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Physicochemical and Microbiological Assessment of Groundwater from Ijan-Ekiti South Western Nigeria

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Abstract: Physicochemical and microbiological analyses of water samples from nine randomly selected hand dug wells and River Eku were carried out using standard analytical procedure and the result were compared with WHO standards. The physicochemical parameters of the water samples analysed were within the WHO standard for drinking water expect for pH value (9.20) obtained for River Eku which does not conform with WHO standard. Calcium has the highest value (3-35-26.23 mg/100 mL) for the major element while Iron value (0.34-4.18 mg/100 mL) was highest for the minor element. However, the water is unsafe on the account of poor microbiological quality of the water samples (Average total bacteria and total coliform counts were 54.4±20.9 per 100 mL of the original water sample and 34.5±14.00 per 100 mL of original water samples, respectively) in the area which exceeded WHO standard. It is recommended that the well water be treated to minimize acute problem of water related diseases which are endemic to man.

Key words: Microbiological, physicochemical, groundwater, assessment, River Eku

INTRODUCTION

Water is essential to maintain and sustain human life, animal and plant (Patil and Patil, 2010). The availability of good quality water is an indespensable feature for preventing disease and improving quality of life (Oluduro and Aderiye, 2007). Safe drinking water is a human birthright as much a birthright as clean air however, much of the world's population does not have access to safe drinking water. Of the 6 billion people on earth, >1 billion lack access to safe drinking water (Amoo and Akinbode, 2007). Groundwater constitutes an important source of water supply for domestic and agriculture purposes in Nigeria.

Groundwater is believed to be comparatively much cleaner and free from pollution than surface water. Water pollution is a state of deviation from pure condition whereby its normal function and properties are affected. However, prolong discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to be polluted thereby creating health problems. These problems are much more acute in areas which are densely populated, thickly industrialized and have shallow ground water tables. Rapid urbanization among other factors has further degenerated groundwater quality due to exploitation of natural resources and improper waste disposal practices. Hence, there is always a need for concern over the protection and management of groundwater quality (Patil *et al*., 2001). Groundwater is naturally replenished by surface water from precipitation, streams and rivers when this recharge reaches the water table. Rain water dissolves soluble salts from vegetations, topsoil, river bed, lake bed into water bodies hence, most ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} and NH_4^{+}) in rain water are also found in surface and groundwater (Imoisi *et al*., 2012).

Faecal pollution of drinking water carried water borne diseases which caused a lot of health problems. At present, the menance of water borne dieseases and epdemics still loom large at the horizon of developing countries (Adefemi *et al*., 2007). Water borne diseases are among the most recent proven to be the biggest threat world wide, these contribute 70-80% of health problems in developing countries. These diseases continue to be major source of human mortality and morbidity (Jayana *et al*., 2009).

Groundwater especially well water constitute a major source of water to majority of Nigerians, adequate attention should be given to this important source of drinking water. While drinking water standards are in force for public water systems, private water supplies (well water) are not subject to these standards. Considering the health problems of groundwater contamination, the present study was carried out to assess the quality of ground water from hand-dug wells and stream from selected areas in Ijan Ekiti, Nigeria. In this town, majority of the people rely on water from hand-dug wells and stream for their domestic purposes due to non-availability of pipe borne water.

MATERIALS AND METHODS

The study area: The study area as shown in Fig. 1 is Ijan-Ekiti which is a medium size community in Gbonyin Local Government Area (LGA) of Ekiti-State in Nigeria.

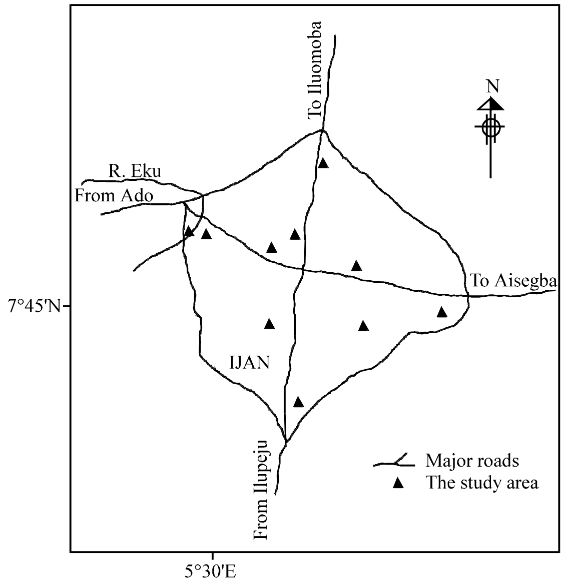

Fig. 1: Ijan-Ekiti in a proportional drawing showing the sample locations (Gbonyln local government secretariat, Ode-Ekiti/Department of Geography and Planning Science, Cortographic Unit, Ekiti State University, Ado-Ekiti)

Geographyically the town is located on longitude 5°30'E and latitude 7°45'N, it shares a boundary with Iluomoba in the North, Igbemo in the South, Ado in the West and Aisegba in the East. The people of the community are majorly farmers, River Eku is a stream that follows through the farmland in the community.

Sample collection: Ten representative water samples (nine from hand dug well, A1-A9 and one from stream, A10) were taken randomly from different locations in Ijan-Ekiti, South-Western Nigeria. The wells were selected from major quarters within the town while the stream Eku is located in the farm settlement. All samples were collected the same day, kept in 2 L acid leached polythene bottles and few drops of HNO_3 were added immediately to prevent loss of metals, bacterial and fungi growth. Analysis was performed within 24 h of collection.

Physicochemical analysis: pH values were determined using pH meter and temperature values were recorded from a mercury-glass thermometer graduated in units of °C. The Electrical Conductivity (EC) was determined using conductimeter while the Totals Dissolve Solid (TDS) in the water samples detected from the Hach TDS meter, all these parameters were determined on the spot. The Total Hardness (THD), Magnesium Hardness (MHD), Calcium Hardness (CHD), free CO_2, acidity, chloride, alkalinity and Total Solid (TS) were obtained by using titrimetric analysis (AOAC, 2005).

Determination of metals: About 5 cm^3 of concentrated hydrochloric acid was added to 250 cm^3 of each water samples and evaporated to 25 cm^3. The concentrate was transferred to 50 mL flask and diluted to mark with deionized water. Metals in the water samples were determined using atomic absorption spectroscopy (Buck Model 200A). Results obtained were averages of replicate determination.

Microbiological analysis: Pour Plate Method was used for the enumeration of total bacterial count and Most Probable Number (MPN) techniques (APHA, 1998) as modified by Olutiola *et al.* (1991) was used for estimation of coliforms in water sample.

Statistical analysis: All data obtained were subjected to statistical analysis, the mean, Standard Deviation (SD) and Coefficient of Variation (CV) were calculated (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The result of physicochemical analysis of water sample from selected hand-dug wells and the stream are shown in Table 1. From the results of the water samples (A1-A10) temperature values ranged between 24.30-27.20 with an average of 26.89, the pH ranged between 6.70 -9.20 with an average of 7.38. The results obtained for temperature and pH are similar to those obtained by Adefemi *et al.* (2007) in water samples from dams in Ekiti; Asaolu *et al.* (1997) in water samples from coastal water of Ondo State; Ipinmoroti and Oshodi (1993) in hand-dug wells in Akure, Ondo State. Adeyeye and Abulude (2004) also have similar results when assessing some surface and ground water resources in Ile-Ife, Nigeria but lower than those reported by Amoo and Akinbode (2007) in well water from Minna and its environ, Niger State, Nigeria.

The temperature and pH values of the stream (A10) was higher than those obtained from the wells as well as the limit prescribed by WHO, this could be due to the increase in rate of chemical reaction and the nature of biological activities since, this govern the assimilative capacity of aquatic system (EPA, 1976). All other well has pH values that fell within the World Health Organization's limit.

The mean values for EC, chloride and acidity are 212.00 μs cm^{-1}, 49.61 mg L^{-1} and 25.56, respectively. In all sites, these values were within the limit prescribed by

WHO. Akalinity and free CO_2 have mean values of 131.89 and 25.58 mg L^{-1}, respectively. The highest value of alkaliniy was observed at the stream (207.00 mg L^{-1}); this could be as a result of discharge of domestic sewage, detergents and agricultural effluents into the body of the stream water (Patil and Patil, 2010).

The mean values of THD, CHD and MHD are 103.00, 72.71and 31.05 mg L^{-1}, respectively. In all samples (A1-A9) expect the stream (A10), these values fell within the limit set by WHO. Adefemi and Awokunmi (2010), reported similar results for the physicochemical parameter of water samples in Itaogbolu area of Ondo State, Nigeria. The higher values of THD, CHD and MHD in the stream when compared with those of wells could be as a result of washing away of sulphate based fertilizer into the stream (Adeyeye and Abulude, 2004).

The mean TS and TDS values are presented in Table 1 as 1.31 and 0.87 mg L^{-1}, respectively. TDS values for all sites are relatively lower than the value prescribed by WHO. The relatively lower TDS value was responsible for lower EC values exhibited by these samples.

Table 2 shows the concentration of metals in the water samples. The concentration range of Fe, Zn, Pb, Mn, Ni, Cu, Na, K, Mg and Ca are 0.29-1.32±0.42, 0.34-4.12±1.46, ND-1.49±0.80, ND-1.01±0.48, 2.38-2.75±2.51, 2.52-7.04±4.53, 3.14-4.49±3.74 and 3.20-26.23±17.28 mg/100 L, respectively. Nickel and chromium were not detected in all the water samples. In the heavy metal examined iron (0.24-1.32±0.42 mg/100 mL) has the highest value compared to other trace metals. This might be due to deposition of the metal from runoff water during erosion and finally leached to the soil but there is no identifiable source, though it has been reported that iron occurs at high levels in Nigerian soil (Ali, 1978; Kakulu and Osibanjo, 1988; Nwajei and Gagophien, 2000; Oyewusi and Adeosun, 2004). The high concentration of iron in water has been reported by several researchers (Adefemi and Awokunmi, 2010; Asaolu and Olaofe, 2005; Adeyeye and Abulude, 2004). In all the water samples potassium (2.52-7.04±4.53 mg/100 mL) has a high concentration compare to other major elements (Na, Ca, and Mg), this might be as a result of the presence of soluble salt of potassium in these locations. This is close in agreement with the fact that potassium is a well known constituent of many plants (Liptrot, 1984; Adeyeye, 1996). The presence of potassium and sodium in the water sample might be of assistant to the consumers in the maintenance of electrolyte in the body plasma thus eliminating the shock that could arise from renal insufficiency (Eastham, 1985). The concentration of the

Table 1: The result of physicochemical analysis of water samples

Samples	Temperature (°C)	pH	Conductivity (μs cm^{-1})	Chloride (mg L^{-1})	Acidity	Alkalinity (mg L^{-1})	Free CO_2 (mg L^{-1})	Total hardness (mg L^{-1})	Calcium hardness (mg L^{-1})	Magnesium hardness (mg L^{-1})	TS (mg L^{-1})	TDS (mg L^{-1})
A1	27.20	7.15	120.00	34.63	20.30	90.00	20.30	56.00	32.60	23.40	1.50	0.94
A2	25.70	7.20	270.00	47.22	23.30	103.50	23.90	196.00	130.40	65.60	1.30	0.69
A3	26.20	6.90	240.00	74.20	22.00	147.50	21.00	98.00	52.60	45.40	1.00	0.82
A4	26.7	7.80	230.00	32.33	13.00	94.50	13.30	80.00	53.10	26.90	0.90	0.67
A5	24.30	6.70	170.00	67.10	26.70	129.00	25.70	164.00	132.40	31.60	1.42	0.93
A6	25.70	7.50	150.00	38.34	27.00	139.00	27.60	50.00	34.10	15.90	1.33	0.74
A7	26.20	7.12	200.00	25.20	48.00	137.00	23.00	84.00	70.20	13.80	0.97	0.88
A8	26.00	6.90	240.00	59.00	23.70	124.40	29.60	118.00	83.80	34.20	2.40	1.46
A9	26.40	7.30	190.00	52.89	21.30	147.00	21.30	62.00	43.10	18.00	1.30	0.73
A10	29.50	9.20	340.00	64.82	25.90	207.00	47.70	130.00	94.30	35.70	1.00	0.82
Mean	26.89	7.38	212.00	49.61	25.56	131.89	25.58	103.00	72.71	31.05	1.31	0.87
SD	1.33	0.71	62.86	16.60	9.13	33.69	9.08	48.23	38.87	15.65	0.44	0.23
CV (%)	5.04	9.62	32.48	33.46	35.72	25.54	35.50	46.46	50.71	50.10	33.10	26.44

Table 2: Concentration (mg/100 L) of metals in the water samples

Samples	Na	K	Ca	Mg	Zn	Fe	Pb	Mn	Ni	Cu
A1	2.56	3.81	15.87	3.74	0.32	0.69	1.49	ND	ND	ND
A2	2.50	5.19	22.46	3.30	0.41	1.34	ND	ND	ND	ND
A3	2.41	4.78	10.63	3.67	0.34	0.47	ND	ND	ND	ND
A4	2.63	4.94	26.23	ND	0.31	0.34	ND	ND	ND	ND
A5	2.48	5.51	24.61	3.69	0.29	0.53	ND	0.07	ND	ND
A6	2.75	4.42	19.02	3.41	0.29	0.90	0.80	ND	ND	ND
A7	2.66	7.04	10.31	4.19	0.29	1.33	ND	ND	ND	ND
A8	2.49	4.54	19.15	4.49	0.31	4.18	0.75	1.01	ND	ND
A9	2.38	2.54	3.35	4.06	1.32	0.34	0.13	0.28	ND	ND
A10	2.31	2.52	23.20	3.14	0.28	0.53	ND	ND	ND	ND
Mean	2.52	4.53	17.48	3.74	0.42	1.46	0.81	0.48	ND	ND
SD	0.13	1.35	7.38	0.44	0.32	1.61	0.63	0.42	ND	ND
CV (%)	5.32	29.24	42.24	11.67	76.68	110.25	84.74	108.90	ND	ND

ND = Not Detected

Table 3: Result of total bacteria and coliform count

	Total bacteria count		Total coliform count	
Samples	10^1	10^2	10^1	10^2
A1	32.0	25.00	10.0	2.0
A2	34.0	28.00	14.0	2.0
A3	39.0	32.00	35.0	10.0
A4	98.0	68.00	44.0	13.0
A5	77.0	35.00	30.0	16.0
A6	59.0	41.00	31.0	20.0
A7	30.0	25.00	20.0	2.0
A8	60.0	14.00	10.0	3.0
A9	47.0	34.00	25.0	15.0
A10	42.0	30.00	27.0	14.0
Mean	54.4	34.50	25.9	10.2
SD	20.9	14.00	10.0	6.4
CV (%)	38.4	40.60	38.6	62.7

Total bacteria count $\times 10^1$, 10^2; Total coliform count $\times 10^1$, 10^2

metals varies from one location to the other as attested by the coefficient of variation (5.32-110.25), this could be attributed to geological distribution of minerals that vary from one location to other.

The results of total bacterial count and total coliform count were shown in Table 3. The average bacterial count of water samples were 54.4±20.9 per 10 mL of original water samples and 34.5±14.00 per 100 mL of original samples, respectively while the average total coliform count were 25.9±10.0 per 10 mL of original water samples and 10.2±6.4 per 100 mL of original water sample respectively. These values were lower than the one reported by Ipinmoroti and Oshodi (1993) when assessing the water quality of shallow wells located close to dump sites in Akure, Ondo-State but similar to the results reported by Oluyege *et al.* (2011) from water samples in selected areas in Ado-Ekiti, Nigeria. The values of the bacteriological analysis were higher than the WHO (1998) standard for drinking water. Hence, the water must be treated before use.

CONCLUSION

The study revealed that the physicochemical, metal and microbiological analysis of the water samples are comparable to results of other studies conducted in other parts of Nigeria. The result also revealed that the values obtained were lower than the permissible limit recommended by WHO for drinking water except the microbiological analysis values that were higher than WHO standard hence, water needs proper treatment before use.

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