

Quality Assessment of Ground and Surface Water Resources in Ekor, Yakurr Local Government Area, Cross River State, Nigeria

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Abstract

Water quality assessment is of great importance for ensuring use of safe water. The water quality can be described by its physical, chemical and biological characteristics. However, conditions of the quality is difficult due to the variability of pollutants and biological, physical and chemical substances, which are wide range of indicators to be measured. In this research, water quality of Ekor, Yakurr Local Government Area of Cross River State was assessed. The collected samples were analyzed for pH, conductivity, TDS, BOD, nickel etc. The analytical data was evaluated by the chemical characteristics of the water collected from the seven locations within the study area for its suitability for drinking and irrigation uses. For the suitability of the ground water for drinking purpose, who include total hardness ranging from 153.9 to 256.5 with average value of 153,1 indicating that the water is hard. The pH values (except GW3) ranged from 6.5-8.5, indicating that the water is slightly acidic. The assessed water quality was checked in par with the Nigerian standard for drinking water quality (NSQDW). Nevertheless, in order to ensure a more adequate quality of drinking water in the area, proper and constant water quality control and monitoring programmes should be implemented.

Keywords: *Water quality, chemical characteristics, pH levels, water monitoring Nigerian standard*

INTRODUCTION

Our lives and the lives of all other creatures on earth depend on water, because water is the most important natural resources and without it, life cannot exist. Although human life can exist for weeks without food, the absence of water for only few days has fatal consequences. The presence of safe and reliable sources of water is thus, an essential prerequisite for the establishment of stable community. Good quality water is indicated by being colourless in small volume, blue-green in large quantities. It has no smell, but has an insipid taste; hence, colour is unaccepted in water supply for the purpose of drinking, food and industrial uses. This is because, colour is associated with organic and inorganic substances that constitute hazard to man and machine. Its measurement establishes the density of the irater involved. The pH of water has a very serious effect on its usability. Many chemical reactions are controlled by pH and biochemical activity is usually restricted to a fairly narrow pH of 6.8. However, most of our natural water has a pH [ranging from 5.0 - 8.6m which are only suitable for consumption. The level of nitrate and nitrite show the quantity of nitrogen in an aquatic environment. Nitrate occurs in most natural water and ranges in concentration generally from 0-2mg/l the extremes being rare. Nitrate in concentration above 20mg/l has been reported as the cause of diseases in infants characterized by blood changes and cyanosis, in which the hemoglobin apparently inactive in transporting oxygen. Moreover, nitrate in natural water is generally regarded as evidence of sewage pollution. Amah *et al.*, (2012) during his survey presented the results of groundwater site evaluation scheme and quality assessment of coastal aquifers in Calabar, South-eastern Nigeria based on ground water index (GWPI) scale, developed for the study. The GWPI consists of ten input parameters, and is computed as the sum of the products of weights and ratings assigned to each of the input parameters. The GWPI results further reveal that E-coli (3-50 counts/100ml), chloride (CL) (2.5-21.0 mg/l) and static water level (SWL) (2.3-28.7 m) remain the most significant parameters that contribute to groundwater pollution particularly in the southern zone of the study area. In the near future, water quality in aquifer will be affected due to poor management of human waste-disposal/salt water intrusion, thereby limiting the availability of potable water for domestic and industrial uses. Okorafor (2011), carried out a research to determine the quality of some sachet water products in Ogoja Local Government Area using the World Health Organization (WHO) acceptable standards for drinking water. Ten different (newly produced) products of sachet water were randomly selected from the Local Government on each sampling occasion. The water samples were then subjected to physical, chemical and microbial analysis. The physical-chemical components examined included pH, temperature, conductivity, turbidity, manganese, total hardness, nitrate, nitrite, magnesium, calcium, lead, zinc, copper, total suspended solid, aluminum, iron, fluoride, color, chloride, salinity and total dissolved solids. The microbial examination was for total and faecal coliform counts

using multiple tube fermentation. Results revealed that all the different sachet water products sampled deviated from the WHO standards. The concentration of the micro and macro elements were significantly different ($p < 0.05$) from the WHO recommended benchmark. The total and faecal coliform counts were significantly higher than the required standard. The findings of this study deduce that sachet water samples examined, do not meet microbiological standards for drinking water quality. A report was conducted by Igwe *et al.*, (2018), on the quality of natural waters in carbonate aquifers at a densely populated Odukpani area of cross river state, Southern Nigeria. The study area, Odukpani is underlain by cretaceous sediments of the Calabar Flank. Results from the chemical analysis show that the waters are mostly alkaine with the exception of two mildly acidic samples. Comparison of the water chemistry with standards set by regulatory bodies indicates that the waters are of good quality. A survey of the Physico-chemical and bacteriological characteristics of some streams and boreholes which supply drinking water to the inhabitants of Akamkpa and Calabar municipality were examined by Okorafor *et al.*(2012). The water samples collected from five streams and six boreholes (eleven sampling locations) were subjected to physico-chemical test and membrane filtration techniques. Results from physico-chemical test showed that parameters such as pH, electrical conductivity, odour, calcium, magnesium, nitrate and ammonium, for all the samples were lower than the WHO standard. Only two of the water supply sources (B1 and B4) met the WHO standard (for coliform count), Water samples from streams had a significantly higher coliform (*E. coli*) counts ($p < 0.05$) compared to those collected from boreholes. The potential impacts of unsafe drinking water are discussed and recommendations to salvage the situation offered. The data therefore could serve as a good guide for future groundwater management of that area. In line with previous studies, this research was carried out to assess the quality of Ground and Surface water resources in Ekorl, Yakurr local government Area, Cross River State, Nigeria

2. Material And Methods

The samples were collected from different boreholes and streams in Yakurr Local Government Area of Cross River State. The boreholes were in Epenti, and the stream was located in Kesekpan, other water sources were gotten from Ajere beach & Epenti beach. The water samples were then collected and stored in plastic bottles which were stoppered to enhance easy transportation from the sample sites to the place of analysis (laboratory). For all the samples, some physicochemical parameters were determined using standard methods.

2.1 Fieldwork and sampling technique

2.1.1 Mode of Collection

The water samples were collected after rinsing the sample bottles with the river water, by filling the sample bottles and packing them in ice packed coolers and transported to the laboratory at Cross River State Water Board Limited for analysis. Before sample collection, in-situ analysis was carried out to determine the pH of the samples as well as the temperature. A field pH-meter used in measuring the pH of the respective samples was calibrated with buffer solution before being used. A thermometer was also used in measuring the temperature of the samples. During the analysis, the pH-meter after calibration was introduced into a little quantity of the samples. After which the reading was allowed to steady in the screen and the value was recorded. This was done repeatedly on each of the samples to ensure accuracy. Immediately after collection, the sample bottles were labeled accordingly, corked and stored in refrigerator to minimize contamination and escape of dissolved gases.

2.2 Analysis technique

Different analytical techniques were employed in the analysis depending on the availability of facilities. Accuracy, precision, sensitivity and practicability were considered. In this research project, the analytical methods adopted were both chemical and instrumental.

2.2.1 Titrimetric method

This method involves quantitative procedures that are based upon measuring the amount of reagent of a known concentration that is consumed by the analyte. It could be defined as a method which include a group of analytical methods that are based upon determining the quantity of a reagent of a known strength that are required to react completely with the analyte. Thus, this method was used to measure alkalinity, hardness (magnesium/calcium carbonate) etc.

2.2.2 Spectrophotometric method

In this method, water sample was directed or aspirated into a flame and atomized. A detector measures the amount of light absorbed by the atomized element as its own wavelength in the sample. A source lamp composed of that element is used, this makes the method relatively free from spectral or radiation interferences. Hence, the amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the water samples. This method was used to determine manganese, fluoride, carbondioxide, potassium etc.

2.2.3 Electrometric method

In this method, membrane electrodes or probe are used. The procedure is based on the rate of diffusion whatever was tested across the membrane. The rate of diffusion reading was taken on the screen. This method was used to determine pH, electrical conductivity, total dissolved solids (TDS), dissolved oxygen (DO).

2.2.4 Calorimetric method

This method is used in determining the concentration of a chemical element or chemical compound in a solution with the aid of a colour reagent. It is applicable to both organic and inorganic compounds. The method is widely used in medical laboratories and industries for the analysis of water samples in connection with industrial water treatment. This method was also used in determination of nitrate.

2.3 Parameters determined and methods

Appropriate and standard methods were employed for both qualitative and quantitative assessments of all the parameters.

2.3.1 Determination of pH and Temperature

Each of the buffer tablet was dissolved in distilled water and dilute to the mark in a 100ml volumetric flask. The pH meter probe was inserted into the water sample in a beaker, the READ key was pressed and pH reading was taken. The temperature was determined by inserting the thermometer into the sample in a beaker and then noting the reading. This was taken at the sampling site.

2.3.2 Determination of Turbidity

The turbidity meter was switched on & sample bottles were filled and inserted into the holder and the knob was pressed. The reading was allowed to steady before taking the reading on the screen. Where there was no turbidity, the reading showed 0.00. To carry out conductivity, the conductivity probe was rinsed with distilled water and inserted into the sample and reading was noted.

2.3.3 Determination of dissolved oxygen and Salinity

The dissolved oxygen meter has a dual function of reading both dissolved oxygen & salinity respectively. The probe was immersed into the sample and the dissolved oxygen meter was pressed which automatically reads the dissolved oxygen concentration in the water sample. To determine the salinity, the dissolved oxygen/ salinity meter was used. In this case, instead of oxygen button, the salinity button was pressed which reads the salinity of the sample.

2.3.4 Determination of total dissolved solids (TDS)

There is a correlation between this parameter and conductivity. Therefore, the total dissolved solid in each sample was determined by multiplying the conductivity value by 0.67.

$$\text{TDS} = \text{conductivity} \times 0.67$$

2.3.5 Determination of Total suspended solids

A filter paper was weighed using an electronic digital balance and the initial weight noted. 10ml of the sample was then filtered, the filtrate was oven dried at a temperature of about

50°C for an hour. After an hour, the filter paper was re-weighed and the final weight noted. The difference between the final weight and the initial weight then becomes the value for the total suspended solids. Also, to determine the hardness, 1ml of the sample was placed in a reaction cell and 1ml of total hardness reagent H-1k added with a pipette, and allowed for 3min before. Total hardness was determined in the spectrophotometer at a wavelength of 450nm.

2.3.6 Determination of magnesium and Potassium

1 ml of the sample was placed in a reaction cell and mixed and 1ml of magnesium reagent, mg-1k added to it. This was allowed to stand for 3 min and thereafter, 0.3ml of magnesium reagent, mg -2k added, mixed and placed in a spectrophotometer. Magnesium concentration was read at a wavelength of 568nm. To determine the potassium content, the spectrophotometry method was employed. 2ml of the water sample was placed in a reaction cell and mixed with 0.61ml of potassium reagent also added, mixed and allowed to stand for 5min. Readings were taken at wavelength of 690nm.

2.3.7 Determination of nitrate

Using the mass spectrophotometry method, 1 micro spoonful of nitrate reagent NO₃-1A was placed in a dry test tube and 5ml of nitrate reagent NO₃-2A added to it and mixed to dissolve. 1.5ml of the sample was added solely and shaken and allowed for 5min readings were taken at wavelength of 820nm. Using the same method, the copper content was determined. 5ml of the water sample was placed in a reaction cell and the 0.5ml of copper reagent Cu-1k was added and allowed to mixed for 5min before copper concentration was determined at wavelength of 690nm.

2.3.8 Determination of Lead and phosphate content

5ml of the water sample was placed in a reaction cell and 0.5ml of lead reagent was added and mixed. The concentration of lead was determined in the spectrophotometer at a wavelength of 620nm. To determine the phosphate content, 5ml of the water sample was placed in a test tube and S-drops of reagent P/A were added and mixed, I level micro spoonful of P-2A was also added and left to stand for 5 minutes for full colour development. The solution was transferred to a cuvette and phosphate concentration displayed in the spectrophotometer.

2.3.9 Determination of Manganese and Iron Content

5ml of the water sample was placed in a test tube & 4 drops of manganese reagent Mn- was added and shaken. This was allowed to stand for 2min, before 0.2ml each of manganese reagent. Mn-2 & Mn-3 were added, shaken & allowed to stand for another 2min before readings were taken at wavelength of 520nm. Also, to determine the iron content, 5ml of the water sample was placed in a test tube and 0.3ml of iron reagent Fe-I

was added, shaken and allowed to stand for 3min. the iron concentration was then determined at a wavelength of 420nm in the spectrophotometer at wavelength of 420nm. Furthermore, to determine the colour of water, Lovibond comparator was used. The sample was place on the right hand of the comparator and the NSA disc was rotated until the nearest colour match was observed.

2.3.10 Determination of Sulphate and Chlorine content

2.5ml of the water sample was placed in a test tube and 0.2ml of sulphate reagent SO_4^{2-} 1A added & mixed -I level spoonful of sulphate reagent SO_4^{2-} 2A powder was added & mixed. The solution was then tempered in a water bath at 40°C for 5 minutes. 2.5ml of sulphate reagent SO_4^{2-} 3A was added, mixed & filtered. 0.4ml of sulphate reagent SO_4^{2-} 4A was then added to the filtrate & mixed. The solution was again tempered in a water bath for 7min at 40°C . This was transformed into a round cell and placed in the spectrometer to read off the concentration of sulphate in the water sample at wavelength of 520nm. To determine chlorine content, 5ml of the water sample was placed in a test tube and 2.5ml of chlorine reagent Cl_2 was added and mixed. Chlorine reagent Cl_2 was also added, shaken and allowed to stand for I minute before readings are then at wavelength of 460nm.

3.0 Result and discussion

The results of both physiochemical and bacteriological parameters are presented in table 1.0 the water showed a uniform characteristic appearance with some minor variations. The concentration of total dissolved solids was lower than the Nigerian standard of quality drinking water (NSDQW) with maximum value of 500mg/l exception of GWI having a value of 634.2 above the required NSDQW limit. Also, the pH value for all seven (7) samples except GW3 fall below the NSDOW limit of 6.5-8.5 standards, indicating that the water is slightly acidic. The conductivity values range from 43.0-10.57 for all six samples which are below the NSDOW guideline of 1000ms/cm, this shows low salinity intrusion from salt water, and high mineral content which is indicative that there is less TDS in the water sample.

The fluoride (F^-), nitrate (NO_3^-), phosphate (PO_4^{3-}), lead (Pb^{2+}), Nickel (Ni^{2+}) and chloride (Cl^-) concentration ranged from 0.02-0.06, 4.23-8.10, 0.3-0.81, 0.01-0.08, 0.04-0.13 and 21.1-31.0 respectively fall below the permissible limit. Which indicates that the water is not harmful as they do not exceed safety values established by the NSDQW. Nevertheless, chloride may be associated with individual septic disposal system (NDS) and is present in all natural waters, usually in relatively small amount. High concentration of chloride in water is known to cause health hazard. The value of chloride in this study was low and ranged from 25.1-31.0 for the surface water and 16.0-21.1 for underground water with average value of 20.0, which is below the maximum allowable concentration of 100mg/l

(NSDWQ) 2008. This value is harmless as such safe for drinking. However, the total hardness of water samples for all surface water (17.1) which is below the NSDWQ 100mg/l acceptable limit, meaning the water is soft and foamy. This indicates that the surface water is not harmful or corrosive and would not cause mutations as such, it is suitable for domestic consumption. Unlike the surface waters, all the groundwater is above the NSDWQ 100mg/l acceptable limit, ranging from 153.9 to 256.5 with average value of 153.7, hence very hard.

Table 1: The levels of Physiochemical and biological parameters gotten from surface and ground water in the study area (Ekor, Yakurr Local Government

S/N	PARAMETER/UNIT	SW1	SW2	SW3	SGW1	GW2	GW3	GW4	NSDWQ
1.	Temperature (O _c)	28.6	28.3	28.4	28.1	28.5	28.5	27.9	Ambient
2.	Ph	5.10	6.05	6.25	6.25	5.89	6.63	6.15	6.5-8.5
3.	Conductivity ws/cm	43.0	58.8	45.0	1057	740	497	884	1000ws/cm
4.	Turbidity NTU	2.79	13.7	18.5	0.323	0.873	0.573	2.24	5.0NTU
5.	Hardness mg/l	17.1	17.1	17.1	222.3	153.9	256.5	153.9	100mg/l
6.	BOD mg/L	6.29	7.05	6.12	4.80	5.66	4.72	6.19	1.0- 5.0mg/l
7.	Colour (H/U)	<5	<5	<5	<5	10	<5	<5	3.0TCU
8.	Taste	Unobj	Obj.	Obj.	Unobj	Unobj	Unobj	Unobj	Unobj
9.	TDS	25.8	35.3	27.0	634.2	444	298.2	530.4	500mg/l
10.	Chloride (mg/1)	29.2	31.0	25.1	16.D	18.0	21.1	20.0	100mg/l
11.	Fluoride (mg/1)	0.03	0.06	0.06	0.02	0.02	0.03	0.01	1.0mg/l
12.	Nitrate (mg/1)	6.01	4.33	8.01	5.22	5.18	4.23	5.49	1.0mg/l
13.	Sulphate (mg/1)	3.46	2.96	2.68	1.27	1.31	1.10	1.21	100mg/l
14.	Phosphate (mg/1)	0.81	0.77	0.80	0.31	0.38	0.40	0.33	3.5mg/l
15.	Manganese (mg/1)	0.25	0.36	0.30	0.10	0.06	<0.10	0.08	0.1mg/l
16.	Iron (mg/1)	0.67	0.81	0.65	0.36	0.29	0.54	0.29	0.3mg/l
17.	Zinc (mg/1)	0.16	0.13	0.19	0.08	0.12	0.10	0.05	5mg/l
18.	Copper (mg/1)	0.11	0.10	0.09	0.088	0.091	0.085	0.081	1.0mg/l
19.	Arsenic (mg/1)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01mg/l
20.	Chromium vi (mg/1)	0.013	0.01	0.01	0.02	0.05	0.03	0.01	0.01mg/l
21.	Lead (mg/1)	0.05	0.08	0.03	<0.01	ND	0.01	1.90	0.1mg/l
22.	Potassium (mg/1)	3.10	2.90	3.10	1.70	1.90	1.60	0.00	200mg/l
23.	Cobalt (mg/1)	0.022	0.02	0.02	0.05	0.03	0.00	0.00	
24.	Nickel (mg/1)	0.06	0.08	0.04	0.12	0.10	0.13	0.10	0.01mg/l
25.	TCC/00/CFU	TNC	TNC	TNC	108	113	72	TNC	0.CFU/ml
26.	FCC,100/CFU	TNC	TNC	TNC	51	65	48	TNC	0.CFU/ml

4. Conclusion

On the basis of quality evaluation scheme, the physiochemical parameters for all the samples analyzed proves that the water is good, soft, portable and suitable for drinking. The PH values analysed were below the permissible limits exception of GW3 which recorded a high pH value in the regime of 6.63. In other words, samples with pH less than 6.5 should be treated. According to the investigation, the water could also be used for agricultural purposes. The chloride concentration shows absence of salt water intrusion, total hardness reveals that the sample is hard. Furthermore, prevention measures should be made in dumping of refuse in surface water to prevent pollution.

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