the river water. Most of the tested parameters were above the set standards by regulatory water bodies, thus making the water unfit for human consumption without treatment as is currently being practiced. There is thus the need to treat the industrial effluents prior to discharge into the river and also to subject the water from the river to chemical treatment before it can be consumed or used for any other domestic purposes.

### REFERENCES


American Public Health Association (APHA) (2002). Standards Methods for the Examination of Water and Waste Water (18th ed.). Leonore SE, Arnold EG, Trussel, R.R. (eds). APHA Press, Newyork. 3144p.

American Standard Methods (ASTM). ASTM, 2002 Vol. 11.

Anon (2010a). Important water quality factors. Available at: http://www.Important water quality factors.htm. Accessed 23/06/10.

Anon (2010b). Water Quality Management System 3. Microbiological parameters. Available at: www. Water Quality Management System 3.htm. Accessed 23/06/10

Benka-Coker MO, Olimani EI (1995). Investigation of spatial variations in bacteria distribution in surface water of Ikpoba River. Nig. J. Microb., 10:27-32.

Cowan ST, Steel KJ (2004). Manual for the Identification of Medical Bacteria (3rd ed.). Cambridge University Press. London. 331 p.

Edema MO, Omenu AM, Fapeta OM (2006). Microbiology and physiological analysis of different sources of drinking water in Abeokuta. Nig.J. Microb., 13(1): 57-61.

Egborge ABM (1994). Water pollution in Nigeria Volume 1: Biodiversity and Chemistry of Warri River. MacMiller Books, Nigeria, 312p

Federal Environmental Protection Agency, FEPA (1990). Guidelines and Standards for Environmental Pollution Control in Nigeria. FEPA Press, Lagos. 238p.

Ogan MT, Nwika DE (1993). Studies on the ecology of aquatic bacteria on the lower Niger Delta. Tropical Fresh Water Biol., 3: 331 – 324

Okokoyo PA, Rim-Rukeh A (2003). Pollution pattern of Orogodo River, Agbor, Delta State, Nigeria. Afr. J. Appl. Zool. Envt. Biol., 5: 25-28.

Okonkwo N, Odeyemi O (1985) Effects of sewage effluent on the water quality of the receiving stream. Envtl. Polln. Ser. A., 37: 71-86.

Puyate YT, Rim-Rukeh A, Awatefe JK (2007). Metal Pollution Assessment and Particle Size Distribution of Bottom Sediment of Orogodo River,Agbor, Delta State. Nig. J. Appl. Scs. Res., 3(12): 2056-2061.

Rim-Rukeh A, Ikhifa GO, Okokoyo PA (2006). Effects of agricultural activities on the water quality of Orogodo River, Agbor, Nig. J. Appl. Sci. Res., 2(5): 256-259.

Rim-Rukeh A, Okokoyo PA, Nenwiabo O (2004). Self-purification of Orogodo River, Agbor, Nig. J. Sci. Ind. Stud., 2: 65-68.

Ukpong JT (2008). Water Quality parameter of domestic water source in Uyo local Government Area, Nigeria. Int. J. Envtl. Iss., 4: 1-2.

WHO standards for drinking water (2002). Microbiological and chemical aspects. Available at: http://www. WHO Standards for Drinking Water.htm. pp12- 196g. Accessed 20/10/10.