International Journal of Science, Engineering & Environmental Technology (IJOSEET), 5(4): 34-41, 2020
ISSN 0794-9650

www.repcomseet.com

Bacteriological and Physico-Chemical Analysis of Underground Water In Ede And Its Environs

Bolaji, A.S., Attah O.T., Asimi Tajudeen, Akanfe, F.A

Science Laboratory Technology Department, Federal Polytecnnic, Ede, Osun State.

Abstract - Bacteriological and physicochemical analyses of underground water in Ede and it's environs were carried out to ascertain it's potability and further applicabilit. This was with a view of determining the bacterial contamination and effect of some of the chemicals identified from the bodiesof underground water in this community. The water samples were collected from Ede North, South and Egbedore local government areas in Ede, Osun State, Nigeria. The bacterial species isolated from the water samples were identified using the basic bacteriological procedure, while the physicochemical analyses were determined using the AOAC method. The physico-chemical parameters complied with the acceptable standard with few exceptions. None of the samples complied with the bacteriological standards as Total coliform count exceeded 1525 MPN/ml. Several bacterial species were isolated which included, Enterobacter, Klebsiella, Corynebacterium and Enterococcus. This study revealed the presence of these organisms as potential pathogens that could affect drinking water quality significantly, thus resulting in a great health challenge.

Keywords: underground water, bacterial species, chemicals, analysis

1.0 Introduction

Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers. This groundwateris valuable as a source of drinking water for most communities in the world, especially small ones. Groundwater is beneath the water table and it provides about 0.6 percent of the world's total water and 20 percent of the available fresh water resources (Dan *et al*., 2003). The temperature of groundwater is quite steady because the specific heat capacity of water is high and also because the soil, rock and upper layer of water protect groundwater from heat changing with the climate (Moyo, 2013). The mineral content in the groundwater is usually constant, and could be higher than in the surface water from the same area (Bello *et al*., 2013).

Generally, groundwater quality varies from place to place, sometimes depending on seasonal changes (Seth *et a*l., 2014; Thiyya*et al*., 2014) , the types of soils, rocks and surfaces through which it moves. Naturally occurring contaminants are present in the rocks and sediments. As groundwater flows through the sediments, metals such as iron and manganese are dissolved and may later be found in high concentrations in the water (Moyo, 2013). In addition, human activities can alter the natural composition of groundwater through the disposal or dissemination of chemicals and microbial matter on the land surface and into soils, or through injection of wastes directly into groundwater. Industrial discharges, urban activities, agriculture, and disposal of waste can also affect groundwater quality (Govindarajan and Senthilnathan, 2014). Pesticides and fertilizers applied to lawns and crops can accumulate and migrate to the water tables thus affecting both the physical, chemical and microbial quality of water. Microbial contamination of underground water may affect drinking water quality significantly and this could contribute a major health challenge. It is on this note that bacterial contamination as well as some physicochemical parameters of underground water in Ede community is evaluated to assess its quality.

2.0 Materials And Methods

2.1 Sample Collection

Underground water samples were collected from Egbedore local government areas in Ede, Osun State, Nigeria. Samples were taken from five different locations in each local government area in sterile bottles that were appropriately labeled and transported to the laboratory in ice pack.

2.2. Physico-Chemical Analysis

The physico-chemical tests carried out on the samples included appearance, colour, pH, temperature, dissolved oxygen, total alkalinity, total hardness, calcium hardness, calcium ions, magnesium ions, chloride ions, iron and silica content usingAssociation of Official Analytical Chemistry method (AOAC,2005).

2.3 Bacteriological Analysis

Bacteriological characteristics of the isolates recovered from the samples were determined using the methods described by Bezuidenhout*et al*., (2002). The Most Probable Number-multiple tube technique was used in enumerating the number of coliforms in the samples. Nutrient agar (NA) was used to determine the total heterotrophic count while other conventional media such as Mannitol Salt Agar (MSA) and Eosin Methylene Blue (EMB) agar were also used for identification. All plates were incubated at 37^0C for 24-48 h. Presumptive colonies were confirmed by Gram staining and biochemical characterization of the isolates was carried out for further identification (Cowan and Steel, 1985; Osuinde and Eneuzie, 1999).

3.0 Results and Discussion

3.1 Results

Tables 1, 2 and 3 revealed the physicochemical analysis of water samples from different locations. The parameters analyzed included Appearance, Colour, pH, Temperature, Dissolved oxygen, Total alkalinity, Total hardness, Calcium hardness, Calcium ions, Magnesium hardness, Magnesium ions, Chloride ions, Iron, Silica, Nitrate ions, Nitrite nitrogen, Total solids, Total filterable solid, Total non-filterable, Chlorine demand (BOD), Flocculation (ppm), Carbonate ion and Bicarbonate ion. Table 4 compared the physicochemical parameters of the water samples from different locations.

All water samples from Ede South (ES) and Egbedore (EG) Local Government Areas (LGAs) appeared clear with three out of the five water samples from Ede North (EN). Samples from EN and EG have the highest colour of 20HU exceeding the acceptable values of WHO and EPA while ES had 15HU. The pH of the water samples ranged from 6.6 to 6.96which were still within the acceptable standard. The temperature values ranged from 26.52 – 26.76^0C, Dissolved oxygen was between 3.46 – 4.24 mg/l, Total alkalinity 47.2 – 80 mg/l, Total hardness ranged from 118.4 -157.6 mg/l while Calcium hardness was between 80 – 105.2 mg/l. Samples from EN had highest values for Calcium ions, Chloride ions, Silica, Nitrate ions, Nitrite nitrogen and Carbonate ions while samples from ES had the least values with the exception in Carbonate ion where the least was from EG. Samples from EG had the highest values for Iron, Total solids, Total filterable solid, Total non-filterable, Chlorine demand and Bicarbonate ions with least values in samples from EN with exceptions in Total filterable solids, Chlorine demand and Bicarbonate ions where the least values were from samples from ES. Samples from ES had highest values in Magnesium hardness and Magnesium ions with the least values in samples from EG.

The bacteriological analysis of the water samples is as revealed in Table 5. The total heterotrophic count ranged from $5.67x10^5$to $6.47x10^5$with samples from EG having the highest count. The most probable number (MPN) for presumptive total coliform count of the water samples ranged from 1525 to 1,800 MPN per 100ml with samples from EN having the lowest total coliform count of 1,525 MPN per 100ml.

The bacteria isolated from all the water samples included*Enterobacter cloacae, Klebsiella pneumoniae, Aeromonasveronii, Bacillus polymyxa, Rhodococcuserythropolis, Micrococcus varians, Streptococcus spp, Morganellamorganii, Staphylococcus aureus, Neisserialactamica, Enterococcus mundii, Mycobacterium spp* and species of Lactobacillus and Corynebacterium (Table 6).

Table 1: Physicochemical Analysis of Water Samples from Ede South LGA

Parameters	ES1	ES2	ES3	ES4	ES5	WHO standard	EPA standard
Appearance	Clear	Clear	Clear	Clear	Clear	-	-
Colour (H.U)	15	15	15	15	15	6	15
pH at laboratory	7.6	7.2	6.8	6.4	6.8	6.5	6.5-8.5
Temp.(^{0}C) at laboratory	26.8	26.5	26.9	26.8	26.4	-	-
Dissolved oxygen (mg/L)	5.02	4.08	3.42	4.10	4.60	-	-
Total alkalinity (mg/L)	108.00	56.00	48.00	56.00	80.00	-	-
Total Hardness (mg/L)	134.00	192.00	66.00	142.00	160.00	500	500
Calcium Hardness (mg/L)	114.00	94.00	50.00	56.00	86.00	75	65
Calcium ions (mg/L)	45.60	37.6	20.00	22.4	34.4	-	-
Magnesium Hardness (mg/L)	20.00	98.00	16.00	86.00	74.00	50	50
Magnesium ions (mg/L)	5.00	24.50	4.00	21.50	18.00	-	-
Chloride ions (mg/L)	9.50	64.50	13.00	32.00	57.00	200	250
Iron (mg/L)	0.060	0.080	0.160	0.072	0.044	0.3	0.3
Silica (mg/L)	1.800	0.065	1.080	2.250	1.700	-	-
Nitrate ions (NO^-_3)	0.830	1.000	0.050	0.035	0.066	-	-
Nitrite nitrogen (NO^-_2) (mg/L)	0.028	0.227	0.024	0.008	0.032	-	-
Total solids	56.00	136.00	80.00	162.00	60.00	500	500
Total Filterable Solid	50.00	102.00	24.00	150.00	16.00	NS	NS
Total non Filterable	6.00	34.00	56.00	12.00	44.00	500	500
Chlorine demand BOD	0.22	0.80	0.32	0.40	0.60	5	-
Flocculation (PPM)	15.00	15.00	15.00	15.00	15.00	-	-
Carbonate CO_2^-	108.00	56.00	48.00	56.00	80.00	-	-
Bicarbonate,HCO_3^- (mg/L)	122.00	36.00	85.40	61.00	24.40	-	-

ES= Ede South; NS= No Standard

Table 2: Physicochemical Analysis of Water Samples from Ede North LGA

S/N	Locations							
	Parameters	EN1	EN2	EN3	EN4	EN5	WHO Standard	EPA Standard
1	Appearance	Not clear	Clear	Clear	Not clear	Clear	-	-
2	Colour (H.U)	25.00	15.00	20.00	25.00	15.00	6	15
3	pH at laboratory	7.4	6.8	6.6	6.9	7.0	6.5	6.5-8.5
4	Temp.(^{0}C) at laboratory	26.4	26.8	26.2	26.4	26.8	-	-
5	Dissolved oxygen (mg/L)	3.60	4.02	1.84	3.82	4.00	-	-
6	Total alkalinity (mg/L)	48.00	48.00	76.00	102.00	126.00	-	-
7	Total Hardness (mg/L)	130.00	134.00	156.00	176.00	192.00	500	500
8	Calcium Hardness(mg/L)	78.00	86.00	106.00	114.00	142.00	75	65
9	Calcium ions (mg/L)	31.20	34.40	42.40	45.6	56.8	-	-
10	Magnesium Hardness (mg/L)	52.00	48.00	50.00	64.00	50.00	50	50
11	Magnesium ions (mg/L)	13.00	12.00	12.50	16.00	12.50	-	-
12	Chloride ions (mg/L)	57.5	54.50	61.50	77.50	87.00	200	250
13	Iron (mg/L)	0.100	0.088	0.040	0.080	0.088	0.3	0.3
14	Silica (mg/L)	2.160	2.700	0.700	3.600	1.800	-	-
15	Nitrate ions (NO^-_3)	0.040	2.900	0.050	0.066	1.500	-	-
16	Nitrite nitrogen (NO^-_2) (mg/L)	0.009	0.903	0.030	0.032	0.337	-	-
17	Total solids	108.00	86.00	96.00	40.00	150.00	500	500
18	Total Filterable Solid	78.00	58.00	68.00	36.00	104.00	NS	NS
19	Total Non-Filterable	30.00	28.00	28.00	4.00	48.00	500	500
20	Chlorine demand BOD	0.20	0.30	0.80	1.20	0.2	5	-
21	Flocculation (PPM)	25.00	15.00	20.00	25.00	15.00	-	-
22	Carbonate CO_2^-	48.00	48.00	76.00	102.00	126.00	-	-
23	Bicarbonate,HCO_3^- (mg/L)	73.20	48.00	36.60	61.00	192.00	-	-

EN= Ede North; NS=No Standard

Table 3: Physicochemical Analysis of Water Samples from Egbedore LGA

S/N	Locations							
	Parameters	EG1	EG2	EG3	EG4	EG5	WHO Standard	EPA Standard
1	Appearance	Clear	Clear	Clear	Clear	Clear	-	-
2	Colour (H.U)	20.00	20.00	25.00	20.00	15.00	6	15
3	pH at laboratory	6.4	6.8	7.2	6.2	6.4	6.5	6.5-8.5
4	Temp.(^{0}C) at laboratory	26.80	26.80	26.4	27.10	26.70	-	-
5	Dissolved oxygen (mg/L)	4.50	3.80	4.60	2.90	3.20	-	-
6	Total alkalinity (mg/L)	54.00	58.00	34.00	30.00	60.00	-	-
7	Total Hardness (mg/L)	98.00	134.00	100.00	90.00	170.00	500	500
8	Calcium Hardness(mg/L)	64.00	82.00	90.00	52.00	116.00	75	65

9	Calcium ions (mg/L)	25.60	32.80	36.00	20.80	46.40	-	-
10	Magnesium Hardness (mg/L)	34.00	52.00	10.00	48.00	54.00	50	50
11	Magnesium ions (mg/L)	8.50	13.00	2.5	12.00	13.50	-	-
12	Chloride ions (mg/L)	38.00	58.00	36.00	29.00	80.00	200	250
13	Iron (mg/L)	0.07	0.120	0.800	0.048	0.160	0.3	0.3
14	Silica (mg/L)	1.800	3.600	1.260	0.900	0.834	-	-
15	Nitrate ions (NO^{-}_{3})	0.045	1.000	1.500	0.035	0.067	-	-
16	Nitrite nitrogen (NO^{-}_{2}) (mg/L)	0.010	0.226	0.337	0.008	0.038	-	-
17	Total solids	230.00	182.00	206.00	114.00	166.00	500	500
18	Total Filterable Solid	210.00	142.00	176.00	84.00	126.00	NS	NS
19	Total Non-Filterable	20.00	40.00	30.00	30.00	40.00	500	500
20	Chlorine demand BOD	0.80	1.20	0.60	0.40	1.50	5	-
21	Flocculation (PPM)	20.00	20.00	25.00	20.00	15.00	-	-
22	Carbonate CO_2^{-}	54.00	58.00	34.00	30.00	60.00	-	-
23	Bicarbonate,HCO_3^{-} (mg/L)	183.00	122.00	36.60	107.5	73.4	-	-

EG= Egbedore; NS=No Standard

Table 4: Physicochemical Analysis of Water Samples from Different sources compared

S/N	Parameters	ES	EN	EG	WHO Standard	EPA Standard
1	Appearance	All Clear	Clear	All Clear	-	-
2	Colour (H.U)	15.00	20.00	20.00	6	15
3	pH at laboratory	6.96	6.94	6.6	6.5	6.5-8.5
4	Temp.(^{0}C) at laboratory	26.68	26.52	26.76	-	-
5	Dissolved oxygen (mg/L)	4.24	3.46	3.80	-	-
6	Total alkalinity (mg/L)	69.60	80.00	47.20	-	-
7	Total Hardness (mg/L)	138.8	157.6	118.4	500	500
8	Calcium Hardness(mg/L)	80.0	105.2	80.8	75	65
9	Calcium ions (mg/L)	32.00	42.08	32.32	-	-
10	Magnesium Hardness (mg/L)	58.8	52.80	39.6	50	50
11	Magnesium ions (mg/L)	14.6	13.20	9.9	-	-
12	Chloride ions (mg/L)	35.20	67.60	48.20	200	250
13	Iron (mg/L)	0.083	0.079	0.239	0.3	0.3
14	Silica (mg/L)	1.379	2.192	1.679	-	-
15	Nitrate ions (NO^{-}_{3})	0.396	0.911	0.529	-	-
16	Nitrite nitrogen (NO^{-}_{2}) (mg/L)	0.064	0.262	0.124	-	-
17	Total solids	98.8	96	179.6	500	500
18	Total Filterable Solid	68.4	68.8	147.6	NS	NS
19	Total Non-Filterable	30.4	27.6	32.0	500	500

20	Chlorine demand BOD	0.47	0.54	0.90	5	-
21	Flocculation (PPM)	15.00	20.00	20.00	-	-
22	Carbonate CO_2^-	69.6	80.0	47.2	-	-
23	Bicarbonate,HCO_3^- (mg/L)	65.76	82.16	104.5	-	-

Table 5: Bacteriological Analysis of Water

Sample Code	Total Heterotrophic Count	Total Coliform Count
ES	$5.67x10^5$	1800
EN	$6.26x10^5$	1525
EG	$6.47x10^5$	1800
WHO Standard	$1.0x10^2$	Zero per 100ml
EPA Standard	$1.0x10^2$	Zero

Table 6: Cultural and Biochemical Characterization of the Bacteria Isolates

Isolate code	Cell shape	Gram reaction	catalase	Urease	SIM	Citrate	MR	Vogues proskaeur	Glucose	Mannitol	sorbitol	lactose	Possible organism
EDA2	Rod	-	+	-	- - +	+	-	+	AG	AG	AG	AG	*Enterobacter cloacae*
EDB2	Rod	-	+	-	- - -	-	-	+	AG	AG	AG	AG	*Klebsiella pneumoniae*
EDD2	Rod	-	+	-	- - +	+	-	+	AG	AG	A	A	*Aeromonas veronii*
EDE2	Rod	+	+	-	- - +	-	-	+	AG	AG	A	AG	*Corynebacteriumavidum*
EDF2	Rod	+	+	-	- - -	+	-	+	AG	AG	AG	AG	*Bacillus polymyxa*
EDG2	Rod	+	+	-	- - -	+	-	+	AG	AG	AG	AG	*Rhodococcuserythropolis*
EDI2	Rod	+	+	-	- - +	-	-	+	AG	AG	AG	NC	*Micrococcus varians*
EDJ2	Rod	+	-	-	- + +	+	-	+	AG	AG	AG	A	*Streptococcus mitis*
EDK2	Rod	-	-	-	- + +	+	-	+	A	AG	AG	A	*Morganellam organii*
EDL2	Cocci	+	+	-	- + +	+	-	+	A	A	AG	AG	*Staphyloccus aureus*
EDM2	Cocci	-	+	-	- + +	+	-	+	AG	AG	A	AG	*Neisseria lactamica*
EDN2	Rod	+	-	-	+ + +	+	-	+	AG	AG	NC	AG	*Lactabacillus buchneri*
EDO2	Cocci	+	-	-	- + +	+	-	+	AG	AG	AG	AG	*Enterococcus mundtii*

EDP 2	Rod	+	+	-	- - +	+	-	+	AG	NC	NC	NC	*Corynebacter iumrenale*
EDQ 2	Rod	+	+	-	- - +	+	-	+	AG	AG	AG	AG	*Corynebacter iumsp*
EDR 2	Rod	+	-	-	- + +	+	-	+	A	NC	NC	AG	*Lactobacillus leichmanii*
EDS 2	Cocci	+	-	-	- + -	+	-	+	A	A	A	AG	*Mycobacteriu mmegmatis*
EDT 2	Rod	-	+	-	- + -	+	-	+	AG	AG	AG	AG	*Providencials tuartii*

KEY:

A Acid produced
G Gas produced
AG Acid and gas produced
NC No change
+ Growth
- No growth

3.2. Discussion

The study determined the bacteriological and physico chemical analysis of underground water in Ede and its environs with the view of assessing the quality. The study was aimed at determining the total heterotrophic counts, total coliform countsand number of bacterial species that contaminated the body of water which may affect drinking water quality significantly and could contributemajor health challenges.

The total heterotrophic counts for all the water samples were generally high exceeding the acceptable standard of $1.0x10^2$cfu/ml for heterotrophic count for drinking water (EPA, 2002). This could be as a result of high organic and dissolved salts in the water samples. Water samples from EG had higher bacterial count while the samples from ES had the least count.Groundwater has been found to be contaminated by the fecal material of humans and other animals.This is a cause for concern because fecal material may contain pathogenic (disease-causing) microbes that can infect the intestinal tract of humans (Paul *et al*., 2009).Most of the bacterial types found in soils and surface waters have also been found in groundwater environment. Some of the physico-chemical parameters analyzed in this study were not in line with the acceptable standard of the World Health Organization (WHO) and the Environmental Protection Agency (EPA). Many groundwater quality parameters, such as pH, oxidation/reduction (redox) status, dissolved oxygen, or the presence of specific mineral constituents, may be influenced by microbial activity in the aquifer (Seth *et al*., 2014). The temperature of water samples from the three sources was quite stable which was in line with another study conducted by Bello *et al*., 2013. This could be as a result of high specific heat capacity of water and also because the soil, rock and up layer water protect groundwater from heat changing with the climate.

Furthermore, the total coliform count for all samples exceeded the EPA Maximum Contamination Level (MCL) for coliform bacteria in drinking water of zero total coliform per 100ml of water (EPA, 2003). The increase in the coliform count may be as a result of fecal contamination of the water source (Bello *et al*., 2013; Moyo, 2013). The bacterial isolates recovered from these water samples were both Gram positive and Gram negative. The Gram positive bacteria included *Staphylococcus aureus,Streptococcus mitis, Corynebacterium species and Micrococcus varians*while Gram negative bacteria included *Klebsiella pneumoniae,Enterobactercloacea and Neisseria lactamica*. This corroborated the findings of Frank, 2000.

4.0 Conclusion and Recommendation

4.1 Conclusion

In conclusion, it is very obvious that most of the activities of bacteria in ground water occurred as a result of human activities which can alter the natural composition of underground water as well as dissemination of chemicals into the water bodies. All these must be avoided to guard against infections and diseases that could result from the consumption of contaminated water.

4.2 Recommendation

Therefore, it is suggested that underground water in this environment should be well cited, following the specifications for constructing a standard well (underground water) to avoid bacterial contamination.

REFERENCES

AOAC (2005).Association of Official Analytical Chemists,Washington DC.*Official Methods of Analysis,* 18th edition.

Bello O.O., Osho A., Bankole S.A., Bello T.K (2013). Bacteriological and physicochemical analyses of borehole and well water sources in Ijebu-Ode, Southwestern Nigeria.*Int. J. Pharm. Biol. Sci.*8:18–25.

Bezuidenhout, C.C., Mthembu, N., Puckree, T., and Lin, J. (2002).Microbiological evaluation of the Mhlathuze River, Kwazulu-Natal (RSA). *Water SA* 28: 281-286.

Cowan, S.T and Steel, K.J (1985). Manual for the identification of medical Bacteria (4th edition) Cambridge University Press, London. 217p.

Dan L. Danielopol., Christian Griebler., Amara Gunatilaka and Jos Notenboom (2003). Present state and future prospects for groundwater ecosystems. *Environmental Conservation*.30:104-130.

EPA, (2002).Environment Protection Agency, Safe Drinking Water Act Amendment http:// www.epa. Gov/safe water /mcl. Html

EPA, (2003). Environmental Safe Drinking Water Act. EPA 816 – F – 03 –016.

Frank Chapelle (2000). Ground-water microbiology and geochemistry.Wiley; 2ndeditions.

Govindarajan, M and Senthilnathan, T. (2014). Groundwater quality and its health impact analysis in an industrial area. *Int. J. Curr. Microbiol.* 3:1028–1034.

Moyo N.A.G. (2013). An analysis of the chemical and microbiological quality of ground water from boreholes and shallow wells in Zimbabwe. *Phys. Chem. Earth*. 66:27–32.

Osuinde.M.I. and Eneuzie, N.R. (1999).Bacteriological analysis of ground water. *Nigeria Journal of Microbiology* vol. 13:47-54.

Paul W. J. J. van der Wielen., Stefan Voost, and Dick van der Kooij (2009).Ammonia-Oxidizing Bacteria and Archaea in Groundwater Treatment and Drinking Water Distribution Systems.*Applied and Environmental Microbiology*. 75:4687–4695.

Seth O.N., Tagbor T.A and Bernard O. (2014). Assessment of chemical quality of groundwater over some rock types in Ashanti region, Ghana. *Am. J. Sci. Ind. Res.*5:1–6.

Thivya C., Chidambaram S., Thilagavathi R., Nepolian M andAdithya V.S. (2014). Evaluation of drinking water quality index (DWQI) and its seasonal variations in hard rock aquifers of Madurai District, Tamilnadu. *Int. J. Adv. Geosci*. 2:48–52.