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Full Length Research Paper

Characterization of surface and ground water with reference to microbiological study in Akungba-Akoko, Ondo State

Ajayi Adedayo Olajide

Department of Microbiology, Adekunle Ajasin University Akungba-Akoko, Ondo State, Nigeria. E-mail: jidet02@yahoo.com.

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Water samples were collected from wells, bore holes and some streams at various locations within Akungba-Akoko, Ondo state. Pour plate technique was used for the estimation of Total bacterial count and Coliforms count of the water sources. Mean heterotrophic bacterial counts (cfu.ml) ranged from 1.0 x 10^4 in A.A.U.A storage tank to 122 x 10^4 in Oroke well. Total coliforms counts (cfu/ml) ranged from 0.01 x 10^4 in A.A.U.A storage tank to 36 x 10^4 and 38 x 10^4 in Oroke well and stream, respectively. Microorganisms isolated from the different water sources include *Escherichia coli*, *Klebsiella spp*, *Bacillus spp, Bacillus cereus, Proteus spp, Streptococcus spp, Pseudomonas spp., Flavobacterium spp., Streptococcus feacalis, Pseudomonas aeroginosa, and Staphylococcus aureus*. This study thus revealed that some indicator and pathogenic group of organisms like *E. coli,* S. feacalis and *B. cereus* constituting 13.34% each of the total number of microorganism isolated were largely encountered in the water sources from this area, hence, there is need for proper monitoring of the water sources to avert outbreak of epidemic disease. The pH of water sources ranged from pH 5.52 and 5.87 in Ilale borehole 2 and Ilale well respectively to pH 7.67 in Igbelu well. The temperature recorded range from 23 - 28°C for the sample sources. The wide variation in Physico-chemical parameters like pH from the neutral point signifies presence of contaminants that may favour the spread of some aetiologic agents of diseases that could be controlled through proper health delivery systems.

Key words: Akungba- Akoko, microbiological, Ondo state, ground water, surface water.

INTRODUCTION

Water is a natural resource that is universally needed for our daily activities. Water is been constantly exposed to various pollutant inhabited by bacteria and other forms of microorganism. These microorganisms are ubiquitous in nature that is they are widely distributed in nature both in the aquatic and terrestrial environment including the air (Prescott et al., 2008; Zobell, 1972) . According to Okafor (2005) , and R. Putheti et al. (2009), water is diversified in nature as it may be natural waters which can be grouped into: (a) Atmospheric waters such as rain, hail and snow (b) Surface waters such as stream, ponds, lakes, rivers and estuaries and oceans. (c) Ground (or underground) such as waters spring, well, underground streams. While artificial waters, all of which are surface waters include: (a) reservoirs (b) dams (c) oxidation ponds (d) man-made lakes.

Microorganisms generally may be beneficial or non-beneficial. Those that are beneficial are useful for various clinical, pharmaceutical and industrial processes apart from those that participate naturally as normal flora for proper functioning of human body system. On the contrary those that act as pathogen present in our environment especially as water contaminants could pose deleterious threat to human health and causation of epidemics (Archibald, 2000; Ibiene et al., 2006, Iwatt and Antai, 2006). Various activities of man both at the domestic and industrial level leads to contamination of water which has served as viable habitat for many types of microorganisms (Sabongari, 1982). The study of Oluyege and Famurewa (2005) shows that contamination of drinking water with feacal and other materials may increase the risk of disease transmission to consumers. Similarly, group of organisms such as coliforms may serve as indicator organisms to monitor our water resources and assess their quality (Obire Aguda and R.R. Putheti, 2009; Oluyege and Famurewa, 2005; LeChevallier et al., 1996).

MATERIALS AND METHODS

Study site

Water samples were collected from wells, bore holes and some streams at various locations within Akungba-Akoko, Ondo state. The locations were Adekunle Ajasin University; borehole and storage tank, Oroke; stream, Akunmi; borehole and well, Ilale; borehole and well, Akwa; stream and well, Okele; well and stream, Igbelu; well and Isakare; stream.

Akungba-Akoko is a town in which the Ondo state University now renamed Adekunle Ajasin University is sited in Akoko South West Local government area of Ondo state. It is located between longitude 5.44°E and 5.45°E and latitude 7.24 and 7.28 N. It is a conglomerate of other small towns and villages like Akowonjo, Apole, Okele, Ugbama, Araromi and Ago-Egbira. The town is surrounded by little hills and bounded by some towns such as Ikare in the North, in the East by Oka, in the South by Etioro and in the West by Supare. The notable hills are Otapete in the south, Okerigbo in the North, Akunmeren in the west and in the East by Oke oko hills (Ologungbede, 2003). Samples were collected from selected areas of the town

Sampling techniques

Water samples were collected in 200 ml sterile bottles and transported to the laboratory in a cool box for analysis.

Enumeration of heterotrophic bacteria and coliforms

The water samples were enumerated for their total microbial and coliforms count using a pour plate technique. In doing this 1 ml of each water samples was serially diluted and 1 ml of the appropriate diluents was inoculated into sterile Petri-dish plates onto which a previously sterile plate count agar and E.M.B cooled down to about 45°C were poured and stirred gently. This was allowed to gel and incubated in an incubator at 37°C for 24 h. The total bacterial and coliforms counts were enumerated from these sources.

Isolation and identification of microorganisms from sample sources

Media generally used for these test organisms were plate count Agar (PCA), Nutrient Agar (NA) and Eosin Methylene Blue (EMB). Peptone water was used for the sugar fermentation test. Each of the isolated test organisms were identified by standard microbiological techniques based on their morphological appearances through Gram stain reactions, cultural characteristics on solid media and sugar fermentation tests (Kotzekidou, 1996).

Coliforms count (most probable number method)

This method was adopted in conformity with standard method recommended (APHA, 1992). The test was carried out in some sequential stages, namely presumptive, confirmed and completed test. It was started by inoculating water samples serially diluted to varying strength into lactose broth medium prepared in test tubes into which inverted durham tubes were placed to determine gas evolution by coliforms organisms due to fermentation processes signifying positive result under this context and read appropriately to determine both positive and negative test. The presence of coliforms was however confirmed by streaking the positive sample source on Eosin Methylene Blue (EMB) agar. Some characteristic appearance of the organisms on this media gives a complete observation of the study.

Laboratory analysis of physico-chemical parameters

The pH and temperature of the water samples were determined using appropriate instruments like the pH meter (Model 600 Fisher Scientific Co., U.S.A) and suitable thermometer while the colour was assessed physically.

RESULT

Various forms of microorganisms encountered from site to site in public water sources in Akungba-Akoko as shown in this study. Mean heterotrophic plate counts (cfu/ml) ranged from 1.0×10^4 in A.A.U.A storage tank to 122×10^4 in Oroke well while the coliform counts (cfu/ml) ranged from 0.01×10^4 in A.A.U.A storage tank to 36×10^4 and 38×10^4 in Oroke well and stream respectively. The boreholes on A.A.U. Akungba-Akoko campus and Ilale Street in Akungba did not contain any coliforms which makes that good source of drinking water compared to areas like the Akwa stream, Ilale well, Okele stream, Akunmi well, and Oroke well, which had high counts (1800).

The physico-chemical properties of the different water sources showed variation in some parameters such as pH which ranged from pH 5.52 and 5.87 in Ilale borehole 2 and Ilale well respectively to pH 7.67 in Igbelu well. The temperature recorded also varies from 23 - 28°C for all the sample sources (Table 2). The colour of the water sources physically assessed also has slight variation in their clarity as shown in Table 2. In Table 3, various isolates encountered in the water sources obtained from Akungba-Akoko were identified by stan-dard microbiological methods thus showing the cultural and morphological characteristics of the respective organisms. The distribution pattern of the organism encountered in water sources was also determined during the study (Table 4).

DISCUSSION

This study shows the microbiological quality of water sources in Akungba-Akoko, Ondo state. The total microbial count range from a low of 1.0×10^4 cfu/ml in A.A.U.A storage tank to 122×10^4 cfu/ml in Oroke well while the coliforms count range from 0.01×10^4 cfu/ml in A.A.U.A storage tank to 36×10^4 cfu/ml and 38×10^4 cfu/ml in Oroke well and stream respectively (Table 1). The most probable number of 0 recorded in some borehole sources like that of A.A.U. Akungba-Akoko campus

Table 1. Microbial population of water in study area.

S/N	Sample sources	Total bacterial counts (cfu/ml x10^4)	Coliforms count (cfu/ml x10^4)	MPN
1	Akwa stream	87	24	1800
2	AAUA borehole	18	3	0
3	Oroke stream	102	38	115
4	Akunmi borehole	9	3	8
5	Ilale well	85	16	1800
6	Ilale borehole	37	1	0
7	Oroke well	122	36	1800
8	Okele stream	98	1.9	1800
9	Akunmi well	75	4	1800
10	Oroke stream 2	5.2	0.035	1225
11	AAUA storage tank	1.0	0.01	100
12	Igbelu's well	4.0	0.045	70
13	Akwa well	3.9	0.015	25
14	Isakare stream	4.2	0.065	15
15	Ilale borehole 2	3.5	0.02	1800

Legend: AAUA - Adekunle Ajasin University, Akungba-Akoko.

Table 2. Some physico-chemical properties of water in study area.

Sample sources	pH	Temp. °C	Colour
Akwa stream	6.14	26	Turbid
AAUA borehole	7.03	28	Clear
Oroke stream	6.10	27	Clear
Akunmi borehole	5.92	28	Clear
Ilale well	5.87	28	Clear
Ilale borehole	5.93	27	Clear
Oroke well	5.97	26	Slightly turbid
Okele stream	6.02	26	Slightly turbid
Akunmi well	5.96	28	Clear
Oroke stream 2	7.65	25	Slightly turbid
AAUA storage tank	6.52	23	Clear
Igbelu's well	7.67	24	Clear
Akwa well	7.15	26	Clear
Isakare stream	6.50	25	Turbid
Ilale borehole 2	5.52	24	Clear

and Ilale street in Akungba make it significantly good source of water compared with areas like Akwa stream, Ilale well, Okele stream, Akunmi well, and Oroke well, having high counts up to 1800 and relative high coliforms count on E.M.B agar to complete the test (Table 1). This is consistence with the study of Chukwura (2001); Obire O. Aguda, M., and R.R. Putheti (2009); and Okafor (1985) which shows that the enumeration of low coliforms count or the absence this group of organism is important to ascertain portability of water sources for human consumption. However areas with wide variation in physico-chemical parameters and microbial load can be observed in the study for proper monitoring.

Various forms of organisms were encountered during the study. This includes *Escherichia coli*, *Klebsiella* spp, *Bacillus* spp, *Bacillus cereus, Proteus* spp, *Streptococcus* spp, *Pseudomonas* spp., *Flavobacterium* spp., *Streptococcus feacalis*, *Pseudomonas aeroginosa*, and *Staphylococcus aureus* as shown in Tables 3 and 4. Under this context it was observed that some indicator and pathogenic group of organisms like Escherichia coli, Streptococcus feacalis and Bacillus cereus constituting 13.34% each of the total number of microorganism isolated were largely encountered in the water sources from this area (Table 4). These however signify some potential threat for infectious disease outbreak because of the nature of organisms involved (Ajayi and Akonai, 2005; Oluyege and Famurewa, 2005).

The studies of Sultana et al. (2009) and R. Putheti et al. (2009) stress the importance of provision of safe water supply and bacteriological examination of water to monitor adequately water sources for the presence of coliforms and feacal coliforms with the aim of getting facilities to provide safe drinking water, as per WHO standards (WHO, 1984) as intensified in this study. Generally the result of this study necessitate the importance of routine monitoring of public water sources in this part of Ondo state, Nigeria, largely populated by members of the University community which is a viable institution in the 'State' to avert outbreak of epidemic diseases especially from microbial sources related to those isolated in water obtained from this area during the study. Similarly, data obtained in this study can be useful epidemiologically for monitoring our environment for

Table 3. Morphological and cultural characteristics of isolates.

Isolates	Cultural characteristics	Gram's stainreaction	Shape	Catalase test	Citrate	Oxidase	Urease	Starch	Glucose	Mannitol	Sucrose	Lactose	Fructose	Identification
WS1	Circular shape, dull, wavy edge, flat elevation, pale white colour	-	Short rods	+	+	-	+	-	AG	AG	AG	AG	-	*E. coli*
WS2	Irregular shape, rough, undulate edge, raised elevation, creamy colony	+	Short rods	+	-	-	-	- AG	AG	AG	-	AG	-	*Bacillus cereus*
WS3	Irregular shape, rough, wavy edge, flat elevation, pale white colour	-	Motile rods	+	+	-	+	-	AG	+	AG	+	-	*Proteus* spp
WS4	Irregular shape, smooth, wavy edge, raised elevation, yellow colony.	-	Rods	-	+	-	+	-	AG	+	-	AG	-	*Klebsiella* spp
WS5	Circular shape, smooth surface, entire edge, flat elevation, white colour	+	Short rods	+	-	-		AG	-	AG	-	AG	-	*Bacillus cereus*
WS6	Irregular shape, smooth, entire edge, flat elevation, light brown colour	-	Motile rods	-	-	+	-	-	AG	-	-	-	-	*Pseudomonas* spp
WS7	Circular shape, smooth, entire edge, flat elevation, diffuse in the middle, opaque colour	-	Rods	+	+	-	+	-	-	AG	-	AG	-	*E. coli*
WS8	Irregular shape, rough surface, undulate edge, raised, elevation, creamy white colour	-	Motile rods	+	+	-	+	-	AG	+	+	+	-	*Proteus spp*
WS9	Circular shape, dull, rhizoid edge, flat elevation, pale white colour	+	Short rods	+	-	-		+	AG	AG	-	AG	-	*Bacillus cereus*
WS10	Irregular shape, shiny surface, wavy edge, flat elevation, light green colour	-	Motile rods	-	-	+		-	AG	AG	AG	-	-	*Pseudomonas* spp
WS11	Circular shape, shiny surface, undulate edge, raised elevation, Golden yellow colour	-	Rods	-	-	-	+	AG	AG	AG	AG	AG	AG	*Flavobacterium* spp.
WS12	Circular shape, smooth surface, entire edge, flat elevation, white colour	+	Cocci in cluster	-	-	-	-	+	AG	AG	AG	AG	AG	*Streptococcus feacalis*
WS13	Irregular shape, dull surface, wavy edge, flat elevation, pale white colour	-	Motile rods	-	-	+	-	-	AG	AG	-	AG	-	*Pseudomonas aeroginosa*

Table 3 contd.

WS14	Circular shape, smooth surface, wavy edge, flat elevation, pale white colour	-	Rods	-	+	-	+	-	AG	AG	-	AG	-	*Klebsiella spp*
WS15	Irregular shape, smooth surface, wavy edge, flat elevation, pale white colour	-	Rods	+	+	-	+	-	AG	AG	-	AG	-	*E. coli.*
WS16	Circular shape, smooth surface, rhizoid edge, raised elevation, yellow colour	-	Rods	-	-	-	+	+	AG	+	+	+	+	*Flavobacterium spp.*
WS17	Irregular shape, dull surface, wavy edge, flat elevation, creamy white colour	+	Cocci in cluster	+	-	-	-	+	AG	AG	+	AG	AG	*Staphylococcus aureus*
WS18	Irregular shape, rough surface, undulate edge, flat elevation, white colour	+	Cocci in chain	-	-	-	-	AG	AG	AG	AG	AG	AG	*Streptococcus feacalis*
WS19	Irregular shape, rough surface, wavy edge, raised elevation, white colour	+	Cocci in chain	-	-	-	-	AG	AG	AG	AG	AG	AG	*Streptococcus feacalis*
WS20	Circular shape, smooth surface, wavy edge, flat elevation, pale white colour	-	Rods	-	-	+	+	-	AG	+	-	AG	-	*Klebsiella spp*
WS21	Irregular shape, rough surface, undulate edge, raised elevation, creamy colour	+	Rods	+	+	-	-	+	AG	AG	AG	AG	+	*Bacillus spp*
WS22	Irregular shape, rough surface, undulate edge, flat elevation, white colour	-	Cocci in chains	-	-	+ -	-	-	AG	AG	AG	-	+	*Streptococcus spp.*
WS23	Circular shape, dull surface, rhizoid edge, flat elevation, pale white colour	-	Motile rods	-	+	-	-	-	AG	AG	-	-	-	*Pseudomonas spp.*
WS24	Irregular shape, dull surface, smooth edge, low convex elevation, creamy colour	-	Motile rods	+	+	-	A G	-	AG	AG	AG	-	-	*Proteus spp.*
WS25	Irregular shape, rough surface, undulate edge, raised elevation, cream colour	-	Short rods	+	+	+	+	-	AG	AG	-	AG	-	*Escherichia. Coli.*
WS26	Circular shape, smooth surface, waxy edge, raised elevation, white colour	-	Rods	-	-	+	+	+	AG	AG	AG	AG	AG	*Flavobacterium spp.*
WS27	Irregular shape, smooth surface, entire edge, flat elevation, white colour	+	Cocci in chain	-	-	+	A G	+	AG	AG	AG	AG	AG	*Streptococcus feacalis*
WS28	Irregular shape, dull surface, entire edge, flat elevation, pale white colour	+	Rods	+	+	-	+	+	AG	-	AG	-	+	*Bacillus cereus*

Table 3. Contd.

WS29	Circular shape, smooth surface, entire edge, raised elevation, creamy colour	-	Rods	-	+	-	-	-	AG	AG	-	AG	+	*Pseudomonas aeroginosa*
WS30	Irregular shape, dull surface, smooth edge, low convex elevation, creamy colour	+	Cocci in cluster	+	-	-	+	+	AG	+	+	-	-	*Staphylococcus aureus*
WS331	Irregular shape, smooth, entire edge, flat elevation, light brown colour	-	Motile rods	-	-	+	-	-	AG	-	-	-	-	*Pseudomonas spp*

Legend: +; Positive test -,; negative test, AG; Acid & gas production

Table 4. Distribution pattern of microbial isolates encountered in water in study area.

S/N	Isolates	Occurrence (Number)	Percentage (%)
1	*Escherichia coli*	4	12.9
2	*Klebsiella spp*	3	9.68
3	*Bacillus spp*	1	3.22
4	*Bacillus cereus*	4	12.90
5	*Proteus spp*	3	9.68
6	*Streptococcus spp.*	1	3.22
7	*Pseudomonas spp.*	4	12.90
8	*Flavobacterium spp.*	3	9.68
9	*Streptococcus feacalis*	4	12.90
10	*Pseudomonas aeroginosa*	2	6.45
11	*Staphylococcus aureus*	2	6.45
Total		31	100

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