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RESEARCH ARTICLE

POTABILITY AND QUALITY ANALYSIS OF SELECTED BOREHOLE WATER IN PORT HARCOURT METROPOLIS RIVERS STATE, NIGERIA

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ABSTRACT

The study examined the potability and quality analysis of borehole water in selected communities in Port Harcourt Metropolis. Experimental and cross-sectional research method was adopted. Primary and secondary data sources were used. Random sample technique was used to select (9) nine communities for water sampling. Nine boreholes were purposively sampled in the nine communities for laboratory analysis on the physical, chemical, microbial parameters and heavy metals were tested. Borehole water samples were analyzed for Physico-chemical parameters: pH, temperature, chloride, acidity, Alkalinity, total dissolved solids (TDS), total suspended solids (TSS) and total hydrocarbon content. Microbial parameters were E coli and Salmonella while iron and chromium were tested as heavy metals. Descriptive and inferential statistics as well as weighted Likert scale was used. Results showed mean values of physical parameters; pH (4.8), temperature (27.40C), chloride (10.0. mg/l), acidity (3.6 mg/l), Alkalinity (2.8 mg/l), THC (233.3mg/l), (TDS)(3.0 ppm), (TSS) (2.4 mg/l) Turbidity (0.4 mg/l) . Microbial analysis showed that (8) borehole waters were within permissible limit of NESREA and WHO, except for borehole (BH08) which had insignificant presence of Escherichia coli. Heavy metal analysis showed chromium (Cr) was not detected while iron (Fe) was found in about (7) boreholes but does not have any health implication. On the socio economic angle, about (75%) does not have knowledge about national or international standard water quality criteria. Also the likert scale measurement showed that the most frequent diseases /ailments residents were exposed to was linked to the of consumption of untreated borehole water in the study area, table 12 affirms the assertion. The study recommend amongst others that residents using borehole water should be educated on the possible risks and danger especially when such borehole water was not subjected to national and international water quality treatment standard.

INTRODUCTION

Water is life for people who inhabit the planet earth. It is an essential liquid that boost the sustenance and well-being of all mankind. It is a vital input to economic development, and basic requirement for the healthy functioning of the world's ecosystem (WHO/UNICEF, 2010). Water is also critical to other facets of sustainable development and for environmental protection and food security, etc. Thus increasing access to domestic water supply and sanitation services and improving water resources management are serious efforts to help fight poverty and hunger, safeguard human health, reduce child mortality, manage and protect environmental and natural resources, United Nations (UN 2004). Water is perhaps the most fundamental of all environmental resources and the key for sustainability of the world's ecosystems. Ecosystem, health, in turn, is critical to the quantity and quality of fresh water supply. Without sound water resources development and management human activities can upset the delicate balance between water resources and environmental sustainability (APHA, 2000).

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It is a major natural resource on which living organisms especially humans depend on for their very existence. However access to safe drinking water has been a major human developmental challenge especially in the developing countries. The United Nations has tagged 2005 to 2015 as the International Decade for Action: Water for Life, which aims to implement internationally agreed water related goals set by the United Nations Millennium Declaration that priority must be given to water scarcity, facilitating access to safe drinking water, sanitation and reducing disaster risk (UN, 2004). The overall objective of the UN's safe water availability is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water - related diseases. Although a few African countries have high annual averages of water per person, many already or soon will face water stress (2,000 m^3 or less per person annually) or scarcity conditions (1,000 m^3 or less per person annually) where the population cannot be sustained with available water resources. Given current population projections, over 400 million people are expected to be living in at least 17 water-scarce African countries by the year 2025. Their lack of water will severely constrain food production, environment/ecosystem protection, and economic development, (World Bank, 2010).

Access to safe water is measured in terms of the proportion of the population who have an adequate quantity of water from an improved source such as a household connection, public stand pipe, borehole, protected well, or spring or rain water collection. Reasonable access is the availability of at least twenty litres of water per person per day from a source of one kilometre of dwelling (World Bank, 2010). The World Bank in its Report on nation's development (2010) projected water scarcity in developing countries to 2025. According to the projected water scarcity record, Nigeria belonged to the Economic Water Scarcity Group. Countries with economic water scarcity will have to increase their potable primary water supply by more than 25% through additional storage, management, and periodic evaluation and conveyance facilities. At least 1.1 billion people lack access to adequate safe drinking water and basic sanitation; a silent humanitarian crisis that each day takes thousands of lives, robs the poor of their health, thwarts their efforts towards gender equality, and hinders economic development particularly in Africa and Asia (ADB,2002).

Every year millions of people most of them children, die from diseases associated with inadequate potable water supply, sanitation and hygiene; diseases transmitted through water are the second leading cause of death among children worldwide after respiratory disease (UN, 2014). Water for enhanced sustainability does not merely mean the existence of large quantity of water, but in forms and safe quality for human consumption, and prevention of the attendant ill health and socio-economic adverse effects (USEPA, 1990). Water may be available naturally in large quantity globally. However until water is conserved, made safe for drinking, transported and delivered for easy accessibility, water cannot be said to be easily available and of quality suitable for human utilization and achieving sustainable development (UNESCO, 2002). Natural phenomena such as salt water intrusion into fresh water aquifers, weathering and leaching of chemical compounds into aquifers, and anthropogenic activities such as improper waste management, abstraction methods, improper poor storage and delivery of water to homes, can alter the quality and availability of ground water for usage.

Consequently, the study will address the following questions:

- What are the major sources of public water supply and in Port- Harcourt Metropolis?
- What proportion of Port Harcourt city residents relies on boreholes for drinking and other domestic uses?
- What proportion of the population has access to adequate potable quality water supply?
- Does the quality of borehole water in Port-Harcourt city meet portability standards of WHO and NESREA?
- What is the awareness level (if any) of the citizenry on safe drinking water and other uses for achieving sustainable development?

Aim and Objectives of the Study: The aim of this study was to determine the potability and quality of selected borehole water supply to Port Harcourt residents as compared to NESREA and World Bank Standards.

The following are the research objectives to

- Determine the major source(s) of water supply in Port Harcourt Metropolis.
- Determine the percentage of the population that has access to quality and potable drinking water and for other uses.
- Collect samples of water (boreholes) in Port - Harcourt Metropolis for laboratory analysis and confirmation of portability status.
- Determine through questionnaire administration the awareness level of the populace on safe drinking water usage standards for enhanced health and achieving Sustainable Development.

Hypothesis Statement

Ho: There is no statistically significant difference between the Borehole water quality and WHO and NESREA standard for drinking water in the study area.

MATERIALS AND METHODS

Water Sample Collection: Representative samples of water (boreholes) from residential areas in Port Harcourt Metropolis was collected and analysed. Water from each located private borehole was sampled with the aid of Global Positioning System (GPS) to ascertain point of collection. At each borehole location, water sample for physico chemical parameters was collected in one litre plastic containers that have been sterilized with (10% $HN0_3$). Water samples for hydrocarbon content were collected in brown glass bottles including samples for heavy metals. Water samples for microbial analysis were collected in separate plastic containers. Prior to collection of the water samples, the containers was properly labelled with indelible ink to reflect collection point in Port Harcourt Metropolis, date and time of sample collection. Also the containers were rinsed first with the water to be sampled.

In-Situ Measurement and Samples Preservation: The borehole water temperature, electrical conductivity, pH and Total Dissolved Solids (TDS) were determined *in-situ* using the YSI multi probe system meter (model 5220). The water samples for other physico chemical and heavy metals analyses was acidified to pH of less than 2 to prevent photo oxidation and preserve the integrity of the samples and preserved in coolers in the ice cooler for onward transportation to the laboratory and immediate analysis (within 24 hours).

Sources of Data Collection: Primary and Secondary data were used for the study. The primary data was the collection of the water bore hole samples from the study area. Standard methods and procedures were used for the analysis of the water samples collected. The water samples were tested for physico-chemical properties, hydrocarbons, heavy metals and microbiological contents. The secondary data acquisitions were derived from journals, textbooks and the internet resources.

Sampling Frame and Sampling Techniques: About 35 selected communities represented the 30% of the communities in Port Harcourt Metropolis. This method was adopted as being representative of the study population. In the selected 35 communities, a random sample technique was adopted to select communities for bore water sample collection. At the end of the exercise about nine (9) communities were selected for water borehole samples. The areas where sample were collected were further identified in the map using the GPS to locate sampling points. The same sample point areas were purposively selected for questionnaire administration.

Instrumentation /Data collection: Information on the awareness of the residents on availability of quality potable water and its health implications for achieving sustainable development was obtained by the administration of a well-structured questionnaire. Furthermore, about twenty persons (20) each from sample areas was purposively selected for questionnaire administration in the nine communities to elicit their responses.

Table 1. List of Communities selected for sample collection in the study area

Sample Station	Communities	Questionnaire Allocation
BH 01	Eliozu	20
BH 02	Rumuolumeni	20
BH 03	Diobu(Emenike Street)	20
BH 04	P.H Township(Radio Rivers)	20
BH 05	Woji(YKC)	20
BH 06	Elelenwo(St.Marks)	20
BH 07	Rumukwurushi(Holy trinity)	20
BH08	Rukpoku	20
BH09	UniPort	20

Data Analysis: The laboratory analysis was compared to health, environmental safe guard and national and international standards. These analytical results were presented in tables, and chart and graphical formats. The data collected was analysed by the use of mean and rank order Statistics. The Likert scale method by (Allen and Seaman, 2007) was weighted in the design of the questionnaires as follows:

Strongly Agree (SA) -1 point
Agree (A) - 2 points
Undecided (UD) -3 points
Disagree (D) - 4 points
Strongly Disagree - 5 point

Weighted Means

This was gotten by adding all the points and dividing by the number of options. For example $\frac{5+4+3+2+1}{5} = 3.0$. This implies that item mean lower than 3.0 will be accepted, while those higher than 3.0 will be rejected. The comparison between means were tested at 95% confidence interval (p=0.05) using z test. The map showing the various samples collection points and the geographic coordinates for reference purposes is shown in figure 1.

RESULTS AND DISCUSSION

Physico-Chemical Analyses

The physico-chemical properties of borehole in sampled communities are displayed on Table 2. The analysis shows that temperature ranged between 27 ^{0}C and 28 ^{0}C. The pH values ranged from 4.00 - 5.30. The analysis means that pH concentration was slightly acidic in the study area. The concentration of chloride (mg/l) ranged from 6.00 (mg/l) to 15.20 (mg/l) with mean concentration of (10.00mg/l). The level of acidity (mg/l) showed range of values between 2.40 (mg/l) and 5.20 (mg/l) and a mean concentration value of 3.6 (mg/l). High acid in water can lead to elevated toxic metals in water which gives water a sour taste. The water Alkalinity recorded range values between 1.60 (mg/l) and 4.00 (mg/l) with mean value of 2.8 (mg/l) in the study area.

Total dissolved solids (TDS) showed range values between 2.25 ppm and 4.40 ppm with mean value of (3.0 ppm). Total suspended solids (TSS), the range of mean values was between (1.96 mg/l) and (3.11 mg/l), while the mean value from all sampling stations was (2.4 mg/l). The total hydrocarbon concentration ranged from (150 mg/l) to (300mg/l) with a mean value of (233mg/l). THC concentration is an indication of unsuitable items being flushed down into the water and turbidity showed 0.04NTU in the whole study area.

Comparison of Physico-chemical Parameters with NESREA and WHO Standards: Table 3 shows the comparison of the values obtained for each physical and chemical parameter of borehole water with the NESREA and WHO standards maximum acceptable limit. The results showed that the values for each physical and chemical parameter for each sampled Borehole were all lower when compared with the NESREA and WHO standards for groundwater quality for drinking water. In other words NESREA standards and WHO permissible limits had higher values than the obtained values of the water boreholes physical and chemical parameters understudied in the sampled borehole sites in the study area. However, for TSS (mg/l) and TDS (mg/l) the overall mean value of TSS of 2.4 mg/l was lower than permissible standards. The TDS (mg/l) showed mean of 3.0 (mg/l) concentrations in all sampling stations. Table 5 presents the Metal chromium (Cr) and iron (Fe). The former was not detected, while the later was found in seven sample points. Iron (Fe) in water will cause reddish –brown staining of laundry, dishes, utensils and even glassware. It does not health hazard, but its presence in water may cause taste, staining and accumulation problems. Iron in water could result from contact with rocks and minerals or other environmental factors. The need to test for iron in water is not as critical as it is for other types of contaminants that can cause problem.

Table 6 shows the total coliform bacteria are known as "indicator organisms" meaning that their presence provides indication that other disease causing organisms may also be present in the water body. The total bacterial count in the borehole water sampled were very insignificant when compared to WHO and NESREA standards (<10cfu/100 ml). It can be noted that except for borehole (BH08), all the water samples from the other boreholes were within the permissible standards of NESREA and WHO drinking water standards. Possible cause of high coliform count could be the proximity of certain boreholes to soak away pit and poor sanitary completion of boreholes may have led to contamination of groundwater. Total coliforms can also originate from environmental sources such as soils or from biofilms.

Hypothesis Testing

H_0: There is no statistical significant difference between the borehole water quality and WHO standard for drinking water in the study area.

H_1: There is a statistical significant difference between the borehole water quality and NESREA and WHO standards for drinking water in the study area. Table 7 shows the results computed for the stated hypothesis, using the One Sample T-test. The distribution showed that the level of significance of 0.798 and 0.992 for temperature (^{0}C) and pH were higher than the significant level of 0.05, which means the null hypothesis (H_o) was accepted for these parameters.

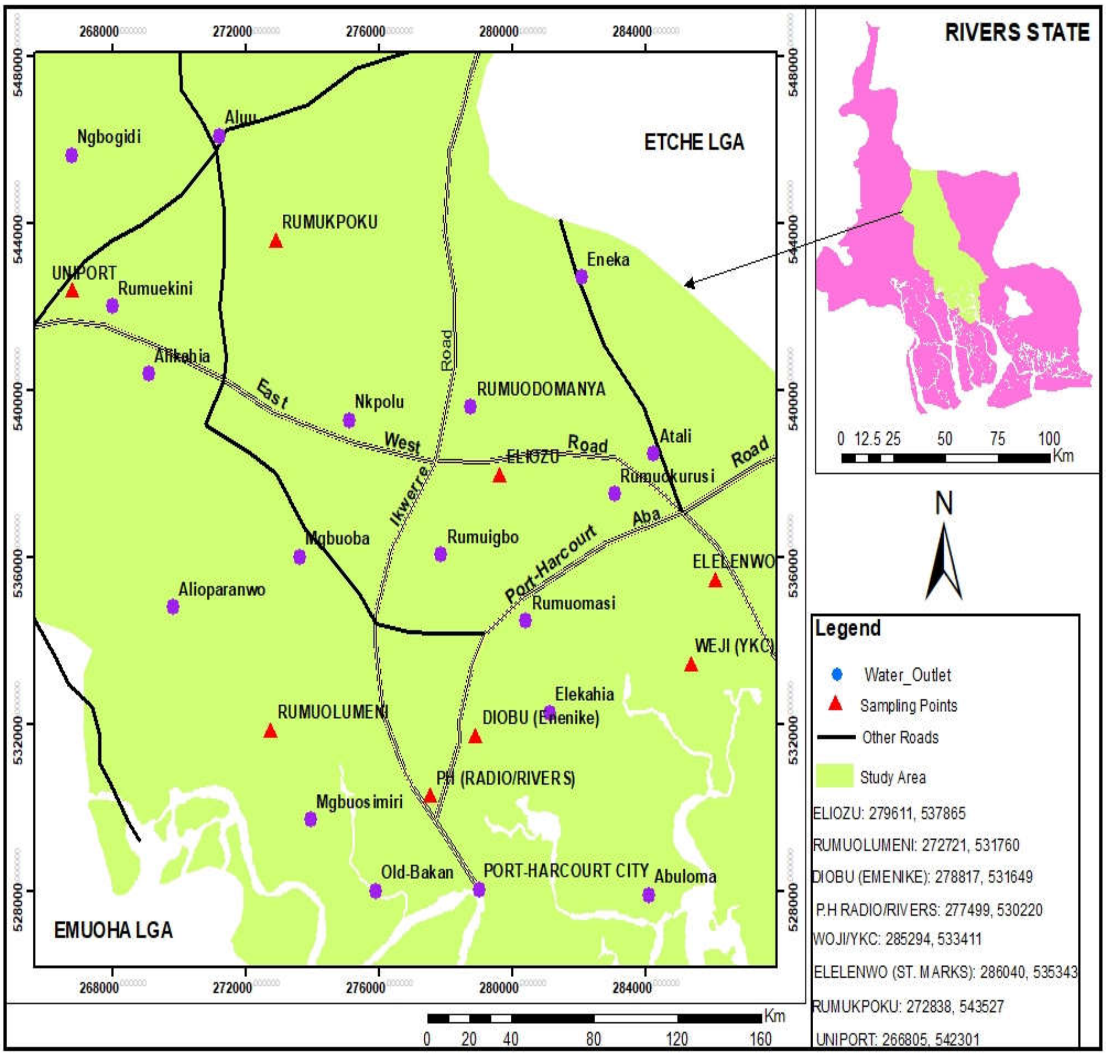

Figure 1. Port Harcourt Metropolis Showing Sample Points with Coordinates (GEM Cartography Laboratory, 2019)

Table 3. Physico-Chemical Parameters of Water Borehole Quality

Stations	Temp. (^{0}C)	pH	Cl (mg/l)	Acidity (mg/l)	Conductivity	Alkalinity (mg/l)	$S0_4^{2}$-	THC (mg/l)	TDS (ppm)	TSS (mg/l)	Turbidity (NTU)
BH 01	28	5.30	11.20	5.20	06.4	4.00	2.07	300.00	3.20	3.00	0.04
BH 02	28	5.00	11.20	4.80	06.2	4.00	1.38	300.00	3.10	2.80	0.04
BH 03	27	5.10	6.00	2.40	04.7	3.20	1.38	150.00	2.35	2.10	0.04
BH 04	28	4.50	15.20	3.20	08.8	2.00	2.5	150.00	4.40	3.11	0.04
BH05	27	4.00	12.40	4.40	07.9	2.80	5.5	300.00	3.95	2.81	0.04
BH06	27	5.00	7.20	3.60	05.4	2.40	4.1	150.00	2.70	2.10	0.04
BH07	27	4.20	8.80	3.20	04.5	2.00	2.8	300.00	2.25	2.00	0.04
BH08	28	5.50	10.00	2.40	05.2	1.60	2.1	150.00	2.60	1.96	0.4
BH09	27	4.30	8.00	3.20	04.8	2.80	3.5	300.00	2.46	2.15	0.4
Mean	27.4	4.8	10.0	3.6	5.9	2.8	2.8	233.3	3.00	2.4	0.4

Table 4. Comparison of Physico-chemical properties of water borehole with NESREA and WHO standards

Stations	Temp. (^{0}C)	pH	Cl (mg/l)	Acidity (mg/l)	Conductivity	Alkalinity (mg/l)	$S0_4^{2}$-	THC (mg/l)	TDS (ppm)	TSS (mg/l)	Turbidity (NTU)
Bh 01	28	5.30	11.20	5.20	06.4	4.00	2.07	300.00	3.20	3.00	0.04
Bh 02	28	5.00	11.20	4.80	06.2	4.00	1.38	300.00	3.10	2.80	0.04
Bh 03	27	5.10	6.00	2.40	04.7	3.20	1.38	150.00	2.35	2.10	0.04
Bh 04	28	4.50	15.20	3.20	08.8	2.00	2.5	150.00	4.40	3.11	0.04
Bh05	27	4.00	12.40	4.40	07.9	2.80	5.5	300.00	3.95	2.81	0.04
Bh06	27	5.00	7.20	3.60	05.4	2.40	4.1	150.00	2.70	2.10	0.04
Bh07	27	4.20	8.80	3.20	04.5	2.00	2.8	300.00	2.25	2.00	0.04
Bh08	28	5.50	10.00	2.40	05.2	1.60	2.1	150.00	2.60	1.96	0.4
Bh09	27	4.30	8.00	3.20	04.8	2.80	3.5	300.00	2.46	2.15	0.4
Mean	27.4	4.8	10.0	3.6	5.9	2.8	2.8	233.3	3.00	2.4	0.4
**Who	Ambient	6.5-8.5	<250	300	NS	300	500	500	<500	<1000	25
*Nesrea	Ambient	6.5	250	300	NS	300	500	500	500	1000	25

Table 5. Analysis of Metals in boreholes water in the study area

S/N	Stations	Cr	Fe (mg/l)
BH01	Eliozu	ND	0.283
BH02	Rumuolumeni	ND	0.044
BH03	Diobu	ND	ND
BH04	P/H Township	ND	0.080
BH05	Woji(YKC)	ND	0.214
BH06	Elelenwo	ND	0.039
BH07	Rumukwurushi	ND	ND
BH08	Rukpoku	ND	0.063
BH09	UniPort	ND	0.029
**WHO		0.002	0.5
*NESREA		0.002	0.5

Table 6. Microbiological analysis of water boreholes in the study area

S/N	Stations	Salmonella	Escherichia coli
BH01	Eliozu	ND	ND
BH02	Rumuolumeni	ND	ND
BH03	Diobu	ND	ND
BH04	P/H Township	ND	ND
BH05	Woji(YKC)	ND	ND
BH06	Elelenwo	ND	ND
BH 07	Rumukwurushi	ND	ND
BH08	Rukpoku	ND	0.06
BH 09	UniPort	ND	ND
**WHO		<_10cfu/100ml	<_10cfu/100ml
*NESREA		<_10cfu/100ml	<_10cfu/100ml

Source: * NESREA; **WHO, 2010. BH- Borehole

Table 7. One sample T-test computed for Hypothesis

Physico-Chemical/ Properties	One sample T-test						Remark
	T test	Df (n-1)	Significant At 0.05 alpha level	Mean Difference	95% Confidence Interval of the Difference		
					Lower	Upper	
Temp	-.264	8	0.798	-.14222	-1.3825	1.0981	NS
pH	-.010	8	0.992	-.00222	-.4978	.4933	NS
Chloride	-4.091	8	0.003	-187.24333	-292.7903	-81.6964	S
Acidity	-11.992	8	0.000	-239.37667	-285.4061	-193.3473	S
Hardness	-66.617	8	0.000	-279.14000	-288.8027	-269.4773	S
TDS	-77.462	8	0.000	-445.90000	-459.1742	-432.6258	S
TSS	-2.787	8	0.024	-42.14333	-77.0085	-7.2782	S
THC	6.735	8	0.000	524.11333	344.6549	703.5718	S

* S – Significant; NS – Not Significant

Table 8. Source of water supply in the study area

S/N	Sources of water	No. of Respondent	Percentage
1.	Private individual bore holes supply	115	63.8
2.	Rivers State Water Board(Govt. provision)	-	-
3.	Water vendors	55	30.5
4.	Hand dug wells	10	5.5
	Total	180	100

Table 9. Distance/Access to water supply within the neigh bourhood in the study area

S/N	Distance (meters)	No. of Respondent	Percentage
1.	50(m)	150	83.3
2.	100(m)	30	16.6
3.	500(m)	-	-
	Total	180	100

Table10. Awareness of National or International Standards on Water Quality Criteria

S/N	Response	No. of respondent	Percentage
1.	No	135	75
2.	Yes	45	25
	Total	180	100

Table 11. Residents perception of some environmental or societal habits that makes water unsafe in the study area

s/n	Suggested habits	SA	A	UD	D	SD	X	Remark
1	Construction of Soak away pits in same place with boreholes	105	45	15	15	-	2.0	Accept
2	Lack of cleaning of wells	25	75	25	50	-	2.0	Accept
3	Pollution of nearby surface water with wastes/chemicals	15	40	80	45	-	2.0	Accept
4	Boreholes not drilled by experts (shallow wells)	25	100	-	45	10	2.4	Accept
5	Wells are exposed to runoff , infiltrations and leachate	10	10	30	-	100	2.4	Accept

Table 12. Diseases /ailments residents were exposed to as a result of consumption of untreated borehole water in the study area

s/n	Water Related illness	SA	A	UD	D	SD	X	Remark
1	Infectious hepatitis	110	40	20	10	-	2.0	Accept
2	Dysentery	-	50	45	45	40	2.8	Accept
3	Typhoid	30	50	50	-	50	2.2	Accept
4	Gastroenteritis	25	100	-	40	15	2.4	Accept
5	Cholera	20	80	40	-	40	2.2	Accept

Thus, there is no statistical significant difference between the borehole water quality as indicated by Temperature and pH and WHO and NESREA standards. However, on the other hand, the level of significance of 0.003, 0.000, 0.000, 0.000, 0.024, 0.01, and 0.000 were lower than the significant level of 0.05 (95%) probability levels for the other physico-chemical parameters in the water. This means that all were significant at degrees of freedom of 9. Thus, the null hypothesis (H_0) was rejected for all these (Chloride, Acidity, Alkalinity, TDS, TSS and THC) tested physico-chemical properties in groundwater. The alternative hypothesis (H_1) was accepted, which means that there is a statistical significant difference between the borehole water quality as indicated by Chloride, Acidity, Alkalinity, TDS, TSS and THC and WHO and NESREA standard for drinking water in the study area.

Socio –economic Characteristics of Respondents in the Study Area: Table 8 indicates that about 115 respondents (63.8%) get their water supply from private boreholes. Also, about 55 respondents (30.5%) get their own water supply from water vendors, while about 10 respondents say their supply are from hand dug wells. No respondent attested to public or government supply of water in the study area. This negates the United Nations Millennium Development Goals initiative which Target 10 says: Have, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation, this is far from being realised. Table 9 shows the distances covered by residents to get water supply. The table reveals that about 150 respondents (83.3%) say their water supply was gotten about (50 meters) , while about 30 respondents (16.6%) get their water supply in about (100mters) distance, this is patronised by water vendors. Table 10 indicates that about 135 respondents (75%) does not have knowledge about national /international standard water quality criteria, while about 45 respondents (25%) are aware. This indicates that most of the residents do not treat their water even the least treatment of iron removal was not known. This portends danger to the health and wellbeing of the residents of the study area. Table 11 showed the residents perception of some environmental and societal habits that makes water unsafe for drinking. From item 1, about 105(58.3%) respondents strongly agree, 45(25%) respondents agrees, 15(8.3%) were undecided while 15(8.3%) disagree that construction of soak away pits close to boreholes. Item 2, showed that 25 (13.8%) of residents strongly agree that one of the societal habit was lack of cleaning of the wells, 75(41.6%) agree, 15(8.3%) undecided, 50(27.7%) disagree. Item 3, showed 15(8.3%) strongly agree that it was Pollution of nearby surface water with wastes/chemicals, 40(22.2%) agree, 80(44.4%) were undecided and 45(25%) strongly disagree. Item4, showed 25(13.8%) strongly agree that the habit was Boreholes not drilled by experts (shallow wells), 100(55.5%) agree, and 45(25 %) disagree and 10 (5.5%) strongly disagree. Item5, showed 10(5.5%) strongly agree that wells are exposed to leachate, runoff and infiltrations from storm water, and10 (5.5%) agree, 30(16.6%) undecided and 100(55%) strongly disagree .From item 1-5, have their criterion mean below (3.0) therefore validates the assertions. Furthermore, table 12 elicits the type of illness residents are exposed to as a consumption of untreated borehole water supply in the study. From item 1, 110(61.1%) strong agree, 40(22.2%) agree, 20(11.1%) undecided, 10(5.5) strongly disagree that infectious hepatitis was the major ailments suffered by the residents in the study area. Item 2, 50(27.7%) agree, 45(25%) were undecided, 45(25%) disagree and 40(0.5%) strongly disagree that dysentery was the major ailments. Item 3 showed that 30(16.6%) strongly agree, 50(27.7%) agree, 50(27.7%) strongly disagree that typhoid was the major ailments. Item 4; 25(13.8%) strongly agree, 100(55.5%) agree, 40(22.2%) disagree and 15(8.3%) strongly disagree that gastroenteritis was the major ailments. Item 5; showed 20(11.1%) strongly agree, 80(44.4%) agree, 40(22.2%) were undecided and 40(22.2%) strongly disagree that cholera was the major ailments. Also from item 1-5 they all fell below the criterion mean (3.0) and were accepted.

FINDINGS AND DISCUSSION

Findings revealed slight acidic content in borehole (BH04) and (BH08) facilities and the same pH levels. Conversely, the pH of water is very important in that changes in pH values may affect the toxicity of poisons in the water (WHO 2006). The variation of pH among sampling stations may be due to the level of CO_2 content in respective water samples because pH level in water fluctuates daily because of photosynthesis and respiration in water. Temperature (^{0}C) varied among sampling stations. The ambient temperature limit for water quality was stated as a regulatory standard. Alkalinity in water indicates the sum of calcium and magnesium salt contents. The Alkalinity value ranges from (1.6 mg/l to 4.00mg/l) for soft water. Findings revealed that the total (Alkalinity) hardness of all sampled borehole had mean value that fell within groundwater hardness.

Therefore, findings revealed that low total hardness values have been reported for similar studies carried out in Owerri and Nsukka by Edema *et al*., (2001); Onweluzo and Akuagbazue (2010) both in south eastern Nigeria. The borehole water samples are all soft water since their hardness values fall within the stipulated range for soft water. The concentration of TDS (mg/l) in sampled bore hole water ranged from (2.10mg/l to 4.40mg/l). TDS in water could produce undesirable taste which also has some health effects. Therefore, the lesser the concentration of TDS (mg/l) in water samples the better the taste and water quality. TSS (mg/l) content in water was also found to fall within permissible limits. High TSS (mg/l) has effect on the concentration of silt, decayed plants remains and animal matter. THC (mg/l) in water borehole was a characteristics exploration and exploitation of crude oil which can pollute underground water resources in the study area. To this effect the underground flow and discharge properties of water in the study area need constant management strategies. Findings of the study have revealed that all the physico-chemical parameters understudied were within the standard limits recommended by WHO and NESREA in sampled borehole water in the study area. On the analysis for microbiological, it was discovered that the eight(8) borehole had their water fall within acceptable WHO and NESTREA standards, except BH08 which had a little quantity of Escherichia coli at 0.06 cfu/100ml present in the water. On the analysis for metals, Chromium (Cr) was not detected, while Iron (Fe) was found in seven borehole water out of the nine sample stations. Furthermore on the socio-economic aspect of the data analyses, resident were asked their sources of water supply. Table 8 showed that about 115 respondents (63.8%) get their water supply from private boreholes. Also, about 55 respondents (30.5%) get their own water supply from water vendors, while about 10 respondents say their supply are from hand dug wells. More so they were asked if they understood any method of water analysis. Table 10 indicates that about 135 respondents (75%) does not have knowledge about national or international standard water quality criteria, while about 45 respondents (25%) are aware. The assertion indicates that most of the residents do not treat their water even the least treatment of iron removal was not known. This portends danger to the health and wellbeing of the residents of the study area. Also, respondents were asked the most frequent diseases /ailments which residents were exposed to as a result of consumption of untreated borehole water in the study area, table 12 affirms the assertion.

Recommendation

The study conclude that due to the little trace of Escherichia Coli found in (BH08) sampling, makes the water quality unsafe for drinking. The study, also revealed that since the residents did not know any national or international standard quality measure for water treatment, it puts the entire populace at risk and danger of being frequently affected by water related diseases or ailments as attested to by this research. Thus, in order to promote quality and potability of borehole water facilities in the study area, it was recommended that: Detailed and continuous monitoring and assessment of other chemical species in the area such as total phosphorus concentrations which are indicative of pollution from human and animal. Increase the frequency of sampling and analysis needed to effectively monitor the quality of the borehole water to ascertain potability. Early detection of possible contamination can lead to faster implementation of corrective measures, preventing an imminent waterborne disease outbreak. Residents using borehole water as their source of water should be educated of the possible risks and danger especially when such borehole water is subjected to national and international water quality treatment standard. There should be aggressive public education and enlightenment which should also include possible means of treatment of water such as boiling and use of chlorination tablets so as to prevent possible adverse health effects. In addition, community participation through protection of drinking water sources from contamination could help improve the water situation in the area thereby ensuring a health environment such as discouragement of residents' construction of borehole close to soak away pits, the minimum 30 meters or more distance should be maintained. Public health worker should be more proactive in their services to the people and adequately empowered to carry out their functions.

Conclusion

The study has examined the status of the quality and potability of borehole water in some selected communities in Port Harcourt Metropolis Rivers State. The study discovered that the mean values of the sampled parameters were lower than WHO and NESREA standard for drinking water quality except for (BH08) where little insignificant quantity of Escherichia Coli was found Therefore, the study concludes that the quality of sampled boreholes in selected communities in Port Harcourt Metropolis are not potable and are unsafe for human consumption, this conclusion was based on the fact that residents claim ignorant of any means of water treatment(National and International).

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