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PHYSIOLOGICAL ANALYSIS AND BACTERIOLOGICAL QUALITY OF OGUN RIVER, NIGERIA

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ABSTRACT
Pollution pressures in form of untreated wastes are exerted on Ogun River via human activities. This river serves as a main source of drinking water to animals waiting to be slaughtered for human consumption and for other domestic purposes by local resident. This research was carried out to determine effects of abattoir effluents on physicochemical parameters and microbial quality of Ogun River. Water and soil samples from the abattoir were subjected to physicochemical analysis by standard methods. Bacterial population were isolated from both samples by standard cultural methods and identified by standard biochemical characterization. Physicochemical analysis showed the pH, temperature, and nitrate are appreciably within normal recommended limits while other parameters exceeded recommended limit for public safety. The total viable count for all the samples which was between $1x10^4$ and $9.2x10^2$ cfu/ml. This exceeded the WHO permissible limit of $1x10^2$ cfu/ml. The bacterial isolates that were identified includes; *Bacillus subtilis, Escherichia coli, Salmonella* spp, *Staphylococcus* spp *Acinetobacter* spp, *Comomonas* sp., *Pseudomonas stutzeri,* and *Aeromonas hydrophila.* The findings of this work underscored the need for proper and efficient effluents treatment system suitable for the reduction of toxic constituents and pathogens that are capable of causing public health hazard.

Keywords: Pollution, Physico-chemical parameters, Effluents.

INTRODUCTION

Environmental pollution arising from industrialization, urbanization and agricultural activities constitute a major threat to human existence. Global environmental challenges majorly associated with human existence include air, land and water pollution (Mellouki *et al*. 2016; McClure *et al*. 2006). The impact of water pollution is mostly felt by regions that depends largely on water for various human activities such as fishing, farming, drinking etc. Water pollution as a result of direct domestic activities can lead to increase in water-borne disease such as typhoid fever, cholera, diarrhea some of which can be of bacterial or viral origin and can be mild or severe (Botzenhart and Wiedenmann 2001).

Apart from the direct health implications on man, water pollution can lead to imbalance in the ecosystem. Untreated wastewater discharge into water bodies from various sources constitute huge menace in the aquatic habitat (Rhind, 2009). One of such river is Ogun River, a significant river in the western part of Nigeria that is suffering from heavy anthropogenic pollution especially by activities of the Kara Market on the outskirt of Lagos, along Lagos-Ibadan expressway. According to author's personal observation, the abattoir is a major slaughterhouse along this axis and it is known for high animal slaughter activities as over 50% of the meat consumed daily in Lagos and some part of Ogun State are bought from this abattoir

Effluent discharged from the abattoir into Ogun River has a significant impact on the physicochemical content, microbial diversity and ecosystem of the river. Indiscriminate disposal of abattoir waste such as animal blood, ash, and intestinal contents can greatly affect the receiving water body and increase the accumulation of toxins in the biological system. Dissolved blood content from effluent has been reported to have a high chemical oxygen demand (COD) value by 375, 000 mg/L compared normal standard (Tritt and Schuchardt, 1992; Singh *et al*., 2015). Intestinal waste from abattoir may further introduce enteric pathogens such as *Salmonella* spp, *Shigella* spp, and *Enterococcus* spp into the surface and groundwater which is harmful to humans and animals. Studies have shown some of these microbial isolates to possess mobile genetic element that are capable of harboring antibiotic resistance genes (Odumosu *et al*. 2016).

Ogun river serves as a source of water for surrounding resident who utilizes it for various purposes such as farming and other domestic uses. Pollution of the river as a result of the abattoir activities can have a significant effect on these dependent as well as the aquatic lives. There is a need for the assessment of the river safety and microbial contamination level which is considered a risk factor in the spread of infectious disease of public health concern. Therefore, this study was designed purposely to determine the bacteriological quality and physicochemical properties of the river as regards its current safety and human use.

MATERIALS AND METHODS

Study area

Kara Market is located beside Ogun River at coordinates 6.6472 ° N, 3.3829° E. The river is a waterway that rises in Oyo state and flows through Ogun state and discharges into the Lagos lagoon. This study was carried out between December 2014 to February 2015.

Sample collection: A total of 15 samples comprising of 5 effluents (200mL each), water (200mL each) and soil (5g each) were collected between December 2014 and February

2015. The samples were collected from different sites non-specifically at random in the abattoir and the river aseptically and respectively into sterile 250 ml amber bottle and properly labeled while 5g of soil samples were collected at random and wrapped in aluminum foil, both were maintained at 4°C by placing on ice and taken straight to the laboratory for analysis. Five samples were collected once a month for three consecutive months, description of sites and samples collection are found in Table 1

Pre-Sample analysis: Direct observation of samples colours, odours, and temperature of water and soil samples, were observed and carried out immediately on site by physical assessment and thermometer respectively.

Physicochemical analysis of the samples

The oxygen in the water sample was fixed on site by the addition of 2ml of Manganese sulfate ($MnSO_4$) and 4ml of Alkali-iodide azide ($NaOH^+$ KI^+ NaN_3). Water sample was analyzed for the following physicochemical parameters: temperature, turbidity, pH, alkalinity, acidity, total hardness, biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrate content, dissolved oxygen, total suspended solids (TSS), total dissolved solids (TSD), and conductivity.

Total solid determination was carried out by evaporating completely in an oven at 120°C while the total suspended solid was determined according to (Joel *et al*., 2009) with modifications. A 50 ml water sample was filtered and paper oven dried at 110°C for 1 h then cooled in a desiccator. The determined residue was used to calculate the TSS. Total dissolved solids (TDS) was determined by measuring the electric conductivity using a conductivity meter (HM Digital COM-100). The electrical conductivity meter was standardized with 342ppm sodium chloride calibration solution and the comparison of the TDS in water samples was done with the World Health Organization (WHO, 1996)

Biological Oxygen Demand (BOD_5^{20}) was determined using the respirometric method as described by (Roppola et al., 2007) except in this study the incubation was carried out for 5 days in a sample bottle thermostatted to 20 ± 1°C in an incubator. Chemical oxygen demand was carried out according to (APHA/AWWA/WEF, 2012). Twenty-five millimeter of water sample was added to H_2SO_4 in a reflux flask and thoroughly mixed together. A 10 and 30 ml volumes of 0.25N $K_2Cr_2O_7$ and H_2SO_4-Ag_2SO_4 reagent respectively were added to the flask along with anti-bumps granules and refluxed for 2 h with gentle heat. The mixture is cool and washed down from the walls of the condenser with distilled water. The mixture was diluted to 150 ml and titrated with FAS solution using ferroin as indicator.

Bacteria counting and isolation from samples

Serial dilutions of each water sample was carried out by pipetting 1ml of each into 9ml of sterile distilled water in test tubes, and dilutions was carried out to 10^3. One thousand microliter (1ml) of final dilution was inoculated on cetrimide, eosin methylene blue, MacConkey and nutrient agar to detect the presence of members of *Pseudomonas* spp, *Enterobacteriaceae*, Bacillus and other bacteria genera respectively in the samples. The number of organisms with distinct growth on the plate were counted after incubation on nutrient agar and recorded as colony per ml. For isolation of bacteria from soil samples, 5g of each of the soil sample, was crushed aseptically after gentle heating and diluted in 90 ml of sterile distilled water, while 10 ml of sample was used in the case of wastewater and followed by serial dilution and inoculation on different freshly prepared selective media (as described above), by using the glass spreader, and incubated at 37°C for 24 – 48 h. All bacterial isolates were identified using standard biochemical methods. The isolates were maintained at 4°C until further use.

RESULTS

The summary of the physicochemical properties of the water samples are depicted in Table 2. The average temperature range of the samples was 28°C while the pH of the water sample was 7.1, acidity value and alkalinity was 1900 and 450 mg/L respectively. Biodegradable oxygen demand of the river water was 5.022mg/L while the COD value was 1680mg/L. Both parameters are above the acceptable limit of 2.0 and 80 mg/L respectively.

Table 3 shows the bacteria load from the soil, effluent river water sample. The range of the microbial count for all sample is 1.0 $x10^4$ and 9.2 x 10^2 (cfu/ml). The river water had the highest microbial count with the range of 3.2 x 10^4 and 9.2 x 10^2 cfu/ml followed by effluent with range of microbial load of 1.0 x 10^2 and 7.0 x 10^2 cfu/ml. The soil samples had the lowest microbial load range of 1.0 $x10^4$ and 4.0 $x10^4$ cfu/ml (Table 3). Selected bacteria identified from all sampled sites are presented on Table 4 *Bacillus* spp (*Bacillus subtilis* and *Bacillus amyloliquefaciens*) were isolated and identified in all the sampled points compared to other bacteria genera. (Table 4). *Pseudomonas stutzeri*, *Enterobacter aerogenes*, *Exiguobacterium profundum*, *Enterococcus faecium* were isolated from the soil samples, *Aeromonas hydrophila*, *Acinetobacter baumannii*, *Comamonas* spp were isolated from the river water while *E.coli* was isolated from the effluent sample (Table 4).

DISCUSSION

In Nigeria, majority of the rural populace depends on river, streams and well water because they do not have access to potable water for their domestic use. Overtime, accounts of natural water and other sources of water supplies qualities in Nigeria have not been satisfactorily reported with microbial contamination exceeding permissible level and harbouring harmful genes (Esharegoma *et al*., 2018).

In this study, the physicochemical parameters and microbial analysis of Ogun river was investigated to establish its safety and domestic use. Results of the present study revealed unacceptable limits of most of the parameters investigated. The pH of the water which was 7.1 was within the WHO limits of 6.0 – 9.0 while the temperature of 28°C is in agreement with the WHO standard of 27°C. Total dissolved solids (TDS) of 40 mg/L of the water falls below the WHO standard for good water quality which is 500 mg/L. A similar low TDS has been previously reported in Orogodo river in Agbor Delta state (Esharegoma *et al*., 2018) and groundwater

in Kano (Emmanuel and Nurudeen, 2012). The dissolved solids are the inorganic salts and other organic matters that are dissolved in water. Elevated TDS often result in hard water and leaving deposits and films inside pipes and home appliances. However lower TDS is considered non-hazard except on cases of extremely low TDS which has been found to give a flat taste (USEPA 2012). In this case, TDS will be expected to contain most waste generated by abattoirs such as animal bones, faecal matters, ash etc. High TDS often leads to high turbidity in water, surprisingly, despite the low TDS in the water, the turbidity was above the limit (Table 2). This suggests that other anthropogenic sources may have been responsible for the high turbidity.

The water BOD and COD values of 5 and 1680 mg/L respectively are higher than the acceptable limit of 2 and 80 mg/L of the WHO standards (Sobsey, 2002). This result is in agreement with previous study on Ogun river by Alani et al., 2014. High BOD and COD values of water often suggest the presence of pollution from organic and inorganic loads especially from such places as Kara Abattoir. Since abattoirs effluent are rich in blood and faecal contents, such discharge into the water are responsible for obtaining value above the permissible limits in this study. The dissolved oxygen value was approximately 20 mg/L contrary to the acceptable limit of 5 mg/L. All these put together will definitely have an adverse effect and detrimental conditions on the fishes and the survival of other aquatic lives.

The range of total bacterial count for all the samples evaluated in this study was between 1 x 10^4 and 9.2 x 10^2 (cfu/ml), the values obtained exceeded the normal acceptable limits of 1 x 10^2 (cfu/ml) recommended by the WHO. High bacterial count in this study suggest high pollution of the water body and the surrounding soil by rich protein contents especially from blood which serves as nutritive medium for the growth of most bacteria. The microbial count of the present study corroborate previous ones relating to microbial analysis of abattoir (Atuanya *et al*., 2012; Ogunnusi and Dahunsi 2014), it appears most results obtained are always above the WHO recommended limit hence suggesting high prevalence of poor water quality among the investigated rivers, of which if consumed or used for domestic purpose may lead to water-borne disease infection or an outbreak of disease such as cholera. Untreated effluents from abattoir contain several microorganisms which serves as pathogens to humans because of the gut contents of the livestock that are introduced into the waste during the process (Ogunnusi and Dahunsi, 2014). Diseased animals or carriers, as well as those harbouring resistant bacteria that are slaughtered in the abattoir, are easy route of human contamination and transmission of resistant pathogen via consumption and domestic use of the water such as farming, bathing, cooking etc. The gut is rich in enteric bacteria and other normal intestinal flora that are not supposed to be found in drinking water and that suggest why *E. coli* and other gut bacteria such as *E. faecium* were among the bacteria isolated in this study.

In conclusion, this study has identified a possible source of water contamination which may lead to serious health hazards if activities goes unabated. It is, therefore, recommended that government should with immediate effect enact laws that will make provision for treatment of abattoir effluent and waste before discharging into the environment.

Table 1: Description of sample sites

Sample	Area of collection	Description of site and its surrounding
River water	Bank of Ogun river	About 1 metre from the river bank into the river.
Effluent	Gutter that leads to the river	This site is a gutter channeled from the slaughtering slab to the river. Contains water mixed with blood used in rinsing the slab.
Pomo water	Skin processing site	Animal skins are burnt and processed with fire.

Table 2: Summary of physicochemical parameters tested

Parameters measured	Water sample	WHO standards*	Remarks
pH	7.1	6.0 – 9.0	WL
Temperature	28^{o}C	27	WL
Alkalinity	1900 mg/L	-	-
Acidity	452 mg/L	-	-
Nitrate	15.295Abs	45	WL
Total hardness	190 mg/L	0-75	AL
Dissolved oxygen	19.5mg/L	5.0	AL
Biochemical O_2 Demand	5.022mg/L	2.0	AL
Chemical O_2Demand	1680mg/L	80	AL
Turbidity	40 Abs.	25	AL
Total solid	94 mg/L	-	-
Total dissolved solid	40 mg/L	500	WL

AL = Above Limit WL = Within Limit (WHO, 2004)

Table 3: Total bacteria count from sampled sites

Samples sites	Mean bacteria count
Effluents	$2.0 \times 10^3 - 7.0 \times 10^2$
River water	$3.2 \times 10^4 - 9.2 \times 10^2$
Soil	$1.0 \times 10^4 - 4.0 \times 10^4$

Table 4: Selected bacteria identified from samples sites

Samples sites	Selected identified bacteria
Effluents	*Bacillus subtilis, Bacillus amyloliquefaciens, E.coli,*
River water	*Bacillus subtilis, Bacillus amyloliquefaciens, Aeromonas hydrophila, Acinetobacter baumannii, Comamonas* spp
Soil	*Bacillus subtilis, Bacillus amyloliquefaciens, Pseudomonas stutzeri, Enterobacter aerogenes, Exiguobacterium profundum, Enterococcus faecium*

REFERENCE

Alani, Rose, Alo, Babajide and Ukoakonam, Friday. 2014. "Preliminary Investigation of the State of Pollution of Ogun River at Kara Abattoir , Near Berger , Lagos" 2 (2): 11–23.

APHA/AWWA/WEF. 2012. "Standard Methods for the Examination of Water and Wastewater." *Standard Methods*. doi:ISBN 9780875532356.

Atuanya, E I, N A Nwogu, and E A Akpor. 2012. "Effluent Qualities of Government and Private Abattoirs and Their Effects on Ikpoba River , Benin City , Edo State , Nigeria" 6 (5): 196–201. doi:10.5829/idosi.abr.2012.6.5.6672.

Botzenhart, K, and A Wiedenmann. 2001. "Water-Borne Infections ." *Tagliche Praxis*. doi:10.1007/978-3-540-48996-2_3409.

Emmanuel Bernard and Nurudeen Ayeni. 2012. "Physicochemical Analysis of Groundwater Samples of Bichi Local Government Area of Kano State of Nigeria" XXXIII (2): 81–87. doi:10.1007/s13398-014-0173-7.2.

Esharegoma, Omonigho Solomon, Nkem Chinedu Awujo, Inetianbor Jonathan, and Igbeta Peace Nkonye-asua. 2018. "Microbiological and Physicochemical Analysis of Orogodo River , Agbor , Delta State , Nigeria" 5 (2): 34–42.

Joel, O F, B S Akinde, and C U Nwokoye. 2009. "Determination of Some Physicochemical and Microbiological Characteristics of Sewage Samples from Domestic, House-Boat and off-Shore Facilities Discharge Point." *Journal of Applied Sciences and Environmental Management*.

McClure, Jo A., John M. Conly, Vicky Lau, Sameer Elsayed, Thomas Louie, Wendy Hutchins, and Kunyan Zhang. 2006. "Novel Multiplex PCR Assay for Detection of the Staphylococcal Virulence Marker Panton-Valentine Leukocidin Genes and Simultaneous Discrimination of Methicillin-Susceptible from -Resistant Staphylococci." *Journal of Clinical Microbiology*. doi:10.1128/JCM.44.3.1141-1144.2006.

Mellouki, Abdelwahid, Christian George, Fahe Chai, Yujing Mu, Jianmin Chen, and Hong Li. 2016. "Sources, Chemistry, Impacts and Regulations of Complex Air Pollution: Preface." *Journal of Environmental Sciences* 40 (February): 1–2. doi:10.1016/j.jes.2015.11.002.

Odumosu, B.T., O. Ajetunmobi, H. Dada-Adegbola, and I. Odutayo. 2016. "Antibiotic Susceptibility Pattern and Analysis of Plasmid Profiles of Pseudomonas Aeruginosa from Human, Animal and Plant Sources." *SpringerPlus* 5 (1). doi:10.1186/s40064-016-3073-9.

Ogunnusi, T A, and O V Dahunsi. 2014. "Isolation and Identification of Microorganisms from Abattoir Effluents from Oyo , Oyo State , Nigeria" 02 (02): 218–22.

Rhind, S. M. 2009. "Anthropogenic Pollutants: A Threat to Ecosystem Sustainability?" *Philosophical Transactions of the Royal Society B: Biological Sciences* 364 (1534): 3391–3401. doi:10.1098/rstb.2009.0122.

Roppola, Katri, Toivo Kuokkanen, Jaakko Rämö, Hanna Prokkola, and Eeva Heiska. 2007. "Comparison Study of Different BOD Tests in the Determination of BOD 7 Evaluated in a Model Domestic Sewage." *Journal of Automated Methods and Management in Chemistry*. doi:10.1155/2007/39761.

Singh, Lakhvinder, Praveen Sharma, and Asalapuram Ramachandran Pavankumar. 2015. "Chemical Oxygen Demand Elimination and Decolorization of Textile Industrial Effluent by an Indigenous Fungal Species Aspergillus Foetidus." *Clean - Soil, Air, Water*. doi:10.1002/clen.201300956.

Sobsey, M.D. 2002. "Managing Water in the Home : Accelerated Health Gains from Improved Water Supply." *World Health* 8 (11): 1–83. doi:10.1111/j.1461-0248.2005.00820.x.

Tritt, W.P., and F. Schuchardt. 1992. "Materials Flow and Possibilities of Treating Liquid and Solid Wastes from Slaughterhouses in Germany. A Review." *Bioresource Technology* 41 (3). Elsevier: 235–45. doi:10.1016/0960-8524(92)90008-L.

USEPA. 2012. "2012 Edition of the Drinking Water Standards and Health Advisories." *2012 Edition of the Drinking Water Standards and Health Advisories*, no. March: 2–6. doi:EPA 822-S-12-001.

World Health Organization (WHO). 1996. "Total Dissolved Solids in Drinking-Water." *Health Criteria and Other Supporting Information* 2: 2. doi:WHO/HSE/WSH/10.01/14

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