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Assessment of Quality of Drinking Water from Ogun State, Nigeria

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Abstract. Human survival is largely dependent on the quality of available drinking water. It is worth of knowing that drinking water from any source contain amount of trace elements. This study investigated the physiochemical parameters and analyzed the trace elements concentration in drinking water in Ogun State, Southwestern Nigeria. Water samples were collected from all the local government areas of the State. The pH, electrical conductivity and trace element of each sample were determined using the pH meter, electrical conductivity meter and atomic absorption spectrometer (AAS) respectively. The pH measured varies between 5.02 and 7.35 and the electrical conductivity obtained ranged between 23.7 and 336 μScm^{-1}. The trace elements determined in the samples were Copper (Cu), Calcium (Ca), Chromium (Cr), Zinc (Zn), Iron (Fe), Manganese (Mn) and Nickel (Ni) with mean concentrations 71.72, 0.53, 0.44, 0.08, 0.36, 0, 0.002 mgl^{-1} and respectively. The study revealed that 80% of the water samples were acidic and electrical conductivity measured were within set limit except for a location. The trace element concentrations measured were within acceptable limits except for copper concentation that exceeded the set limit for drinking water. The study therefore recommended periodic monitoring of the water in order to ascertian the quality of water supply to the entire State.

Keywords: Trace elements, Drinking water, Electrical conductivity, pH

1. Introduction

Nigeria as one of the developing is facing the problem of inadequate and shortage of safe and portable water for more than four decade. This acute scarcity of water has led the inhabitants to look for portable water that is fit for human consumption. The population of Abeokuta metropolis is about 605,461 as projected from 1991Census with a growth rate of 3.5 percent with 120 million liters per day (MLD) as a demand daily for water. With the increase in the demand of water in the State, the State water corporation supply is not able to provide enough water that will go round their citizenry therefore every home have to get another source of good water supply [1]. In quest for good water citizenry has resulted to getting water from unwholesome sources that can lead to epidemics and spread of water borne diseases. Measurement of pH is important for all actions that require water. Life sustanance is largely dependent on maintaining the right pH level. Animals and human beings bank on internal processes to support their blood pH level. The right pH for the blood circulating in our veins should be between 7.35 and 7.45. The measured pH, quantity of carbon (iv) oxide (CO_2) dissolved in the water to form ions and the temperature of measurement determine the conductivity. The concentration of ions available in the water can also alter the conductivity such as ammonium, sodium and chloride. Conductivity therefore clinches on the chemical make-up of water [2].

Trace elements exist in very minute but quantifiable quantities in water, rocks and soil. The common trace element distribution of water, rocks and soil can put human health in jeopardy and be the basic source of element toxicity and deficiency [3]. Studies have shown that metamorphic basement and younger granite rocks is associated with iodine deficiency disorders (IDD) that suggest increase in goiter which is not common in the sedimentary basement. Mining/mineral activities activate these trace elements through weathering whereby they found their way into the environment in the water bodies and soil. It has also been noted that areas with elevated radioactivity level are prone to increase in the concentration of trace elements [4 – 8]. Trace elements may come from common sources, filtered from soils and rocks according to their geochemical mobility or come from man-made sources, emanate from industrial pollution and human land occupation [9]. The expansion of industrial activities has escalated the problems environmental pollution and the degradation of many aquatic ecosystems with the pile of metals in plants and biota. Although trace metals at low concentrations are important to healthy living however, when in high levels it may be harmful to health. The trace elements concentrations levels of in food and water can put human health at risks and therefore need urgent attention. Hence, it is therefore necessary to measure the pH, electrical conductivity and trace element concentration of the water samples in the study area.

2. Materials and Method

Drinking water samples were collected in 75 *cl* plastic containers from more than one source in each local government of the study area. The first source of water being the boreholes is situated at the local government secretariats. Samples were collected and stored under temperature suitable for further experiment. In measuring the pH, calibration was done to cater for changes in potential in the reference and measuring electrodes. After calibration the electrodes were rinsed with distilled water and wiped. The samples were put into a separate 25 cm^3 beakers and then the measuring electrode was dipped into the first beaker. The readings were recorded once it became steady. The electrode was rinsed while the procedures were repeated for the remaining samples. The conductivity of water is related to the concentration of the ions and their mobility. The ions in water act as electrolytes and conduct the electricity. Calibration of the meter was done with 0.1N Potassium Chloride. The electrode was thoroughly rinsed with de-ionized water and carefully wiped with a tissue paper. Part of the sample was transferred into different 20 cm^3 beakers and then the electrode was dipped into the sample solution taken in a beaker. Afterward, the final measurement was recorded when the meter was steady.

The samples were digested with nitric acid (HNO_3) and hydrochloric acids (HCL), after which they were made acidic. The digested solutions were taken for analysis with the atomic absorption spectrometer (AAS). The samples were homogenized: 0.5 g of water was weighed into a 250 *ml* beaker. Thereafter, 10 *ml* of Aqua Regia (1:4v:v HNO_3:HCl) was added. The vessel was heated on a hot plate for at least 2 hr with boiling, rinsing of the beaker walls, flip-flop, and addition of more of the aqua regia solution during heating (if necessary) whenever the solution dried up. Samples were then transferred into centrifuge tubes and watered down to a final volume of 30 *ml* with distilled de-ionized water. The samples were then diluted as necessary and analyzed for trace metals using AAS. The atomic absorption spectroscopy is related to the Beer-Lambert law given in equation 1

$$C = \left[\frac{I_o}{I} \right] \tag{1}$$

C is the absorbance, I is transmitted intensity and I_0 is incident intensity

The concentration of the sample, the absorbance and the spectrum of absorption of the sample in the element are known. The concentration of the element is measured when a known quantity of energy passed through the atomized sample by measuring the amount of light. The characteristic wavelengths of light emitted depend upon different atom the elements absorb. The concentration of the element is measured in milligrams per liter (mgl^{-1}) and the characteristic concentration needed to produce 1% absorption signal is presented in equation 2.

$$\text{Characteristic Concentration} = \frac{\text{Characteristic of standard}\left(\frac{\text{mg}}{\text{l}}\right) \times 0.0044}{\text{measured absorbtion}} \qquad (2)$$

3. Results and Discussion

The pH values obtained ranged from 5.02 to 7.35 as shown in Table 1 with pH mean value of 5.82. The pH value is a crucial indicator alkalinity of or acidity and the concentration of hydrogen ion in water [3]. The pH values lower than 6.5 are weighed to be too acidic for human drinking and can cause health problems such as acidosis. Also, pH values higher than 8.5 are weighed to be too alkaline for human utilization. According to the WHO guidelines for drinking water quality, the permissible range is from 6.5-8.5 [10]. The results revealed that samples from Odeda (pH value 6.56), Ijebu North (pH value 6.59), Ota (pH value 6.54) and Ewekoro (pH value 7.35) are within the recommended level for pH values. The highest pH value was 7.35 from Ewekoro while the lowest obtained value was 5.02 from Ijebu Northeast. Figure 1 shows one location was above 7. Six of the locations have pH of above 6 and thirteen others have pH below 6 but not less than 5. This shows that water samples in most of the areas are too acidic for human consumption as they are below 6. The acidity may be as a result of effluence and pollution from many manufacturing companies located in the State. The measured electrical conductivity is presented in Table 1 with mean value of 72.3 μScm^{-1}. Electrical conductivity (EC) represents the total concentration of soluble salts in water. The WHO permissible limit for electrical conductivity (EC) of water is 300 μScm^{-1} [10]. Only one sample does not fall within the WHO permissible range, which is the EC obtained from Ewekoro. This could be as a result of accumulated limestone in the area. Figure 2 shows that the values obtained from twelve locations are below 50 μScm^{-1}, four locations are below 100 μScm^{-1}, two locations below 150 μScm^{-1}, one below 250 μScm^{-1} and one is just below 350 μScm^{-1}. This study corroborates the study of [11] in a study of water in hand-dug wells in Ghana.

The trace elements obtained from the various samples are shown in Table 2. Traces of Copper (Cu) were found in all samples with the highest concentration obtained from Abeokuta South with 492.95 mgl^{-1} while the lowest amount came from Ikene with 0.81 mgl^{-1}. Zinc (Zn) was obtained in all samples but in far less quantity than that of Copper with the highest level found in Yewa North with 0.23 mgl^{-1} and the least found in Ijebu East, Abeokuta South, Odeda and Ogun Waterside all with 0.02 mgl^{-1}. Chromium (Cr) was obtained in all samples also, with the highest concentration obtained from Ota with 1.98 mgl^{-1} while the least value came from Abeokuta North with 0.02 mgl^{-1}. Nickel (Ni) was only found in two samples and in little quantity which are from Ogun Waterside with 0.02 mgl^{-1} and Owode with 0.01 mgl^{-1}. No trace of Manganese (Mn) was found in any of the samples. Traces of Iron (Fe) were found in 18 of the samples with the highest amount obtained in Odeda with 1.12 mgl^{-1} and the least coming from Remo North with 0.01 mgl^{-1}. Traces of Calcium (Ca) were also obtained in 18 of the samples with the highest value coming from Ogun Waterside with 4.921 mgl^{-1} and the least coming from Owode, Remo North, Ikene and Ipokia all with 0.1 mgl^{-1}. It was observed that concentration of Cu in eight locations exceeded the 0.05 to 30 mgl^{-1} limit set by the WHO for Cu in water [2]. This may be due to the variation in pH and distribution system in each location [12].

Table 1: pH and EC results

ID NO.	LOCATION	PH	EC
1S	OWODE	5.57	41.9
2S	YEWA NORTH	5.28	53.2
3S	ABEOKUTA NORTH	6.45	213
4S	IJEBU ODE	6.2	43.5
5S	IJEBU EAST	5.33	23.9
6S	IFO	5.31	41.6
7S	IMEKO-AFON	5.61	21.3
8S	YEWA SOUTH	5.13	53.8
9S	SHAGAMU	6.12	59.8
10S	OTA	6.54	37.8
11S	REMO NORTH	5.63	29
12S	IJEBU NORTH-EAST	5.02	23.7
13S	ABEOKUTA SOUTH	5.85	131.6
14S	EWEKORO	7.35	336
15S	ODOGBOLU	5.31	32.9
16S	IKENE	5.25	33.1
17S	ODEDA	6.56	131
18S	IPOKIA	5.71	33.6
19S	IJEBU NORTH	6.59	29.6
20S	OGUN WATERSIDE	5.5	76.3
MEAN		**5.8155**	**72.33**
RANGE		**5.02-7.35**	**23.7-336**

Table 2: Trace Elements in the samples in (mgl^{-1})

| ID NO.	Cu	Zn	Cr	Ni	Mn	Fe	Ca
1S	1.11	0.2	0.55	0.01	ND	0.1	0.1
2S	2.03	0.23	0.5	ND	ND	0.1	0.11
3S	44.11	0.05	0.02	ND	ND	0.42	0.45
4S	1.66	0.04	0.15	ND	ND	0.11	0.22
5S	35.37	0.02	0.1	ND	ND	0.93	0.22
6S	0.9	0.16	0.77	ND	ND	0.1	0.22
7S	48.26	0.03	0.04	ND	ND	0.53	0.756
8S	2.22	0.21	0.49	ND	ND	0.42	0.4
9S	3.04	0.04	0.16	ND	ND	0.41	1.01
10S	1.52	0.07	1.98	ND	ND	0.22	ND
11S	1.1	0.06	0.1	ND	ND	0.01	0.1
12S	29.02	0.04	0.13	ND	ND	0.92	0.09
13S	492.95	0.02	0.09	ND	ND	1.1	0.73
14S	194.11	0.03	0.31	ND	ND	0.11	0.21
15S	3.33	0.08	1.54	ND	ND	0.22	0.43
16S	0.81	0.04	0.12	ND	ND	ND	0.1
17S	410.94	0.02	0.2	ND	ND	1.12	0.54
18S	155.95	0.06	1.48	ND	ND	0.23	0.1
19S	1.18	0.1	0.04	ND	ND	ND	ND
20S	4.86	0.02	0.11	0.02	ND	0.21	4.91
MEAN	71.7235	0.076	0.444	0.0015	ND	0.363	0.5348
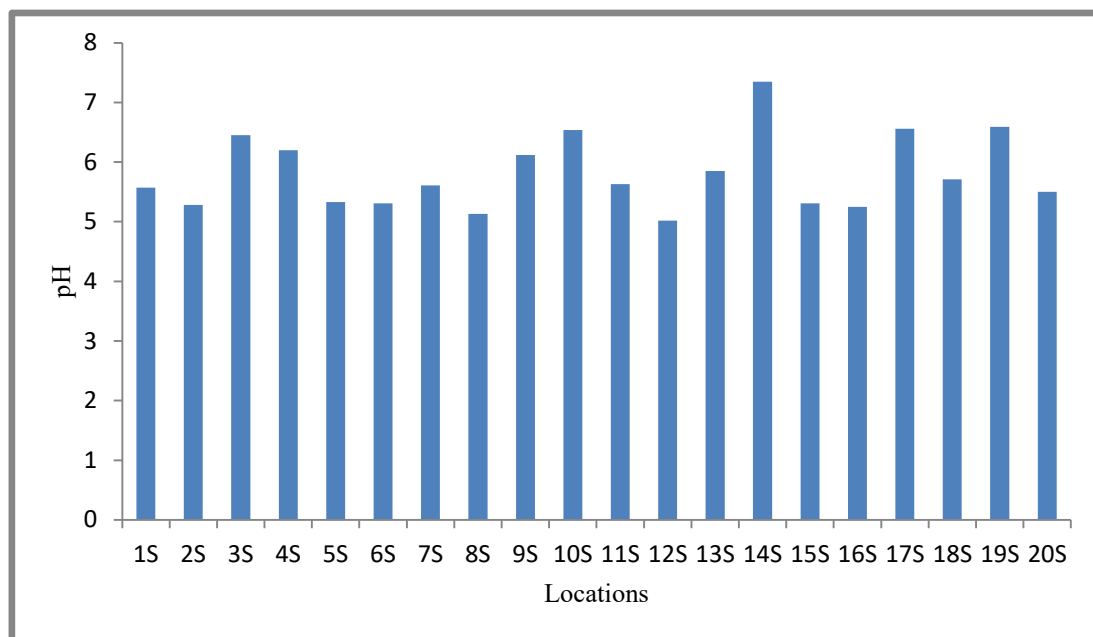
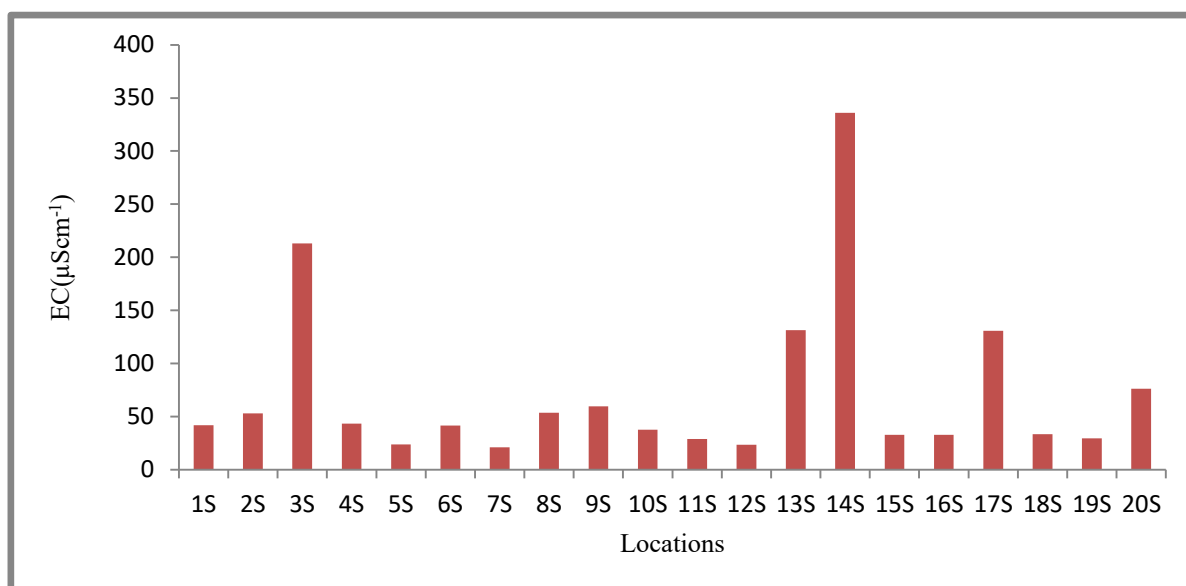Figure 1 Variation of pH with Locations

Figure 2 Variation of EC with Locations

4. Conclusion

The pH, electrical conductivity and trace elements in drinking water in Ogun State had been measured using standard methods. Trace elements such as Zinc, Iron and Chromium were found in all the water samples, though they were within the permissible limits but Cu concentration exceeded the set limit in some locations. It was found that only 20% of the locations had pH within the recommended limit, also the mean EC values obtained was 72.33 μScm^{-1} with one location exceeded the recommended level. This study recommends that assessment of the quality of drinking water should be done continuously to study the source and level of toxic pollutants which are responsible for the contamination of groundwater quality in the study area. The study recommends that further research should be done on the local government areas by collecting more samples per location and at different seasons of the year to properly determine the quality of the water.

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