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Microbial and physicochemical properties of ground water of Ilaro, South-West, Nigeria

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ABSTRACT

The present study was carried out to determine the microbial quality and physicochemical properties of ground water in Ilaro, a semi-urban settlement. Plate count agar (PCA), MacConkey broth and eosin methylene blue agar (EMB) were used in the microbial analysis. The results showed that the most probable number (MPN) ranges from 0 – 50 per 100 ml while the total viable count (TVC) ranged from 0.07 x 10^2 – 4.12 x 10^2 cfu ml^{-1}. *Bacillus subtilis, Bacillus cereus, Staphylococcus aureus, Streptococcus faecalis, Escherichia coli, Enterobacter aerugenosa* and *Micrococcus luteus* were isolated. The physicochemical properties measured using their respective meters showed that the water was acidic. It was concluded that treatment before consumption is necessary to avoid borne diseases.

Key words: Bacteria, chemical parameters, quality, drinking water,

INTRODUCTION

Water is one of the most important and most precious natural resources. It is essential in the life of all living organisms from the simplest plant and microorganisms to the most complex living system known as human body (Onifade and Ilori, 2008). Moreover, while living things may exist for a considerable time without other essential nutrient, they soon die without water. The protoplasm of most living cells contains about 80% water and any substantial reduction in this percentage is disastrous. All living organisms require a wide variety of inorganic compounds for growth, repair, maintenance and reproduction. Water is one of the most important as well as one of the most abundant of these compounds and vital to organisms (Tortora et al., 2002). Ground water is a complex chemical solution which is in dynamic state, the composition of which to a large extent is attributable to the solution of material in soil and rocks by percolation and partly to chemical reaction between this water and the host medium. Ground water exists within earth's surface and become borehole water when pumped or conveyed to the surface via a network of pumps. It is an important source of drinking water in African towns and cities; the quality of this resource is often being compromised because of urbanization and combined use of aquifers as a repository for human waste (Cronin et al., 2006, 2007; Taylor et al., 2004). The Household, commercial and industrial wastes that end up in dumps, wastes lagoons, or septic systems often pollute ground water. Residential areas with septic systems usually add nitrate nitrogen, bacteria, viruses and synthetic organics used in household (Arnade, 1999; Cronin et al., 2007). The most dangerous form of water pollution occurs when faecal contaminant like *Escherichia coli* enters the water supply. Pathogens such as *Salmonella* spp., *Shigella*, *Vibrio cholerea* and *Escherichia coli* that are shed into water body through faecal contamination perpetuate many diseases. Since ground water moves slowly, many years may pass before a pollutant released on the land surface above the aquifer is detected in water taken from the aquifer some distance away. Soil type, pore size, porosity, season and water table level play important roles in ground water pollution (Arnade, 1999; Cheung and Venkitachalam, 2004). Unfortunately, contamination is often widespread before detected. In evaluation of any ground water resources, the quality and quantity is most importance. In other words, the chemical, physical and biological characteristics of water are of major importance in determining whether or not the water is suitable for domestic, industrial or agricultural use (Okonko et al., 2008; Okonko et al., 2009; Onifade and Ilori, 2008). Recently, there is growing awareness of impact on the environment of effluents and solid wastes of anthropogenic origin (Obahiagbo and Okiemen, 2007).

In many developing countries, availability of potable water has become a critical and urgent problem. 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 disease with a large population. The objective of this study was to assess the microbiological quality and physiochemical properties of ground water in Ilaro.

MATERIALS AND METHODS

The study area

Ilaro is a semi- urban settlement located in western part of Ogun State, South-West Nigeria. It has been the head quarters of Egbado South local government since 1976. The inhabitants are predominantly farmers, traders, staff of the Federal polytechnic and Civil Servants. Ground water samples were collected from different locations in Ilaro, Ogun state, Nigeria. The research was conducted between November 2009 and April 2010, for a period of six months.

Method

Ground water samples were collected from different locations in Ilaro, Ogun State, Nigeria and were analysed within 4 hours of collection. Physicochemical and bacteriological analyses were carried out according to methods of FAO (1997) and Okonko et al. (2008). The pH was measured with a pH meter (potable model 200VWR scientific) and the conductivity was measured with Thermo Orion model 105 after standardizing with KCl and NaCl solution. The pH meter was calibrated with buffers 4 and 9 before use while the chlorines were determined using Morh's method (Greenberg et al., 1992). Geographical positioning satellite (GPS) Extrex legend model was used to determine the position of each ground water. Temperature was measured at the point of collection using a digiton Thermometer (model 275-K) as described by FAO (1997) and Okonko et al. (2009). The media used for the bacteriological analyses were plate count agar (PCA), Mac Conkey broth and eosin methylene blue agar (EMB). The required amounts of the media were weighed and prepared according to the manufacturer's instructions. Plate count agar was used for total viable count (TVC), MacConkey broth for the presumptive test and eosin methylene blue agar was used for confirmed test. Standard of Okonko et al. (2009) was adopted while uninoculated plates and tubes served as controls. The pure isolates obtained were identified using morphological and biochemical tests as described by Holt et al. (1994).

RESULTS AND DISCUSSION

The physicochemical properties of ground water samples collected from Ilaro, South-West Nigeria, are shown in Table 1. The locations where the samples were collected are also shown in Table 1. The pH ranged from 3.41 – 5.38. Lowest pH value was recorded in sample AKU and the highest in sample EXP. The pH values indicate that the water is highly acidic. All the water samples had pH values less than IARC (1980) recommended values for drinking water and lower than the values recorded in previous studies of Ayedun et al. (2009). The reason for it may be due to different sampling period or release of trace element from the rocks into the ground water over a period of time. The temperature values ranged from 29.4–43.9 °C with a mean of 31.6 °C. Water at high temperature contains less dissolved gases (Yusuf, 2007). The temperature of water from subterranean springs is less affected by seasonal variation of temperature (Ipinmoroti, 1993). The alkalinity ranged between 60 mg l^{-1} $CaCO_3$ and 400 mg l^{-1} $CaCO_3$. The lowest alkalinity was recorded in sample FPI and the highest in sample AKU. Alkalinity indicates the level of carbonates, bicarbonate and hydroxyl group in water sample but the hydroxyl group is not common to natural water. The low alkalinity is similar to what was reported by Yusuf (2007). Chlorine of the samples ranged from 1.82 – 125.73 mg l^{-1}. Highest chlorine value was recorded in sample LES and the lowest in samples FPI and SAB. This trend is in variance to what was reported by Fasuwon et al. (2008) but lower than WHO recommended limits. The depth of the wells ranged from 6 – 68 m (Table 1). The electrical conductivity ranged from 40.8 – 400 µS cm^{-1}, which is far below the recommended limit of 1000 µs cm^{-1} by WHO. Conductivity indicates the presence of dissolved solids and contaminations especially electrolytes but does not give information about specific chemical constituents. The redox potential values ranged from 97– 212 mV. The highest and lowest values were recorded in samples TTD and LESS II respectively. The redox potential shows that the ground water samples were not highly oxidized. The total viable count (cfu ml^{-1}) and most probable number (MPN) of coliform 100 ml^{-1} of ground water samples in Ilaro, South-West, Nigeria is shown in Table 2. The microbial load was different from one sample to another, and ranged from 0.07 x 10^2 – 4.12 x 10^2 cfu ml^{-1}. The highest total viable count (TVC) was recorded in sample LES II while sample OTG had the least. Some of the ground water samples fall within standard limit and others exceeded standard limit of 1.0 x10^2 cfu lm^{-1}. The results corroborate well those of Okonko et al. (2008) on different water samples used for domestic purposes in Lagos and Abeokuta. The most probable number of total coliform count ranged from 0-50 coliform 100 ml^{-1} of ground water sample (Table 1). There was no coliform recorded in samples FPI and OTG, the two samples fall within the recommended standard, while other samples exceeded the limit (Okonko et al., 2008, 2009). Sample LES had the highest total coliform count. The presence of coliform in samples AKU (Akiniku), IGE (Igbo–ewe), LES (Leslie), LES II (Leslie II), ORA (Orita), SAB (Sabo), EXP (Express) and TTD (Tetede-Okeola) indicaltes faecal contamination of ground water, as a result of proximity of the wells and boreholes to septic tanks, soak away and refuse dumping sites (Table not shown). Arnade (1999) reported that there were significant correlations between increasing faecal coliform, nitrate and phosphate concentration and decreasing distance between wells and septic tanks. Soil porosity of the area might also play important roles in the percolation of the contaminated water from the soak away and septic tanks to the wells and bore holes.

Table 1: Physicochemical parameters of ground water samples.

Sample Code	pH	Alkalinity (mg/L $CaCO_3$)	Tempt. (^oC)	Cl^-(mg/l)	EC (µS/cm)	Depth (m)	*RP (mv)*	GPS	Location
AKU	3.94	400	*32.2*	63.77	400	11	*182*	N06 5311.0 E003 0130.1	Akiniku
IGE	4.89	180	30.7	12.75	100	13	127	N06 5332.3 E003 0112.5	Igbo –ewe
OTG	4.53	160	31.7	52.84	100	15	146	N06 5335.6 E003 0058.6	Otegbeye
LES	4.05	140	32.4	125.73	200	9	174	N06 5312.8 E003 0045.5	Leslie
LES II	3.41	100	31.9	45.55	400	10	212	N06 5301.5 E003 0037.1	Leslie 2
ORA	4.00	220	29.4	12.75	200	17	178	N06 5302.1 E002 5955.1	Orita 1
SAB	4.59	100	*30.4*	*1.82*	200	6	141	N06 5219.4 E003 0033.1	Sabo
FPI	5.23	60	31.2	1.82	40.8	68	120	N06 5314.3 E002 2527.4	Fed. Poly.
EXP	5.38	380	31.1	14.58	342	16	107	N06 5333.6 E002 5951.6	Express
TTD	5.37	180	34.9	56.49	41.9	6	97	N06 5410.5 E003 0028.8	Tetede Okeola
WH	6.5-8.5	200	__	__	1000	__	__	__	__

EC: Electrical conductivity RP: Redox Potential GPS: Geographical Positioning Satellite

Table 2: Total viable count and most probable number (MPN) of coliform per 100 ml of water sample.

Sample code	Total viable count	MPN per 100 ml
AKU	$0.30x10^2$	10
IGE	$1.20 x10^2$	2
OTG	$0.07 x10^2$	0
LES	$3.70 x10^2$	50
LES II	$4.12 x10^2$	40
ORA	$2.10 x10^2$	17

SAB	0.11×10^2	4
FPI	0.12×10^2	0
EXP	0.63×10^2	14
TTD	3.21×10^2	35
Standard limit	1.00×10^2	NIL

Table 3: Distribution of bacterial isolates from different ground water samples.

Sample code	***Bacillus cereus***	***Bacillus subtilis***	***Enterobacter aerogenes***	***Escherichia coli***	***Micrococcus luteus***	***Staphylococcus aureus***	***Streptococcus faecalis***
AKU	+	–	–	–	–	–	–
IGE	–	+	+	–	–	–	+
OTG	–	+	–	–	+	–	–
LES	+	+	–	+	–	+	–
LES II	+	+	–	+	+	–	–
ORA	–	–	+	–	–	+	–
SAB	–	–	+	–	–	+	–
FPI	–	+	–	–	–	–	–
EXP	+	–	–	–	–	+	–
TTD	+	+	–	+	–	–	–

+: Present - : Absent

Seasons may play vital roles in the level of contamination of ground water. Arnade (1999) found that inability of septic tank leachate to percolate through the soil during the wet season resulted in ground water contamination thus posing a health risk to those who drink from local well.

The presence of coliforms in most of the ground water samples in this study makes them unfit and unsafe for human consumption (Edema et al., 2001, Okonko et al., 2008, Onifade and Ilori, 2008 and Okonko et al., 2009).

The distribution of bacterial isolates from the different ground water samples is shown in Table 3. *Bacillus cereus*, *Bacillus subtilis, Enterobacter aerogenes*, *Escherichia coli*, *Micrococcus luteus*, *Staphylococcus aureus* and *Streptococcus faecalis* were the organisms isolated. *Bacillus* sp. was present in all the water samples except samples ORA and SAB. *Enterobacter aerogenes* was present in samples ORA, SAB and IGE. *Escherichia coli* was isolated from samples LES II, LES and TTD. *Micrococcus lutues* was found in samples OTG and LES II. *Streptococcus faecalis* was recorded only in sample IGE while *Staphylococcus aureus* was isolated from samples LES, ORA, SAM and EXP The isolation of these bacteria was in agreement with similar works carried out by other researchers (Chao et al., 2004; Okonko et al., 2008; Onifade and Ilori, 2008; Okonko et al., 2009). Isolation of *Streptococcus faecalis, Enterobacter aerogenes* and *Escherichia coli* indicates faecal contamination either of human or animal origin, as *Escherichia coli* is used as an indicator of water borne pathogens (Chao et al., 2004; Onifade and Ilori, 2008). The presence of indicator organisms is an indication that there is high probability of having pathogenic enteric organisms in the water. This might be the source of water borne diseases such as cholera, recently reported in some developing countries. Faecal coliforms, nitrates, and phosphates present in septic effluent are responsible for such diseases as shigellosis, typhoid fever, gastroenteritis, blue baby syndrome (NRC, 1998)

Conclusion

Bacteriological analyses of the ground water showed that, the total viable count of most of the water samples was too high and the presence of coliform, which make the water unsafe for human consumption. Likewise the physicochemical parameters showed that ground water from the studied areas are acidic and require pretreatment before consumption.

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