African Journal of Biotechnology Vol. 7 (5), pp. 617-621, 4 March, 2008
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB07.217
ISSN 1684–5315 © 2008 Academic Journals

Full Length Research Paper

Microbiological and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos State, Nigeria

Okonko Iheanyi Omezuruike[1]*, Adejoye Oluseyi Damilola[2], Ogunnusi Tolulope Adeola[3], Fajobi, Enobong A.[4] and Shittu Olufunke B.[5]

[1]Virology Department, College of Medicine, UCH, University of Ibadan, Ibadan, Nigeria.
[2]Department of Biological Sciences, Tai Solarin University of Education, Ijebu-Ode, Ogun State, Nigeria.
[3]Enviromental Microbiology and Biotechnology Unit, Department of Botany and Microbiology, University of Ibadan, Ibadan, Nigeria.
[4]Federal College of Wildlife Management, New Bussa, Niger State, Nigeria.
[5]Department of Microbiology, University of Agriculture, P. M. B. 2240, Abeokuta, Nigeria.

Accepted 29 November, 2007

Samples of tap, well, stream, and wastewaters were collected from Abeokuta and Ojota (both in Nigeria) state and analyzed microbiologically and physico-chemically using standard methods. Total viable count was by pour plate technique while most probable number (MPN) counts were by the multiple tube fermentation technique. The pH (at 25^{O}C) ranged from 3.10 to 8.33 for the untreated raw water samples while temperature ranged from 28 to 30^{O}C while the turbidity of the water and waste water samples ranges from 0.08 to 1.00. All the water samples were found to harbor coliforms organisms in numbers greater than the required WHO/FAO standards for water. The total viable counts for all the water samples were generally high exceeding the limit of 1.0 x 10^{2} cfu/ml for water. The MPN count ranges from 9.3 to 44 MPN/100 ml. The fecal coliform counts on EMB agar plate ranged between 5 and 48 cells, also exceeding the standard limit for water. The Isolated organisms were identified to be *Staphylococcus aureus, Salmonella* species, *Escherchia coli, Pseudomonas aerugionosa, Enterobacter aerogenes, Bacillus* species, *Proteus* species, *Klebsiella* species, *Flavobacterium* species and *Acinetobacter* species.

Key words: Microbiological analysis, standard methods, water, WHO/FAO.

INTRODUCTION

Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability (Lamikanra, 1999; FAO, 1997). The provision of portable water to the rural and urban population is necessary to prevent health hazards (Nikoladze and Akastal, 1989; Lemo, 2002). Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is palatable and safe for drinking (Tebutt, 1983). Potable water is defined as water that is free from diseases producing microorganisms and chemical substances deleterious to health (Ihekoronye and Ngoddy, 1985). Water can be obtained from a number of sources, among which are streams, lakes, rivers, ponds, rain, springs and wells (Linsely and Frazini, 1979; Kolade, 1982). Unfortunately, clean, pure and safe water only exists briefly in nature and is immediately polluted by prevailing environmental factors and human activities. Water from most sources is therefore unfit for immediate consumption without some sort of treatment (Raymond, 1992).

The consequences of waterborne bacteria and virus infection; polio, hepatitis, cholera, typhoid, diarrhea, sto-

*Corresponding author. E-mail: mac2finney@yahoo.com.

Table 1. Physico-chemical properties of the water samples.

Sample	Colour	Odour	Taste	Presence of particles	Temp (°C)	pH (25°C)	Turbidity Abs (540 nm)
A-Tap water	Colourless	Odourless	Tasteless	None	28.0	8.01	0.08
B-Well water	Colourless	Odourless	Tasteless	None	29.0	7.61	0.14
C-Stream (Somorin)	Colourless	Odourless	Tasteless	None	28.0	8.57	0.13
D-Stream (Alabata)	Creamy	Odourless	Tasteless	Particulate	28.0	7.63	0.50
E-Ogudu River Ojota	Bluish	Highly offensive	ND	Suspended	29.2	5.51	0.56
Standard limit	Colourless	Not offensive	Tasteless	None		6.8 - 8.5	1.5 mg/L

mach cramps, etc, have been well established but nitrate contamination is just as deadly. Consequent to the realization of the potential health hazards that may result from contaminated drinking water, contamination of drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases (Edema et al., 2001; Fapetu, 2000).

The original source of any drinking water is rich in aquatic microbes, some of which could be dangerous if they enter the human body. Accordingly, the treatment of water for drinking involves stages where microbes are removed or destroyed before the water gets into homes. After purification the water is subjected to tests by bacteriologists to ensure the safety for human consumption. A long series of dilutions is not necessary by some sample because most water supplied are fatty low in bacteria content, while others require long series of dilutions (Fawole and Oso, 2001).

In many developing countries, availability of water has become a critical and urgent problem and it is a matter of great concern to families and communities depending on non-public water supply system. Conformation with microbiological standard is of special interest because of the capacity of water to spread diseases within a large population. Although the standards vary from place to place, the objective anywhere is to reduce the possibility of spreading water borne diseases to the barest minimum in addition to being pleasant to drink, which implies that it must be wholesome and palatable in all respects (Edema et al., 2001). The principal objectives of municipal water are the production and the distribution of safe water that is fit for human consumption (Lamikanra, 1999). A good knowledge of the chemical qualities of raw water is necessary so as to guide its suitability for use. Thus, regular physico-chemical analysis of water at source must be carried out to determine or check the effectiveness of treatment process. This work is therefore, in an attempt to examine the different sources of drinking water in Abeokuta and Ojota compared with standard table water for conformity to microbiological and physico-chemical standards for treated water samples as well as examines the different domestic and industrial effluents/ waste water for conformity to standards for effluent discharges.

MATERIALS AND METHOD

Samples of tap, well, stream, and river water were collected at different locations in Abeokuta, Ogun state and Ojota, Lagos state. Water representing different turbidities were collected in sterile two water plastic containers and were taken to the laboratory and analyzed within 6 h (maximum transit time – 4 h, maximum process time - 2 h). NAFDAC approved Eva Table water (produced by Nigeria Bottling Company, Coca-Cola) was used as control.

Water samples were analyzed for physiochemical and bacteriological quality and the chemical characteristics were determined by the methods of FAO (1997) and Ademoroti (1996). Temperature was measured at the point of collection using a digitron thermometer (model 275-K) as described by the methods of FAO (1997) and standardized mercury in glass centigrade thermometer as described by Edema et al. (2001) and Ademoroti (1996). Turbidity was determined by measuring the absorbance of the sample at 540 nm wavelength using colorimeter (MODEL 6025 JENWAY, UK) as described by Kareem et al. (2002). The turbidity absorbance readings at 540 nm wavelengths were taken immediately after collection of raw water and waste water samples.

The media used for the bacteriological analysis of water include plate count agar (PCA), nutrient agar (NA), lactose broth (LB), and Eosin Methylene blue agar (EMB). All the media used were weighed out and prepared according to the manufacture's specification, with respect to the given instructions and directions. A serial dilution method was used for total viable count and the presumptive test for coliforms. The sterility of each batch of test medium was confirmed by incubating one or two uninoculated tubes or plates along with the inoculated tests. The uninoculated tubes or plates were always examined to show no evidence of bacterial growth. Any uninoculated tube or plate that showed evidence of bacterial growth was discarded. The pure cultures of the bacterial isolates were subjected to various morphological and biochemical characterization tests to determine the identity of the bacteria isolates with reference to Bergey's Manual of Determinative Bacteriology (Buchanan and Gibbon, 1974).

RESULTS AND DISCUSSION

The physico-chemical properties of the freshly collected water samples (which served as a starting point for these studies) are shown in Table 1. Some of the potable water samples, particularly the tap, well, stream and the Ogudu river water samples did not comply with the standard limits for drinking water and waste discharges. The Ogudu river water sample has very high offensive odour. The pH (at 25°C) range of 7.61 to 8.57 recorded for the untreated water samples and the pH 8.01 for tap water

Table 2. Total viable counts (TVC) of the water samples.

Samples	24 h of incubation (cfu/ml)	48 h of incubation (cfu/ml)
A-Tap water	1.6×10^3	1.8×10^4
B-Well water	1.4×10^4	1.7×10^4
C-Stream (Somorin)	1.5×10^4	1.9×10^4
D-Stream (Alabata)	1.0×10^4	1.2×10^4
E-Ogudu River Ojota	1.8×10^4	2.6×10^4
Standard limit	1.0×10^2	1.0×10^2

Table 3. Most probable number (MPN) of the water samples.

Samples water	MPN/1 00 ml	Coliform count on EMB (cfu/ml)
A-Tap water	16.0	5.0×10^2
B-Well water	16.0	36×10^2
C-Stream (Somorin)	44.0	48×10^2
D-Stream (Alabata)	24.0	24×10^2
E-Ogudu River Ojota	39.0	38×10^2

could be considered as being within acceptable range for natural waters except a deviation recorded for Ogudu river (pH 5.51). As far as the pH is concerned they vary from pH range of 5.51 - 8.57 indicating that Somorin stream water had the highest pH value of 8.57. According to Medera et al. (1982), the pH of most natural waters range from 6.5 - 8.5 while deviation from the neutral 7.0 is as a result of the CO_2/bicarbonate/carbonate equilibrium. The pH of brackish water bodies stated by Imevbore (1985) ranged from 6.5 - 7.4. This temperature range of 28 - 30^{O}C of water samples and the water body is believed to have been influenced by the intensity of the sunlight as temperature rose from 28 - 30^{O}C on relatively hot days (Mulusky, 1974). This was also reported by Banwo (2006). Alabaster and Lloyd (1980) also reported a temperature ranges of 26 and 30^{O}C in a similar study and attributed it to the insulating effect of increased nutrient load resulting from industrial discharge.

The generally low pH values obtained in the river water might be due to the high levels of free CO_2, in the water samples, which may consequently affect the bacterial counts. This was also reported by Edema et al. (2001). The pH of water is extremely important. The fluctuations in optimum pH ranges may lead to an increase or decrease in the toxicity of poisons in water bodies (Ali, 1991). The turbidity (absorbance reading taken at 540 nm wavelength) of the water and waste water samples ranges from 0.08 to 1.00. Turbidity was observed to increase if the colour of the water changes from white to light-yellowish, reddish or grayish and from there to greenish or brown (Table 1).

The microbiological analysis of the water and waste water samples is shown in Tables 2 - 4. The total viable count (TVC) indicates that the Ogudu River has the highest microbial load after 24 and 48 h of incubation having a value of 1.8×10^4 cfu/ml and 2.6×10^4 cfu/ml respectively, which was higher than the recommended value. The TVCs for all the water samples were generally high, exceeding the limit of 1.0×10^2 cfu/ml for water (Table 2). Recommended standard for water is nil (FAO, 1997).

According to a study by Baxter-Potter and Gilliland (1988) on straight river water shed when precipitation and stream flows are high, the influence of continuous sources of pollution such as finding individual sewage treatment plants, industrial and institutional sources and waste water treatment facilities overshadows weather driven sources such as feed between run-off and urban storm water which leads to generation of faecal colliform concentrations. However, illegal dumping of domestic wastes, livestock management, faecal deposit and waste dumps also affect bacterial concentration in run-off.

The most probable number (MPN) for the presumptive total coliform count of the water samples ranges from 16 to 44 MPN/100 ml (Table 3). It indicates that water from Somorin stream had the highest total coliform counts of 44 MPN/100 ml followed by the Ogudu River having 39 MPN/100 ml. Owing that the total coliform count of these untreated water samples were grossly contaminated. The coliform count on EMB agar plate also showed that Somorin stream water had the highest coliform counts of 48 cells/ml, also followed by Ogudu river (38 cells/ml) and well water (B) (36 cells/ml). Although the Ogudu River and the two streams are a flowing one, it is open to various objects uses and gross contamination as well as turbidity which may result from the presence of high levels of organic waste matter. Recommended standard for water is less than 2MPN 100 ml (FAO, 1997).

The fecal coliform counts per 100 ml of the water samples on EMB agar plate ranged between 5 and 48 cells (Table 3), which also exceeds the standard limit for

Table 4. Morphological characteristics of isolates.

Isolate	Morphological Characteristics	Organism
W1	Non-spore forming and non-motile, Gram positive cocci, circular, low convex with entire margin, smooth, medium, opaque, golden yellow colony on Nutrient Agar, grown at pH 7 and 37^{O}C	*S. aureus*
W2	Dark centered, gram negative, non endospores forming colony on Salmonella-Shigella Agar.	*Salmonella* sp.
W3	Gram negative, circular, low convex, with entire margin, mucoid, opaque, small, non endospores forming rod shaped, pinkish glistering with metallic sheen colony on Eosin Methylene Blue (EMB) Agar; grown at pH 7, 37and 45^{O}C.	*E. coli*
W4	Non-spore forming, Gram negative short rods, colourless colony on Nutrient Agar, grown at 4and 42^{O}C	*P. aerugionosa*
W5	Gram negative, non endospores forming rod, light-yellow colony with feather-like margin.	*E. aerogenes*
W6	Spore forming, Gram positive rods, creamy white colony on Nutrient Agar with entire margin	*Bacillus* sp.
W7	Non-spore forming and non-motile gram negative rod colony on Nutrient Agar that appeared translucent with serrated or feather-like margins	*Proteus* sp.
W8	Gram negative rods on Nutrient Agar	*Klebsiella* sp.
W9	Gram negative rods that appeared yellowish with entire margin on Nutrient Agar	*Flavobacterium* sp.
W10	Gram positive rod that appear grey-white with undulated margin on Nutrient Agar	*Acinetobacter* sp.

Table 5. Biochemical characteristics of isolates.

Test	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Catalase	+	+	+	-	-	+	+	+	+	+
Oxidase	-	+	-	-	-	-	-	-	-	-
Motility	-	-	-	+	+	+	-	-	+	+
Indole	-	+	+	-	-	-	+	-	-	+
Methyl-red	-	-	+	-	(+)	-	+	-	+	-
Voge-Proskauer	+	+	-	+	+	+	-	+	+	-
Citrate utilization	-	+	-	+	+	-	-	+	-	+
Urease	+	-	-	-	+	-	+	+	-	+
Hydrogen sulphide	ND	+	ND	+	-	+	-	-	-	-
Starch hydrolysis	-	-	-	-	-	-	-	+	-	-
Gelatin hydrolysis	-	+	-	+	(+)	+	+	(+)	+	-
Nitrate utilization	-	-	+	-	+	+	+	+	(+)	-
Coagulase	+	ND	ND	ND	ND	ND	ND	ND	ND	ND
10% NaCl	-	-	+	ND	-	-	-	-	-	-
Glucose fermentation	A	A/G	A	A/G	A/G	AG	A	A	AG	A
Xylose fermentation	-	-	A	ND	ND	-	ND	ND	ND	ND
Lactose fermentation	-	A/G	A	A/G	A/G	A	-	-	-	A
Sucrose fermentation	A	A/G	A	A/G	-	AG	AG	AG	AG	A
Maltose fermentation	A	A/G	A	-	A	A	A	A	A	A
Mannitol fermentation	A	A	A	AG	A	AG	-	A	A	A
Galactose fermentation	ND	AG	ND	ND	A	AG	A	A	A	A
Fructose fermentation	A	ND	A	A	A	A	A	A	A	A
Sorbitol fermentation	A	ND	A	-	A	A	-	A	A	-
Arabinose fermentation	AG	ND	A	A	AG	AG	-	AG	AG	AG

W1=*Staphylococcus aureus* W2 =*Salmonella* sp.
W3 = *Escherchia coli* W4 = *Pseudomonas aerugionosa*
W5 = *Enterobacter aerogenes* W6 =*Bacillus* sp. sp.
W7 =*Proteus* sp. W8 =*Klebsiella* sp.
W9 =*Flavobacterium* sp. W10 =*Acinetobacter* sp.
A = Acid production only A/G = Acid production with gas
ND = Not determined (+) = Late Positive

water. The presence of coliforms group in this water samples generally suggests that a certain selection of water may have been contaminated with faeces either of human or animal origin. Other more dangerous micro-organisms could be present (Richman, 1997). This result compared favourably with the report of Banwo (2006) which indicates that the presence of bushes and shrubs makes likely possible that smaller mammals may have been coming around these water bodies to drink water, thereby passing out faeces into the water.

The Morphological characteristics of the isolates obtained from the water samples on Nutrient Agar (NA) and Eosin Methylene blue (EMB) agar is shown in Table 4. The completed coliform test showed a positively completely confirmed test for all the water samples. The gram's reaction and endospores staining reaction for the characterization of isolates obtained are also shown on Table 4. The Biochemical characteristics of the isolates obtained from these water samples is shown in Table 5. The isolated bacteria species were identified to be same with those commonly encountered in water and aquatic environments as was also reported in a study on streams surface water in Wyoming in U.S.A. reported by Clark and Norris (1999) and reviewed by Banwo (2006). These identified isolates include *Staphylococcus aureus, Salmonella* species, *Escherchia coli, Pseudomonas aerugionosa, Enterobacter aerogenes, Bacillus* species, *Proteus* species, *Klebsiella* species, *Flavobacterium* species and *Acinetobacter* sp. (Table 5).

Recommendation

The pathogenic organic and the indicator organisms present in all the water samples render them unfit for human consumption though they can be used for other purposes. Water should meet different quality specifications depending on the particular uses. Thus, potable and domestic water should be harmless for the health of man and should have proper organoleptic properties and should be suitable for domestic use. Water quality should be controlled in order to minimize acute problem of water related diseases, which are endemic to the health of man.

REFERENCES

Ademoroti CMA (1996). Standard method for water and effluent analysis, March prints and Consultancy, Foludex press Ltd. Ibadan, p. 182.

Alabaster JS, Llyod R (1980). Water Quality for fresh fish. 1st edition Butterworth, London, p. 283.

Ali J (1991). An Assessment of the Water Quality of Ogunpa River Ibadan, Nigeria. M.Sc. Dissertation. University of Ibadan, Ibadan, Nigeria.

Banwo K (2006). Nutrient Load and Pollution Study of Some Selected Stations along Ogunpa River in Ibadan, Nigeria. M.Sc. Dissertation. University of Ibadan, Ibadan, Nigeria, p. 107.

Baxter-Potter W, Gilliland M (1988). Bacterial Pollution of Run-off from Agricultural Lands. J. Environ. Qual. 17(1): 27-34

Buchanan RE, Gibbons NE (1974). Bergey's Manual of Determinative Bacteriology 8th edition. The Williams and Wilkins company, Baltimore.

Edema MO, Omemu AM, Fapetu OM (2001). Microbiology and Physicochemical Analysis of different sources of drinking water in Abeokuta. Nigeria. Niger. J. Microbiol. 15(1): 57-61.

Fapetu OM (2000). Comparative Analysis of Different Sources of Drinking Water in Abeokuta South L.G A., Ogun State (B.Sc. Thesis) UNAAB Abeokuta, p. 44.

Fawole MO, Oso BA (2001). Laboratory manual of Microbiology: Revised edition spectrum books Ltd Ibadan, p. 127.

Food and Agriculture Organization (FAO) (1997a). Chemical analysis manual for food and water, 5th Ed, FAO ROME 1: 20-26.

Food and Agriculture Organization (FAO) (1997b). Annual Report on Food Quality Control; 1: 11-13.

Ihekoronye AI, Ngoddy PO (1985). Integrated Food Sciences and Technology for the Tropics. Macmillan Press London, Oxford. pp. 95-195.

Imevbore AMA (1985). The Investigation of Faecal Pollution in the Surface Waters of Niger Delta of Nigeria. Final Rep. N.D.D.A. 3: 4-94.

Kolade OA (1982). Shallow wells as supplementary Sources of water in Nasarawa. Gwon. Jos (M.Sc. Thesis). Department of Geography and Planning, University of Jos, Nigeria, pp. 8-11.

Lamikanra A (1999). Essential Microbiology for students and practitioner of Pharmacy, Medicine and microbiology. 2nd ed. Amkra books Lagos, p. 406.

Lemo OO (2002). Bacteriology Determination of Water with long term storage (BSc. Thesis) UNAAB Abeokuta, p. 40.

Medera V, Allen HE, Minear RC (1982). Non metallic constituents; Examination of Water Pollution Control. A reference handbook Physical, Chem. Radiol. Exam. 2: 169-357.

Mulusky DS (1974). Ecology of Estuaries. Heinemann Educational Books, London, pp. 5-103.

Nikoladze GDM, Akastal S (1989). Water treatment for Public and Industrial Supply MIR Publisher Moscoul, p. 163.

Raymond F (1992). Le Problame dis ean dans le monde (problems of water), EB and Sons Ltd., UK, pp. 123-126.

Richman M (1997). Industrial Water Pollution, Wastewater 5(2): 24-29

Tebutt THY (1983). Principles of Quality Control. Pergamon, England, p. 235.