Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Archives of Applied Science Research, 2012, 4 (2):1002-1006
(http://scholarsresearchlibrary.com/archive.html)

ISSN 0975-508X
CODEN (USA) AASRC9

Heavy metal and bioload levels of Otamiri river, Owerri, Imo State, Nigeria

[*1]Duru, Majesty, K.C., [2]Nwanekwu, Kenneth, E., [1]Adindu, Eze, A., and [3]Odika, Prince,C.

[1]Department of Biochemistry, AbiaState University, Uturu, Nigeria
[2]Department of Microbiology, Imo State University, Imo State, Nigeria
[3]Conc Educational Services and Research Centre, Owerri, Imo State, Nigeria

---

ABSTRACT

Heavy metal and bioload levels of Otamiririver was investigated. Four sites designated upstream (UPSI), upstream II (UPSII), fallout point (FP), and downstream (DS) at 100meters apart, were water collection points from the river. Analysed water samples collected from the river showed that apart from total iron at upstream I, all other identified heavy metals in the river water were lower than those of maximum permissible limits. Metals such as cadmium, chromium, arsenic, mercury and cobalt used as indices of heavy metal pollution of water body were absent in Otamiririver. Pseudomonas aeruginosa, Proteus spp, Staphylococcus epidermuchsi,Escherichia coli, Klebsiella species, Proteus species, Vibro species, Shigella species and Salmonella species wereamong the microbes identified and isolated from Otamiririver. High bioload levels per group of microbes for total heterotrophic bacteria count, total coliform count, total viable bacteria count, and total fungalcount were observed in the this study. The present study has shown that the levels of microbes in Otamiririver are alarming hence those that depend on the river water especially for domestic uses should purify it before usageas to avoid possible contamination of the diseases associated with the identified microbes.

Key words: Heavy metal, biolaod, Otamiririver, pollution, contamination.

INTRODUCTION

The supply of clean and uncontaminated water is a great challenge facing developing nations. Water bodies in developing countries are predisposed to pollution [6, 25]. In Nigeria, pollution is a major threat to both surface and underground water bodies [7, 8]. This emanates mostly from indiscriminate dumping of refuse, untreated sewage, oil spillage, etc[20]. Apart from problem of accessibility of clean water from these contaminated water bodies, it is known that pollution of water could lead to health hazard, sanitary nuisance, severe economic and social consequences [3, 15, 21, 22].

Incidence of diseases such as typhoid, paratyphoid, giardiasis, infectious hepatitis, leptospiriosis, schistomiasis,shigellosis, amoebiasis,etc., could be inherent from consumption of contaminated water. The pathogens associated with these diseases have been directly or indirectly detected as having link with contaminated water [35, 36]. Aside microorganisms, water bodies are also known to contain numerous chemical elements at different levels [21]. These chemicals also add to give information on the pollution status of water although; some may not constitute a health hazard to the health of people directly but may give room to the growth orpresence of some microorganisms, which may impair health in water [19, 18,22].

Otamiririver, one of the major rivers that flow through Owerri the capital city of Imo State in south eastern region of Nigeria and Its environs, is among such water bodies threaten by pollution as a result of waste disposal [6]. Apart from the agrochemicals that are being washed into Otamiririver from farm lands surrounding its banks during rain

fall, some industries, institutions, and outlets situated along the river also empty their waste water into the river [6]. Due to its importance as water resource to the populace within Owerri municipality and its delicate environs, the present study investigated the heavy metal and bioload levels of the river.

MATERIALS AND METHODS

Water sample collection

The water samples were collected in September, 2010 from Otamiririver at four sampling points. The sampling points were designated upstream I (UPSI), upstream II (UPSII) fallout point (FP) and downstream (DS). The samples were collected at 100 meter intervals. The sampling was done in the evening against the water flow. Six composite samples were collected and pooled together at each sampling point. The samples for heavy metals analysis were collected in clean sterile bottles with screw caps in duplicates, using disposable sterile hand gloves while those for microbial analysis were aseptically collected in four sterile tubes.

Heavy metal analysis

Metals analyzed, which include Cd, Cr, Pb, Cu, Mn, Total Fe, Zn,,Ar,Pb, and Hg, were determined using Atomic Absorption Spectrophotometric (AAS) methods as described by [19].

Bioload analysis.

For identification and isolation only, some water sample from different collection points were pooled together while the other bioload analysis were separately done with each water sample collected.Inoculation on different culture media using the spread plate technique as described by [12] method was usedfor thewater samples collected. After serial dilution, groups of microbes; total heterotrophic, total coliform, total viable; and total fungi were estimated using selective media and spread plate inoculation techniques according to [24] and modified by [13].The method describedby[33]was used for faecal coliform isolation.KF- streptococcus agar was used for faecal streptococci while thiosulphate citrate bile sucrose agar (TCBS) was used to isolate *Vibro*species as recommended by [32]. The enumeration of*Salmonella* species was carried out using the bismuth sulphate agar [34]. Media preparations were according to manufacturer's instructions and incubation generally, except for faecal coliform, was at 35 -37°C for 24 h.

RESULTS AND DISCUSSION

Table1.Result of heavy metals analysed in Otamiririver (mg/l)

Parameters	UPS1	UPSII	FP	DS	Maximum permissive limit
Cadmium	ND	ND	ND	ND	0.05
Chromium	ND	ND	ND	ND	0.05
Copper	0.19±0.04	0.08±0.01	0.04±0.02	0.03±0.03	1.0
Manganese	0.07±0.03	0.04 ±0.02	0.03±0.01	0.04±0.01	0.1
Total iron	1.12±0.33	0.30±0.01	0.22±0.01	0.14±0.03	0.3
Zinc	2.01±1.22	0.95±0.10	0.30±0.09	0.40±0.01	5.0
Arsenic	ND	ND	ND	ND	0.05
Mercury	ND	ND	ND	ND	0.001
Cobalt	ND	ND	ND	ND	0.0022
Lead	ND	0.01±0.00	0.03±0.00	0.05±0.02	0.01

Values are means± standard deviation of triplicate determinations.
UPSI=UpstreamI, UPSII=UpstreamII, FP= Fallout point, DS=Downstream, ND= Not Detected

Investigated heavy metals in the present study (Table 1) have soluble properties, which have generated concern in water development globally, especially in terms of their toxicity [26, 28]. Heavy metals in water are classified into portable, above permissible limits, hazardous, toxic and highly toxic [28, 29]. Concentrations of heavy metals above permissible limits are generally not suitable for consumption. Water containing cobalt above permissible limit can have an erythropoietic effect such as increased incidence of goitre in humans. Toxic concentration of lead in humans has been implicated for causing kidney damage, cerebral oedema, anaemia, etc. Mercury and arsenic have been implicated for respiratory poison and hypertensionrespectively [23, 26, 29]. Manganese, iron, zinc, and copper are noted for astringent taste, discoloration and turbidity in water [19, 28]. Aside the values of iron in UPSI, other heavy metals detected in Otamiririver were blow WHO permissible limits. Cadmium, chromium, arsenic, and cobalt were not detected in the river. Their absence could indicate the nontoxic nature of Otamiri, river.

Table 2.Identification of bacteria isolates from Otamiririver

Key + = Present, = Absent

Characteristics of the colony	Gram Reaction	Motility	Spore stain	Catalase	Coagulase	Urease	VogesProskaur	Citrate	Indole	Hydrogen Sulphide	Methyl Red	Oxidase	Glucose	Maltase	Lactose	Sucrose	Manitol	
Raised with dry surface and bluish green colour on nutrient agar (NA)	Gram negative rods	+	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	*Pseudomonas aeruginosa*
Large sized, cream flat moist slimy wary translucent colonies with offensive odour	Gram negative rods	+	-	-	-	+	+	+	-	-	+	-	+	-	-	+	-	*Proteus species*
Cream coloured raised convex colony, moist with entire edge smooth surface	Gram positive rods, cocci inclusive	-	-	+	+	-	+	+	-	-	+	+	+	+	+	+	+	*Staphylococcus epidermuchsi*
Pink entire flat lactose fermenting colonies on macconkey agar cream coloured on agar nutrient	Gram negative rods in singles	+	-	+	-	-	-	-	+	-	+	+	+	+	+	+	+	*Escherichia coli*
Raised slimy colonies with entire edge that are mucoid and lactose fermenting on macconkey agar	Gram negative in short chains pairs and single	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	*Klebsiella species*
Yellow creamy entire colonies on TCBS agar	Gram negative curves rods	+	-	+	-	-	-	+	+	-	-	+	+	-	-	+	+	*Vibrio cholerae*
Non-Lactose fermenting pink mucoid colonies on Macconkey agar with dark discouration on BCA	Gram negative rods	+	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	*Salmonella species*
Raised average size pink colonies on DCA	Gram negative rods	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	*Shigella species*
Cream raised colonies on nutrient agar	Gram positive rods in single short chains	+	+	-	-	-	+	+	-	+	-	-	+	+	-	+	+	*Bacillus species*
Purple to light red colonies.	Gram negative long rods with rounded ends.	-	+	+	-	-	-	+	-	-	-	-	-	+	-	-	-	*Chromobacteria species*

Escherichia coli, Klebsiella species, Proteus species, Shigella species and *Salmonella species* belong to the family entrobacteriaceae. Their presence in water indicates faecal contamination of the water. *Escherichia coli*, an indicator of these enterobacteria in water is harmless but the others have been implicated as the causative agent of one waterborne disease or the other. For instance, *Salmonellaspecies* have been implicated in typhoid fever and gastro-intestinal upset, while *Shigella species* have been implicated in bacterial dysentery. *Proteus species* implicated in urinary tract infection in humans [2].*Staphylococcus epidermitis* and *Bacillus species* are pathogenic and non-pathogenic bacteria respectively. *Staphylococcus epidermitis* implicated with mucous of man and other warm blooded animals [3]. The presence in water signifies waste material contamination of the water body from humans and other warm blooded animals whereas*; Bacillus species* are harmless but are saprophytic in nature. Their presence in water indicates the presence of decomposing organic materials in a water body. [27, 30].*Chromobacteria species* are pigmented bacteria classified as chromogenic bacteria. [31]Stated that chromogenic bacteria are constituents of natural water body and hence, poses no problem. The identified bacteriaspecies have earlier been identified in a related work by [1, 9, 16].

Table 3.Bioload per group of microorganism in Otamiririver (cfu/ml)

Group of microorganism	UPSI	UPSII	FP	DS
THBC	4.8×10^6	6.0×10^4	4.1×10^5	5.1×10^6
TCC	4.2×10^4	2.8×10^2	3.6×10^4	3.7×10^4
TVBC	2.8×10^4	2.9×10^4	3.8×10^4	3.7×10^4
TFC	3.0×10^3	3.1×10^3	3.7×10^4	3.2×10^4
Total Salmonella	1.9×10^2	1.7×10^2	2.2×10^2	1.8×10^2
Total Vibrio	0.8×10	1.0×10	1.6×10	1.0×10
Faecal Streptococci	2.0×10^2	1.6×10^2	2.8×10^2	1.3×10^2
Faecal Coliform	2.4×10^2	2.6×10^2	3.1×10^2	3.4×10^2

Results are means of triplicate determinations.; HBC = Total Heterotrophic Bacteria Count.; TCC= Total Coliform Count.; TVBC = Total Viable Bacteria Count.; TFC= Total FungalCount.

[37]reported that water have a wide range of organisms which include indigenous species, saprophytic species as well as human pathogen contaminants.[34]observed that significant increase in bacteriological load in rivers could lead to high risk of infectious disease transmission. [10] revealed that higher bacterial concentrations were strongly linked to total coliform and faecal coliform. High microbial population in an aquatic system is a reflection of the input of microorganisms from extraneous sources, and availability of growth supporting organic matter [30].High counts of bacterial load reflect the level of water pollution as it give indication of the amount of organic matter present. The mean total bacterial counts as obtained for the sites in the present study were remarkably high. This is alarming as Otamiri river water serves the populace within Owerri municipality and its environs for domestic purposes. High values of THBC were obtained in Otamiririver. This could be as a result of human activities such as washing, bathing, etc. Waste water containing chlorine from Owerri municipal water treatment plant which has entry point at a distance close to UPSII and flushing action of the river, may be the cause of the reduced THBC observed in UPSII and FP respectively in the present study. Human waste and waste of warm blooded animals could be responsible for the high values of total coliform count observed in the river. The drop observed in UPSII fortotal coliform count could be as a result of waste water containing chlorine and sunlight bactericidal effect which the site is exposed to [9,38]. The total viable bacteria count values of the present study were high. The highest value observed at FP, could be as a result of waste water from a near by abattoir that enters the river at a distance close to the FP. This waste water may have contained additional microbes that are viable. The decrease observed at DS could be as a result of flushing action of the river while that of UPSII still relates to waste water containing chlorine discharge into the river by Owerri municipal water treatment plant. Fungi are aerobic, multicellular, non-photosynthetic, chemoheterotrophic eukaryotic protists most of which are saprophytic obtaining their food from dead organic matter [4].s Fungi are the principal [4]. The high values recorded at FP and DS are traceable to the fact that water containing organic materials from Ohanjuku saw mill (Owerri municipal solid waste dump) enters the river at FP. The total fungi counts for the river are high. This further reflects the refuse dump ground unto which lands surrounding Otamiririver have been converted to by people leaving close to the river. Total *Salmonella*, total *Vibrio*, Faecal *Streptococci* and faecal coliform observed in the present study are high. This could link Otamiri river water to diseases such as typhoid fever, salmonellosis, cholera, leptospnosis, etc, on consumption[4]. These diseases manifest with different signs and symptoms such as high fever, jaundice,diarrhoea, ulceration of the small intestine, extreme dehydration, etc[4].

CONCLUSION

Although this study has revealed that Otamiririver is low in terms of heavy metal concentration but the river has high levels of bioload. Hence, those populace within Owerri municipality that depend on the river water especially for domestic purposes should endeavor to subject the water to thorough purification processes such as chlorination, boiling ,ozonization, etc, before usage.

REFERENCES

[1]. Ogulie, T.E., Ogubulie, J.N. and Umezuruike,I,*African Journal of Biotechnol*, **2008,** 7(6): 324-830.
[2].Blum D, Huttley SRA, Okoro JI, Akujobi C, Kirkwood BR, Feachem RG .*Epidem Inf.*,**1987**, 99:429-437.
[3].Okafor N. Aquatic and Waste Microbiology, Fourth DimensionPublishers Ltd., Enugu, Nigeria.**1985**, pp. 43-85.
[3].U.S. Environmental Protection Agency (USEPA) BasicHydrogeology. In:
Groundwater and contamination.USEPAHandbook on groundwater. Office of Research and Development. USEPA/625/6-90/016a**, 1992**.
[4].Yospe-Purer, Y and Golderman S.,*Microbiol.*,**1987**,53:1138-1141.
[5].Nwanebu, F. C., Ogbulie, J. N., Obi R. K. and Ojiako O. A.,*Journal of Public Health and Epidemiology*,**2011**,3(8), pp. 358-361.
[6].Akubugwo, E. I and Duru, M. K.C.,*JETEAS*, **2011**, 2 (6): 934-937.
[7].Akaninwor, J.O., and Egwim, O.,*JNES*, ***2006***,3(3): 173 – 182.
[8].Amadi, B.A., Chikezie, P.C, and Okeoma, H.C., JNES. **2006**, 3(3): 983 – 187.
[9].Ekhaise, F.O., and Anyasi, C.C., African Journal of Biotechnol.,**2005**, 4(10):1062 – 1065.
[10]. Crowther, J. Kay, D. and Wyer, M.D.,*Water Res.*,**2001**, 35:4029-4038.
[11].Duffus, H., Toxic metals in: Environmental Toxicology. Edward Arnold London,**1980**, 1 – 79.
[12].Chessbrough, M., Laboratory Manual for tropical countries. Vol.II. Microbiology ELBS.Tropical Health Technology and Butterworth, London, **2001**.
[13].Okpokwasili, G.S.C. and Okorie, B.B.,*Trib Int.*, **1988**, 21: 215 – 220.
[14].Ray, K.L., Joseph, B.F., David, L.F., and George, T.C., Water Supply system in: Water Resources Engineerring. 4thedition, McGraw Hill, **1992**, 497 – 567.
[15].UNEP, Fresh water pollution, UNEP GEMS Environment library. No: 6, UNEP Nairobi Kenya,**1991**.
[16].Victor, O.N., Reginald, A.O., Solomon, N.U., and Nelson, A., *Estud. Biol.*,2007, 29(66): 53 – 61.
[17].United States Environmental Protection Agency, Drinking water standards for regulated contaminants. USA Regulation, USA. **1992**, 1-7.
[18].APHA, Standard methods for the examination of water and wastewater. 21 edition, Amercian Public Health Association. Washington DC, **2009**.
[19]. APHA, Standard methods for examination of water and wastewater 20th edition. American Public Health Association. Washington, DC,**1998**.
[20].Asuquo and Okorie, *Tropical Ecology*,**1987**, 30:31-40.
[21].Hutchinson, G.E., A treastise on limnology Vol.1. Geography, Physic and Chemistry. John Wiley and sons Inc, New York, **1957**,1011.
[21].Essien, D. U., *JSET*, **1998**, 5(1): 982-994.
[22]. George-Okafor, U.O.,*World Journal of Biotechnol*.,**2006**,7(2): 1127-1131.
[23].Irukayama, K., *Jap. J.Hygiene*,**1964**, 19: 246.
[24].Mills, A.L., Breul, C., and Cowell, R.R. ,*Can J. microbial*.**1978,** 241: 552 – 557.
[25]. NEST, Human habitats in: Nigeria threatened environmental study/action Nest publication, **1991**, 228-240.
[26].Hem, J. D., Study and Interpretation of the chemical characteristics of natural waters and Geological survey, water supply paper,**1989**, 234.
[27].Ogbulie,J.N., Application of Biotechnology in the Environmentsin;Fundamentals of Biotechnology. Onyeagba, R.A. and Isu, N.R.(eds). TTP Publishers Enugu Nigeria,**1999**,192 – 198.
[28]. WHO, Guideline for drinking water Quality. Expert Committee on International Standards for drinking water, 2nd edition. Austria,**1996**, 20 – 22.
[29]. FEPA, Guidelines and Standards for Environmental Control in Nigeria published by the Federal Environmental Protection Agency, Lagos, **1991**, 15 – 34.
[30]. Sayler, G.S., Nelson, J.O; Justice, A; Colwell, R.R.,*Appl. Ind. Microbiol.*,**1975**, 30 (4): 625 – 638.
[31]. Punmia, B.C., Ashok, J., and Arun, J., Water Supply Engineering. Laxi. Publication Ltd. New Delhi, **2000**, 190 – 198.
[32]. Nwanebu, F. C.,*Int. J. Environ. Health Human. Dev*.,**2003**, 4(2): 22-28.
[33].Blum, D., Huttley, S. R.A., Okoro, J.I.,,Akujobi, C., Kirkwood, B.R, Feachem, R.G., *Epidem. Inf*., **1987**, 99:429-437.
[34].Kampelmacher, E.H, Massesl, D.A, van Noorle-Jensen Vicentie,H., *J. Hyg. Cambridge*, **1971**.
[35]. Goodyer, L., *The Pharmaceutical Journa*l,**2000**, 246(7080): 134-139.
[36]. Nwigwe, H. C. and Okpi, E. C. *World Journal of Biotec*.,**2002**,3(20):550-555.
[37]. Facklam, R., and Peterson, B. F., *J. Clin. Infection Disease*, **2004**, 24: 111-126.
[38].Devrisese, L. A., Collins, M. D., and Wirth, R., Handbook on the Biology of Bacteria, Ecophysiology, Isolation, Identification, Application, 2nd edn.,**1992**, 1465-1481.