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Qualitative Study of Pipe-Borne Water from Selected Locations in Ikwuano, Abia State Nigeria

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Abstract: **In this study, an examination was carried out to ascertain pipe-borne water quality in Ikwuano, Abia state. Eight(8) water samples were collected from selected locations in Ikwuano so as to investigate their physiochemical and biological properties. The following parameters were studied; Biochemical Oxygen Demand (BOD), Total Dissolved Solid (TDS), Total Hardness (TH), Chloride, Alkalinity, Chemical Oxygen Demand (COD), Sulphate, Electrical Conductivity (EC), Dissolved Oxygen (DO), Temperature, Salinity, pH, Turbidity, Acidity, Total Suspended Solid (TSS), Colour, Total Coliform Count (TCC), Streptococcus (STC), Total Viable Bacteria Count (TVB) and Escherichia Coli Count (ECC). The results of the parameters were checked with both global and local standards for drinking water quality so as know its level of conformity with the standards. The results indicated that the water from the selected boreholes was fit for human consumption as evidenced by its conformity with the stipulated standards. However, pH adjustment of the following water samples is recommended;PB1, PB5, PB6 and PB7 so as to make it alkaline.**

Keywords: **Ikwuano, pH adjustment, physiochemical parameters, biological parameters, standards.**

I. INTRODUCTION

Water has been found indispensable to the wellbeing of man . This goes to explain the saying that" Water is life''. Gore [1] pointed out that, the composition of water in the universe is almost equal to the same composition of water in human beings. Water is needed for domestic, industrial and agricultural purposes. According to UNCSD[2], in simple term water is necessary for the sustenance of growth in every part of the society. Asonye et al [3] emphasized that good quality water is a necessity for sustenance of development. Water can be found in three sources;surface water, rainwater and ground water. Among the three sources of water supply, ground water tend to appear in purer form than water from other sources. UNEP [4] enunciated that the most critical sustainability and environmental issues of the twenty first century remain the quantity and quality of naturally occurring water in form of rainwater, surface water and ground water. Groundwater is used widely as a source of irrigation for food production and drinking water supply[5]. Thus, groundwater supplies water to ponds, rivers, lakes, ponds and wetlands and thereby helping in the sustenance of ecosystem and maintenance of water levels[6].

Ground water is already used extensively in Nigeria through hand dug wells and boreholes. Unfortunately pipe-borne water like water from other sources does not attain hundred percent purity. The level of purity varies from one geological conditions of the soil through which the ground water flows and some anthropogenic activities to another.

Irrespective of the essential function of water to life, it also has the potential of transmitting a wide variety of diseases if polluted. Poisonous chemicals are known to percolate the layers of the earth and terminate in ground waters thereby constituting public health hazards. In Ikwuano Local Government Area, certain anthropogenic activity like the improper waste disposal can contribute to ground water pollution. This area suffers from non-provision of potable water supply.

The inhabitants are therefore depending largely on private borehole water supply which is of doubtful quality. Preliminary investigation in the study area indicates that there are many reported cases of these enteric diseases in the health centres.

The study is significant and relevant because portable water is essential to life. This study therefore, became necessary owing to the fact the major source of water in Ikwuano is borehole water. The daily amount of water per capita per day should be 27litres going by World health organization recommendation(WHO). It is not clear how much water is explored per capita in Ikwuano; however it is obvious that many manage far less than 27 liters a day. Ikwuano has a population of 157, 830 that there is a need to assess the various water parameters so as to check their level of compliance with both the global and local standards.

It is necessary to ascertain the water quality in the area under study considering of water in the area because of the increasing population of the area due to the location of three universities within the area; Abia State University, Uturu Extension Umudike (ABSU), Michael Okpara University of Agriculture, Umudike (MOUAU) and National Open University of Nigeria, Umudike study centre (NOUN). The area equally houses a research institute ; National Root Crops Research Institute(NRCRI), Industrial Timber Shade, and Government College, Umudike. The life of staff, students and workers of the universities and over twelve secondary schools and many primary schools and the host communities rely on the nature of borehole water consumed. Also, the increasing population in the area creates challenges in provision of adequate quality water. Ikwuano is in a crisis of increasing poor water quality and communities reject some borehole water during specific seasons. There is a gap in knowledge of anthropogenic, geological and hydrological factors impacting on borehole water quality and the patterns of borehole water consumption to identify areas with water stress. Therefore, this study was geared towards ascertaining the characteristics of water supplied from boreholes in the study. The main objectives of this study were to analyze data the water samples collected from boreholes in other ascertain the following;(i). The range of the parameters studied in water samples considering physical, chemical and biological analysis. (ii). The range of conformity to global and local standards of water quality assessment.

II. MATERIALS AND METHODS

Fig. 1: Map of Abia state showing Ikwuano

A. Location of the Study Area:

Ikwuano is located at about 50 25’ 60” degrees North of the equator and about 70 34’ 0” degrees East of the Greenwich meridian. The northern border of Ikwuano local government area is three (3) miles (4. 8 Km) south of Umuahia, the capital of Abia State in South East part of Nigeria. The southern border is 15 miles (24 Km) from Ikot Ekpene in Akwa – Ibom State. Ikwuano also has a border with Olokoro and Ibeku communities in the north and north-west, and Bende in the east; Nkalu in south – east; Oboro – akara in the south and Ohuh – Nsulu in the south and south – west.

Ikwuano by geological description is found within the formation of Benin consisting of sediments of together with sand/shale within the Benin formation which consists of shale/sand sediments with many layerered thin clay beds[7][8].

B. Sample Collection:

The following precautionary measures were taken prior and after sample collection;the containers used for sample collection was washed properly, rinsed and dried before use. The container was also properly covered after sample collection to avoid microbial contamination of the water samples.

Eight water samples were collected from eight selected boreholes in Ikwuano on the same day(11/05/15) and the average sampling time was 9am. The locations for the sampling were Ahiaeke pipe-borne water(PB1), Amawom pipe-borne water(PB2), Umugbalu pipe-borne water(PB3), Umuariga borehole(PB4), Amaoba pipe-borne water(PB5), Isiala pipe-borne water (PB6), Umuokwo pipe-borne water (PB7) and Amandoro pipe-borne water (PB8).

C. Physicochemical Analysis:

The physicochemical characteristics determined include Chloride, Colour, , Chemical Oxygen Demand (COD), Sulphate, Dissolved Oxygen (DO), Temperature, Electrical Conductivity (EC), Total Dissolved Solid (TDS), Biochemical Oxygen Demand (BOD), Total Suspended Solid (TSS), Salinity, pH, Turbidity, Total Hardness (TH), Acidity, Alkalinity,). All methods of analysis were consistent with known standard methods [9][10][11].

***D.* Bacteriological Analysis:**

The following biological parameters were determined; Escherichia coli count, streptococcus count, total viable bacteria count and total coliform count.

The analysis of biological characteristics of the water samples was done in accordance with EPA[12].

E. Experimental Investigation of Water Quality Parameters:

Salinity : 5 drops of a phenolphthalein indicator solution was added to 50ml of sample and neutralized with 0. 1N sulphuric acid . About 1ml of potassium chromate indicator solution was also added before titrating with standard silver nitrate solution until a pinkish-yellow endpoint appears.

Amount of Chloride was calculated as follows:

$$\text{Chloride, mg/l} = \frac{[(A-B)(N)(35.45)]}{V} \times 100$$

where

A = Silver nitrate solution, in ml for sample titration.

B = Silver nitrate solution, used for blank titration (in ml)

N = Normality of the silver nitrate solution

V = Sample volume (in ml).

Total Hardness: 25ml volume of the samples was poured into a neat 250ml conical flasks. 3ml of 3ml of ammonium chloride in concentrated ammonia buffer and 2 drops of Eriochrome Black T indicator were added to it. Titration was carried out against 0. 01M EDTA solution until a colour change from violet to blue was observed.

Calculation:

$$\text{Hardness in mg/l } CaCO_3 = \frac{\text{V}\times\text{M}\times 1000}{\text{ml of sample used}}$$

Where M =Molarity of EDTA Used V=Volume of EDTA used.

pH: The pH was carried with the aid of using the Hanna microprocessor pH meter which was standardized with a buffer solution of pH range between (4-9).

Temperature: This was carried out using a mobile thermometer. This was done by dipping the thermometer into the sample untile a stable reading is observed and recorded.

Conductivity: Conductivity meter was used in measuring electrical conductivity. This was done by dipping the probe into the container containing the samples until a stable reading was obtained and recorded.

Acidity: Acidity was determined by titration, 50mL of water sample was pipetted into a clean 250mL conical flask. Two drops of phenolphthalein indicator were then added and the solution titrated against a standard 0. 01M sodium hydroxide(NaOH) solution until a pink end-point was observed.

Calculation:

Acidity (mg/l) $\frac{(V\times M\times 100{,}000)}{ml\ of\ sample\ used}$

Where,

V = volume of NaOH used

M = molarity of NaOH used.

Alkalinity: 50mL of the sample was pipetted into a clean 250ml conical flask. Two drops of methyl red indicator were then added and the solution titrated against a standard 0. 01M Hydrochloric acid (HCl) solution to a pink end-point.

Total alkalinity (mg/l) =$\frac{(V\times M\times 100{,}000)}{ml\ of\ sample\ used}$

Where,

V = volume of acid used.

M = Molarity of acid used.

Turbidity: Standardized Hanna H198703 Turbidimeter was used for the measurement. Water samples were poured into the measuring bottle and the surface wiped with silicon oil. The bottle was inserted into the turbidimeter laterall and the reading obtained.

Total solids (TS) : The determination of total solids follows Gravimetry. 10ml of water sample was measured and poured into an evaporating dish which was weighed before. The evaporating dish was later dried at a temperature of 103 to 105 C for two and half hours. The dish was transferred into a desiccators and allowed to cool room temperature and weighed. The total solid was represented by the increase in the weight of the evaporating dish.

Total solids (mg/l) = $\frac{[(W2-W1)mg\times 1000]}{ml\ of\ sample\ used}$

Where,

W_1 = initial weight of evaporating dish.

W_2 = Final weight of the dish (evaporating dish + residue)

Total dissolved solids(TDS):A given portion of water was filtered out and 10ml of the filtrate measured and poured into a pre-weighed evaporating dish. Going by the procedure for the determination of total solids as discussed above, the total dissolved solids content of the water was calculated. Total dissolved solids (mg/l) =. $\frac{[(W2-W1)mg\times 1000]}{ml\ of\ filtrate\ used}$

Where,

W_1 = initial weight of evaporating dish.

W_2 = Final weight of the dish (evaporating dish + residue).

$Total\ suspended\ solids$ = Total solid − Total dissolved solid

Dissolved oxygen:Winkler's method was used in the determination of dissolved oxygen. Thus, an excess of hydroxide (OH) ions , Manganese (II) salt and iodide (I-) were added to the samples. White precipitate of Mn $(OH)_2$ was formed which became oxidized by the dissolved oxygen in the water sample into a brown Manganese precipitate

Calculation:

DO (mg/L) = $\frac{(1600\times M\times N)}{\left(\frac{V}{V^2}\right)}$

Where,

M = Molarity of thiosulpahte used.

V = volume of thiosulphate used for titration

V_1 =Volume of bottle with stopper

V_2 = Volume of aliquot taken for titration.

Biochemical Oxygen Demand (BOD): In this experiment, an airtight bottle of a specified size was filled with water sample to an overflowing level and incubated at a specified temperature for 5days. Measurement of dissolved oxygen (DO) was done initially and after incubation and the BOD computed from the difference between initial and final (DO).

Chemical Oxygen Demand (COD): 250ml volume of water sample was heated to 27°C and transferred to a conical flask. 10ml of $KMnO_4$ 0. 0125M was added followed by addition of 10ml of 20% $\frac{V}{VH2SO4}$. The solution was mixed gently and incubated at 27°C for 4 hours. Examination of the mixture was done at intervals, when the pink colour of permanganate disappears, 10ml of KMnO4 was added. 1ml KI solution was added after 4 hours, and titrated with 0. 0125M $Na_2S_2O_3$ with starch as an indicator. The titration continued until the blue colour disappeared.

Calculation: COD (mg/l) = $\frac{[(\text{ml of blank} - \text{ml required of sample}) \times 1000]}{A \times volum\ of\ sample\ used}$

Where,

A = Total Volume of $KMnO_4$ 0. 0125M added to samples.

Total Coliform count (TCC): Presumptive coliform test was carried out using MacConckey broth . The first set of three tube was sterile 10ml double strength broth and the second and third set had 10ml single strength broth.

Total Viable Bacteria Count (TVB): Preparation of nutrient Agar was done in accordance with the manufacturer's instruction and allowed to cool to 45^0C. Twenty milliliters of the culture medium was poured into the Petri dish and properly mixed with the sample. It was done in triplicates.

Escherichia Coli Count (ECC)

All glassware used for this study was sterilized in a hot box oven at 160^oC for one hour.

Nine milliliters of sterile water was transferred into 5 sterile tubes labeled 10^{-1} to 10^{-5}. One milliliter of the sample was transferred into the first test tube (10^{-1}) with a sterile pipette and mixed.

Streptococcus (STC): Streptococcus presence is the most reliable indicators of bacterial contamination of surface and groundwater waters in different countries.

The Pour Plate Technique was used and the culture medium was Nutrient Agar.

III. RESULTS AND DISCUSSION

A. Physicochemical Properties of Water Samples:

The results of physicochemical analysis of water samples got from selected locations in Ikwuano local government area are presented in Table 1. According to Table 1, all the parameters measured were within the standards of Nigerian standard for drinking water quality(NSDWQ) and World health organization(WHO) . The present study shows that chloride values range between 12. 28-29. 89 mg/l for the eight water samples studied as shown in Table 1. This falls within the standards of WHO and NSDWQ. The low value of chloride content may be due to natural purification of water by the soil [13]. Chloride is the most prevalent anion found in water. Enormous quantities of chloride are being excreted by man and animal on a daily basis. It is therefore an indicator of sewage contamination. Excess chloride in drinking water makes it unpleasant for drinking.

The COD values range from 2. 05 to 3. 28mg/l. These values fall within WHO and NSDWQ permissible limit. The low values of COD levels signify the low amount of oxidizable organic material present in water sample.

The biochemical oxygen demand (BOD) values ranged from 1. 09 to 1. 64 mg/l and Dissolved Oxygen (DO) from 3. 09 to 6. 09 mg/l . Dissolved oxygen level is maximum owing to the fact that the COD (Chemical oxygen demand) level is low. Hence, high COD brings about low dissolved oxygen; both parameters are generally within WHO/NSBWQ permissible limit respectively.

Sulphate ions values range from 0. 43mg/l to 3. 43mg/l which are within the standards for WHO and NSDWQ. The result of pH is within the same range of values obtained by Ugwu et al. , [14].

The low range of sulphate ions may be due to the fact that the borehole was not located close to waste dump site. A temperature range of 30. 40 to 30. 65°C was observed in the samples. Cold water is widely more palatable for drinking purposes owing to the fact that high temperature of water brings about microbial growth which in turn leads to odour, taste and colour together with increased corrosion problem[15] . The pH values obtained range from 5. 31 to 8. 33. The following water samples were acidic;PB1, PB5, PB6 and PB7 with pH 5. 79, 5. 31, 5. 48 and 5. 62 respectively while water samples from PB2, PB3, PB4 and PB8 are alkaline with pH of 8. 29, 8. 33. 7. 39 and 7. 33 respectively. The Acidity of some of the water samples may be caused by acid rain and also by the type of minerals found in the area.

Turbidity values ranged from 0. 11 to 0. 97 NTU, which are within the limit 5NTU (Table 1). The values of turbidity may be low owing to the fact that the boreholes are located in a sanitary environment. The values of electrical conductivity range from 23. 40 – 48. 65(us/cm). This falls within the standards. The results are in similar to the values got by Etim and Asuquo[16]. The values for the salinity, total dissolved solid, total suspended solids, total hardness, acidity, alkalinity and colour were within the permissible limits.

TABLE 1: RESULTS OF PHYSIOCHEMICAL PARAMETERS OF WATER SAMPLES

Parameters	***PB1***	***PB2***	***PB3***	***PB4***	***PB5***	***PB6***	***PB7***	***PB8***	**NSDWQ/WHO standards**
Chloride (mg/l)	29. 89	12. 28	18. 11	18. 86	20. 18	11. 75	13. 28	17. 06	250mg/l
COD	2. 34	2. 57	2. 71	2. 46	3. 28	3. 25	2. 23	2. 05	7. 5mg/l
BOD	1. 25	1. 33	1. 41	1. 24	1. 64	1. 59	1. 48	1. 09	6-9mg/l
Sulphate (mg/l)	3. 43	0. 43	1. 84	1. 49	3. 59	2. 28	2. 56	2. 44	250mg/l
Dissolved oxygen	4. 13	3. 09	4. 17	3. 18	5. 91	6. 09	5. 95	3. 74	7. 5mg/l
Temperature	30. 50	30. 65	30. 50	30. 60	30. 55	30. 45	30. 45	30. 40	$30 – 32^0$C
Conductivity (us/cm)	23. 40	48. 65	34. 75	34. 00	33. 95	30. 90	34. 50	25. 30	90. 00 us/cm
Total Dissolved Solid (mg/l)	0. 61	0. 64	0. 73	0. 73	1. 24	0. 93	0. 97	1. 01	259 – 500(mg/l)
Total Suspended Solid	0. 12	0. 13	0. 24	0. 24	0. 12	0. 22	0. 19	0. 17	30mg/l
Salinity (mg/l)	11. 73	19. 21	21. 31	22. 15	20. 14	17. 24	19. 05	17. 35	200mg/l
pH	5. 79	8. 29	8. 33	7. 39	5. 31	5. 48	5. 62	7. 33	6. 50 – 8. 50
Turbidity (NTU)	0. 715	0. 8	0. 46	0. 97	0. 43	0. 52	0. 57	0. 11	5. 00 NTU
Total Hardness	3. 96	5. 40	4. 70	3. 55	9. 10	5. 65	9. 70	2. 30	30. 00 100mg/l
Acidity	1. 13	2. 32	2. 37	1. 42	1. 34	1. 14	1. 13	1. 43	4. 5-8. 2
Alkalinity	6. 84	9. 79	9. 55	8. 19	5. 83	6. 42	6. 77	8. 26	100mg/l
Colour (TCU)	5. 00	5. 00	5. 00	5. 00	5. 00	5. 00	5. 00	5. 00	15 TCU

A. Biological Properties of Pipe-borne water samples

The biological parameters studied include Total Viable Bacteria Count (TVB), Total Coliform Count (TCC), Escherichia Coli Count (ECC) and Streptococcus (STC) . These bacteria were not detected in all the water samples studied as their levels were 0 cfu/100 mL and were non-significant in the samples due to the appearance of the physical environment which was clear from the main origin of pollution like; chemical dump from factory, discharge of untreated raw sewage from households and factories and the rising use of synthetic organic substance from agricultural pollution of contamination all were absent in the samples location.

Table 2: RESULTS OF BIOLOGICAL PARAMETERS

SAMPLES	**TVB**	**TCC**	**ECC**	**STC**
BH1	ND	ND	ND	ND
BH2	ND	ND	ND	ND
BH3	ND	ND	ND	ND
BH4	ND	ND	ND	ND
BH5	ND	ND	ND	ND
BH6	ND	ND	ND	ND
BH7	ND	ND	ND	ND
BH8	ND	ND	ND	ND
NSDWQ/WHO Standards	0	0	0	0

IV. CONCLUSION

The qualitative study of eight water samples in Ikwuano local government area were found to be within the NSDWQ/WHO standards for drinking water. This implies that the potable water in Ikwuano axis is not polluted with organic and inorganic substances and therefore fit for drinking at its present state. However, pH adjustment of the following water samples is recommended;PB1, PB5, PB6 and PB7 so as to make it alkaline.

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