**Assessment Of Access To Safe Drinking Water And Water Quality Of Rural Communities Of Akpabuyo Local Government Area Of Cross River State, Nigeria**

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**Abstract**: Water is the major source of pathogenic microorganisms causing several enteric diseases, and therefore lack of access to safe drinking water of acceptable quality is not acceptable globally. The aim of this study was to investigate the water supply sources and quality of the water accessible by the rural communities of Akpabuyo Local Government Area (LGA) besides the proportion of community members who have access to quality water sources. Descriptive cross-sectional and analytical study designs were adopted for this study. To obtain information on water sources and improved water sources, a cross-sectional design was used to generate data from 420 respondents who were selected and administered questionnaires, followed by bacteriological and physicho-chemical analyses of the water sources of the communities using standard procedures. Two-way analysis of variance using SPSS version 22, was performed on the data on physicho-chemical parameters to determine differences in means of the water quality of the sources of the water. Result shows that public/private borehole 200(47.6%) and surface water from stream 172(41.0%) were the main sources of drinking water. While only 84(20.0%) of respondents have access to improved water supply source, i.e., public/private borehole, most respondents 330(78.6%) prefer mostly borehole water. Total coliform and faecal coliform counts of all the surface water sources exceeded WHO and NSDWQ limits. All the physic-chemical parameters of the drinking water sources met the WHO and NSDWQ standards except pH of all the water sources that were below WHO and NSDWQ standards. There was no significant difference (p > 0.05) between the water sources of the villages. In conclusion, access to water sources and quality of water are inadequate and calls for intervention of government and water treatment in the home.

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**1. Introduction**

Sufficient and wholesome water supply is the most essential and important prerequisite for the sustenance and maintenance of healthy living. Improvement in water supply brings about the corresponding improvement in the health of the public (Park, 2015). Evidently, access to potable water is one of the important criteria for sustainable development of any country. The importance is not only in relation to potable water availability which is required to achieve good personal and domestic hygiene, but most vitally its quality which presents the major threat to man’s health and longevity. Poor quality of water has a great impact on public health by causing acute infectious diarrhoea, and has also been implicated in the spread of water-related diseases such as typhoid, cholera, dysentery, hepatitis, giardiasis, guinea worm and schistosomiasis (Peter, 2013). Water-related diseases place socio-economic burden on the population and health service systems of many countries globally and in particular, those of low income earners (WHO, 2015).

WHO/UNICEF (2014) reported that an estimated 1.1 billion people worldwide lack access to safe drinking water while 2.4 billion do not have access to good sanitation. It is also reported that water supply contributes 80% of the disease burden affecting humans, while some 2.2 million people still lose their lives each year due to poor water and sanitation-related diseases (WHO/UNICEF, 2014). According to the same report, 946 million people still practise open defecation. This has a major implication on health especially where surface water is the major source of drinking water. The global water and sanitation report reveals that drinking of contaminated water is responsible for 88% of the over 4 billion cases of

diarrhoeal diseases that occur in the world every year (WHO, 2014). It is also stated that 94% of the diarrhoeal diseases could be prevented by modifying the environment with improved access to potable water alone which is able to reduce the disease burden by between 20 to 35% in Sub-Saharan African (WHO, 2014). Exposure to unsafe drinking water, inadequate sanitation and hygiene are the leading causes of cholera and a variety of other infectious diseases especially in low income countries (Cunningham & Cunningham, 2007).

Due to the rapid population growth in Nigeria without commensurate provision of basic infrastructures and services like access to wholesome water supply and sanitation especially in rural communities, the quality of life of members of the communities is reduced. Over the years, the lack of access to wholesome water in rural communities in Nigeria has contributed significantly to high prevalence of communicable diseases and accounts for a significant percentage of morbidity and mortality in the country (Mark, 2010). Despite huge amount of money spent by successive Nigerian Governments at the federal and states levels in ensuring access to potable water, coverage in rural communities seems to be either poor or totally absent. Even in a neighboring Akwa Ibom State, access to water sources and the quality of the water are not adequate (Okon *et al.*, 2018), implying that it is a national problem. Absence of access to water and sanitation leads to open defecation which results in serious health consequences like dysentery, typhoid fever, cholera, etc. (Kalu, *et al.*, 2019). This is evident in the coastal communities of the oil rich region of Nigeria where there is no access to wholesome water, and sanitation and defecation into open water is the practice (Cookey *et al.*, 2008).

The aim of this study was to investigate the water supply sources and quality of the water accessible by the rural communities of Akpabuyo Local Government Area (LGA) besides the proportion of community members who have access to quality water sources.

**2. Materials and Methods**

**2.1 Study location**

The study location is Akpabuyo Local Government Area (LGA) of Cross River State, Nigeria which covers an area of 816 km2 (National Population Commission, 2013). It is bounded to the North by Akamkpa Local Government Area, to the East by the Republic of Cameroon, to the South by Bakassi Local Government Area and to the West by Calabar South Local Government Area and Calabar Municipality Local Government Area.

Akpabuyo Local Government Area has a projected population of 397,328 people as at 2006 National Population Census. Akpabuyo Local Government Area consists of ten (10) political wards: Atimbo East, Atimbo West, Eneyo, Idundu, Ikang Central, Ikang North, Ikang South, Ikot Edemodo, Ikot Eyo and Ikot Nakanda. Their major occupations are fishing and farming.

**2.2 Study design**

Both descriptive cross-sectional design and analytical methods were applied in this study. This involved the administration of structured questionnaires to sampled respondents, the use of observation checklist on sources of drinking water as well as collection and laboratory analysis of water samples collected from the selected communities to assess the quality of drinking water sources in the study area. The study population was made up of household heads or adult members of sampled households (both male and female) who were 18 years and above residing in the sampled households. Twelve (12) villages were initially randomly sampled from the ten wards, followed by systematic selection of 35 households from each of the villages for questionnaire administration. The minimum sample size was calculated based on the statistical formula of Lutz (1982), Bluman (2004) and Uwaezuoke *et al*. (2016) in which n = Z2(Pq)/d2 where n is minimum sample size, Z is confidence limit (1.96), P is estimated rural population with access to improved water sources (0.47) and q is 1-p (1-0.47) which is 0.53, d is the precision which is 5% (0.05).

Therefore, n =

Considering an attrition bias of 5%, i.e. 382.8/0.95, equivalent to 402 to obtain the required sample size, 35 households were selected from each of 12 villages, given a study population of 420 respondents.

**2.3 Instruments for data collection**

Primary data for this research were collected using questionnaires and observation checklist. The questionnaire was designed to generate quantitative data from the respondents. The questionnaire consisted of three parts with sixteen items. The first part was used to sample information on respondents’ socio-demographic characteristics; the second part consisted of questions on the sources of water used by respondents, while the third section sampled respondents’ accessibility to water sources and quality of drinking water.

**2.4 Water sample collection**

Water samples were collected aseptically with sterilized sampling bottles from various surface drinking water sources of selected communities, labeled and stored in cooler bags and transported to the quality control laboratory of Cross River State Water Board Limited, Calabar within 6 hours for microbiological analysis. Also, borehole water was equally collected according to standard procedures (APHA, 1998) and transported to the laboratory for microbiological analysis. Collection of samples was duplicated. Also, water samples were collected in polyethylene bottles and carried to the laboratory for physico-chemical analysis.

**2.5 Determination of the microbiological quality of water**

The analysis involved the enumeration of viable bacteria, total coliform and faecal coliform (*Escherichia coli*).

The media used include: Endo agar for total coliform count, MF-C agar base for faecal coliform count and nutrient agar for heterotrophic count. These were prepared based on manufacturer’s instruction and sterilized in the autoclave at 121oC for 15 minutes. These were poured into sterile petri dishes (120ml each) and allowed to cool before inoculation. The glass wares and the stainless steel filtration units used were also sterilized in the hot air oven at 150oC for 1 hour.

The samples were shaken to mix and 100ml filtered through the membrane filter (0.45µm pore size) and placed on the Endo agar, MF-C agar and Nutrient agar for the different counts. These plates were incubated for 24 hours at 37oC. Emerging colonies after the period of incubation were enumerated using a colony count. Counts were recorded accordingly.

**2.6 Determination of the physico-chemical properties of water**

Physico-chemical characteristics of the water samples were analysed using standard methods (APHA, 1998). The pH, temperature and turbidity were measured using a pH meter equipped with a temperature probe thermometer and turbidity meter respectively.

Chemical parameters such as iron, zinc, and manganese were analysed using methods described by APHA (1998) using the atomic absorption spectrometer (AAS). Digestion was done for all the water samples meant for metal analyses. In this case, fifteen millimeters (15ml) of concentrated HNO3 was again added to the 15ml of the mixture obtained. The mixture was then diluted to 50ml with distilled water. This was heated slowly to obtain a gentle refluxing action.

Further heating continued until digestion was complete (a light colored solution). The sample was transferred to a 50ml volumetric flask and diluted to the mark, then allowed to cool for about 30 minutes. The level of the individual metals was then determined using an Atomic Absorption Spectrometer.

**2.7 Method of data analysis**

Data collected from this study was coded, analysed, presented in tables, and expressed in percentages, proportions, means, charts and graphs. Data entry and analysis was done using Statistical Package for Social Sciences (SPSS) version 22 (SPSS for Windows, Armonk, NY: IBM Corp).

**2.8 Ethical consideration**

A letter of introduction was obtained from the Department of Public Health, University of Calabar, Calabar, which served as a permit for entry into the community. A verbal consent was obtained from the Akpabuyo Traditional Council, granting permission to carry out analysis of drinking water sources in their communities. Verbal consent was also duly sought and obtained from respondents who participated in the study. The objectives, benefits and significance of the study were explained to the respondents and participation was strictly voluntary. The participants were also assured of confidentiality of information provided.

**3. Results**

**3.1 Demographic characteristics of respondents**

The results obtained in this study are presented in Table 1 which indicate that 150(35.7%) of respondents were aged between 30 and 39 years, 206(49.0%) were males, 214(51.0%) were females, 173(41.2%) had secondary school education, 137(32.6%) were farmers, 232(55.2%) were single and 188(44.8%) had between 7 and 9 persons in their households.

**3.2 Sources of drinking water and water use**

The main sources as indicated by respondents are represented in Table 2 which shows that the sources of water were public/private borehole 200(47.6%) and stream 172(41.0%). Other essential uses of water were bathing 169(40.2%) and washing of cloth/other materials 132(31.4%). Most respondents 330(78.6%) indicated that public/private borehole was their most preferred source of drinking because of what 170(40.5%) respondents called good quality, not prone to contamination 110(26.2%) and always available 84(20.0%).

**Table 1: Socio-demographic characteristics of respondents (n = 420)**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Number of respondents** | **Percentage** |
| **Age (in years)**  18-29  30-39  40-49  50-59  60+  **Sex**  Male  Female  **Education**  Primary  Secondary  Tertiary  No formal education  **Occupation**  Farming  Trader/business  Civil servant  Student  Artisan  Unemployed  **Marital status**  Single  Married  Divorced  **Number of persons in your household**  1-3  4-6  7-9  10+ | 103  150  87  66  14  206  214  76  173  130  41  137  48  91  43  71  30  232  184  4  40  103  188  89 | 24.5  35.7  20.7  15.8  3.3  49.0  51.0  18.1  41.2  31.0  9.8  32.6  11.4  21.7  10.2  16.9  7.1  55.2  43.8  1.0  9.5  24.5  44.8  21.2 |

**Table 2: Source of drinking water and water use (n = 420)**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Number of respondents** | **Percentage** |
| **Main source of drinking water**  Spring  Public/private borehole  Surface stream  Sachet/bottle water  **Other essential use of water**  Exclusively for drinking  Washing of cloth/other materials  Bathing  Drinking for domestic animals  **Most preferred source of drinking water**  Spring  Surface stream  Public/private borehole  Sachet/bottle water  **Reasons for preferred source of drinking water**  Always available  Easily accessible  Good quality  Not prone to contamination | 17  200  172  31  86  132  169  33  3  31  330  56  84  56  170  110 | 4.0  47.6  41.0  7.4  20.5  31.4  40.2  7.9  0.7  7.4  78.6  13.3  20.0  13.3  40.5  26.2 |

**3.3 Water accessibility, storage and treatment**

Data on water accessibility, storage and treatment are represented in Table 3. 145(34.5%) respondents indicated that average time spent to and from drinking water source is 31-40 minutes and 109(26.0%) respondents indicated 21-30 minutes. Plastic rubbers 202(48.1%) and jericans 103(34.5%) were containers used to store drinking water in most households. Though 150(35.7%) respondents acknowledge that they do not treat their water before drinking, 124(29.5%) respondents used the sedimentation method for treatment of drinking water. Embankment/protection of water source was identified by 191 (45.5%) respondents as the community effort in ensuring safety of drinking water sources while Ventilated Improved Pit Latrine (VIP)/Pit latrine with cover 173(41.2%) and pour flush 102(24.3%) were highlighted as the main types of excreta facility available.

**3.4 Observational checklist for drinking water sources**

Observational checklist for drinking water sources is shown in Table 4. Of the 20 drinking water sources sampled, 20(100%) drinking water sources were used for other purposes like bathing and washing of materials, 17(85.0%) were drinking water source were odourless, 17(85.0%) tasteless and 20(100%) were colorless. Waste disposal methods were satisfactory in 11(55.0%) households and excreta disposal pattern in 15(75.0%) households were satisfactory. While human activities like farming were found around 80% drinking water sources, only 10(50.0%) drinking water sources have a distance of less than 1km from human residence.

**Table 3: Water accessibility, storage and treatment (n = 420)**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Number of respondents** | **Percentage** |
| **Average time spent to and from drinking water source**  <11 mins  11-20 mins  21-30 mins  31-40 mins  >40 mins  **Container used to store drinking water**  Clay earthen pot  Plastic rubbers  Open basin  Jericans  Get water directly from the tap for drinking  **Methods of treatment of drinking water**  Boiling  Cloth filtration  Sedimentation  Addition of alum/chlorine  No treatment  **Community effort in ensuring safety drinking water source**  Regular cleaning  Regulations/law on usage  Embankment/protection water source  Demarcation for drinking and other purposes  No safety plans  **Type of excreta disposal facility available**  Water closet  Pour flush  Ventilated Improved Pit Latrine (VIP)/Pit latrine with cover  Pit latrine without cover  No toilet | 22  45  109  145  99  11  202  87  103  17  45  78  124  23  150  97  42  191  11  79  45  102  173  49  51 | 5.2  10.7  26.0  34.5  23.6  2.6  48.1  20.7  24.5  4.0  10.7  18.6  29.5  5.5  35.7  23.1  10.0  45.5  2.6  18.8  10.7  24.3  41.2  11.7  12.1 |

**Table 4: Observational checklist for drinking water sources (n = 20)**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Yes (%)** | **No (%)** |
| Drinking water sources is used for other purpose like bathing and washing of materials  There is observed evidence of human activities like farming/residence around drinking source  Drinking water source has objectionable odour  Drinking water source has objectionable taste  Drinking water source has colour  Drinking water source contain debris and suspended particulate matters  Waste disposal pattern observed is satisfactory  Excreta pattern as observed is satisfactory  Observed longest distance to water source less than 1km | 20(100)  4(20.0)  3(15.0)  3(15.0)  20(100)  4(20.0)  11(55.0)  15(75.0)  10(50.0) | 0(0.0)  16(80.0)  18(85.0)  17(85.0)  0(0.0)  16(80.0)  9(45.0)  5(25.0)  10(50.0) |

**3.5 Microbiological quality of drinking water sources**

Results on microbiological quality of drinking water sources (Table 5) show that total coliform count and faecal coliform count in addition to heterotrophic count for all water samples 20(100%) exceeded WHO and NSDWQ limits for drinking water (0/100ml).

**3.6 Physico-chemical quality of drinking water sources**

The results presented in Table 6 show the mean values of physico-chemical quality of drinking water sources in the ten villages of Akpabuyo Local Government Area.

Temperature of water samples ranged between 24.6+0.012-25.5+0.0oC, indicating that the temperature for all water samples fall within the WHO and NSDWQ acceptable limits for temperature in drinking water.

The pH of the water samples ranged from 4.57 + 020 – 8.54 + 0.024. From the results it was observed that pH for all samples were below the WHO and NSDWQ acceptable range for pH in drinking water.

All other physical parameters such as turbidity (0.1+0.00-16.6+0.039 NTU), TSS (0.009+0.01.0 -0.028+0.032mg/L), TDS (6.36+0.011-23.75+0.39mg/L) and conductivity (2.25+0.022-62.0+0.0004 micromhos/cm) were within the WHO and NSDWQ limits. Equally, chemical parameters such as Manganese (0.000+0.000-0.06+0.012mg/L), Iron (Non-detectable-2.70+0.039mg/L) and Arsenic (Below detectable limit) were within WHO and NSDWQ limits for drinking water. There was no significant difference (p > 0.05) between the water samples in the villages.

**Table 5: Microbiological quality of drinking water sources**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Drinking water sources** | **Total coliform count (cfu/100ml)** | **Faecal coliform count (cfu/100ml)** |
| 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18  19  20 | Ikot Nakanda stream  Ikot Nakanda stream  Ikot Nakanda borehole  Ekpene Etete borehole  Ikot Asuquo borehole  Ikot Offiong borehole  Ikot Offiong borehole  Esuk Ekpenyong borehole  Esuk Ekpenyong stream  Ebisaereya stream  Ebisaereya stream  Ikot Eneyo borehole  Ikot Eneyo stream  Ikot Umo stream  Ikot Umo stream  Ikot Ekpo stream  Ikot Ekpo borehole  Ifano King stream  Edemikot stream  Edemikot stream  WHO safe limits  NSDWQ limit | TNTC  TNTC  116  121  TNTC  108  110  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  0  0 | TNTC  TNTC  90  95  TNTC  86  92  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  TNTC  0  0 |

TNTC = Too Numerous to Count; WHO = World Health Organization

NSDWQ = Nigerian Standards for drinking Water Quality

Public/private borehole water had zero facecal coliform

**Table 6: Mean of physico-chemical parameters of samples**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Quality parameter | Water sources | | | | | | | | | |
|  | Ikot Nakanda | Atimbo East | Atimbo West | Eneyo | Idundu | Ikang Central | Ikang North | Ikang South | Ikot Edem-Odo | Ikot Eyo (Micromhos/cm) |
| Temp. (oC) | 25.5+0.010 | 25.5+0.020 | 25.5+0.110 | 24.80+.000 | 25.10+.120 | 24.90+.019 | 25.10+.021 | 25.10+.020 | 25.10.002 | 24.6+0.012 |
| pH | 6.02+0.092 | 5.930+.011 | 8.540+.024 | 4.89+0.030 | 4.57+0.020 | 5.88+0.022 | 4.86+0.001 | 4.74+0.100 | 4.74+0.010 | 6.0+0.001 |
| Turbidity (Ntu) | 16.6+0.039 | 8.54+0.029 | 5.71+0.010 | 1.47 | 41.1+0.020 | 2.12+0.012 | 16.06+0.001 | 4.21+0.002 | 4.20+0.010 | 1.0+0.000 |
| TSS (mg/L) | 0.018+0.021 | 0.020+0.010 | 0.016+0.003 | 0.022+0.002 | 0.028+0.032 | 0.009+0.010 | 0.012+0.021 | 0.010+0.020 | 0.010+0.100 | 0.016+0.002 |
| TDS (mg/L) | 6.97+0.001 | 9.05+0.030 | 10.04+0.001 | 20.16+0.011 | 8.29+0.029 | 23.78+0.039 | 65.67+0.012 | 12.77+0.025 | 12.51+0.020 | 6.36+0.011 |
| Conductivity | 62.0+0.0004 | 15.09+0.020 | 14.67+0.005 | 33.60+0.122 | 13.81+0.023 | 39.63+0.030 | 22.09+0.210 | 24.6+0.001 | 24.6+0.001 | 2.25+0.021 |
| Manganese (mg/L) | 0.06+0.012 | 0.02+0.022 | 0.05+0.011 | 0.05+0.091 | 0.03+0.000 | 0.02+0.010 | 0.01+0.010 | 0.00+0.000 | 0.00+0.000 | 0.10+0.001 |
| Iron (mg/L) | 2.70+0.039 | 1.20+0.001 | ND | ND | 1.90+0.001 | 0.02+0.000 | 0.01+0.000 | 3.0+0.011 | 3.0+0.011 | 6.36+0.011 |
| Arsenic (mg/L) | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |

ND = Not Detectable; BDL = Below Detection Limit; NTU = Nephelometric Turbidity Unit; TSS = Total Suspended Solid; TDS = Total Dissolved Solid

**4. Discussion**

This study shows that different proportions of the population of communities in Akpabuyo Local Government Area have access to differing sources of water for drinking and domestic use. These sources were public/private borehole, spring, stream water and sachet/bottle water. However, only 84(20.0%) of the population have access to improved water, i.e., public/private borehole, which a good number of the population 330(78.6%) describe as easily available and good quality water. This proportion is significantly small, compared to neighboring Akwa Ibom which recent study reports that 83.33% of upland and 58.10% coastal area populations have access to improved water sources (Okon *et al*., 2017). However, 13.3% of Akpabuyo rural communities also have irregular access to sachet/bottle water which is processed water. In Nigeria, only about 58% of its citizens have access to improved drinking water sources (Okon *et al.*, 2017).

The main sources of drinking water were mostly private/private borehole 200(47.6%) and surface water from the stream 172(41.0%). This result contradicts a study conducted by Cookey *et al*. (2008) at the coastal communities of Niger Delta where stream was the only source of drinking water for the residents in the rural area. There appears to be some disparity in the provision of water supply to various communities which may be geographical (between urban and rural), or socio-economic (between the rich and the poor) (Okon, 2017). In the rural areas, there is a high dependence on all forms of natural sources of water, e.g., streams, river, rain and wells. Dependence on these sources may result in water-related diseases such as salmonellosis, shigellosis, cholera, giardiasis, etc. (Eja, 2014).

Accessibility to natural water sources still remains a problem to the rural communities of Akpabuyo Local Government Area as 34.5% of respondents indicated that average time spent to and from drinking water sources was 30-40 minutes, indicating that access to potable water in rural areas is still a challenge which makes most people to travel far to fetch water. This agrees with Ravichaudra and Boopathy (2007) who report that more than two third of the world’s poor households do not have access to improved water sources and majority have to fetch water from outside their homes.

The system of water storage was in jericans to avoid contamination, according to 24.5% of respondents, while the only method of treatment was sedimentation. It has been proposed by WHO (2013) that treatment of water may incorporate source protection (i.e., drawing water from a deep inlet away from shore) assisted by sedimentation (using coagulants), filtration (rapid sand) and disinfection (with ozone and chlorine).

The poor access to water of the rural communities of Akpabuyo Local Government Area is suggestive of inappropriate sanitary facilities in the area. Although 10.7% have water closet, 41.2% use ventilated improved pit latrine. 12.1% lack access to toilet facilities and as such defecate in the open. This agrees with the findings of Kalu (2019) who report that absence of sanitation facilities in Cross River and Akwa Ibom States of Nigeria led to open defecation. This indicates that absence of sanitation facilities and thus open defecation, leads to bacterial contamination of water.

Regarding the microbiological quality of drinking water in Akpabuyo communities, heterotrophic or total bacterial count, total coliform and faecal coliforms (*E. coli*) counts of all water samples exceeded WHO and NSDWQ limits for drinking water (WHO, 2006; NSDWQ, 2007). This result agrees with Ravichaudra *et al*. (2007) which detected the presence of faecal coliform over and above the permissible level in surface water sources making it unsafe for consumption.

Physico-chemical parameters such as temperature, conductivity, turbidity, TSS, TDS, Manganese, Arsenic, Iron for all the water samples met the WHO and NSDWQ acceptable limits for drinking water in the current study. This indicates that drinking water sources in Akpabuyo rural communities are safe for human consumption with respect to physico-chemical properties, although the pH levels ranged from 4.0 to 6.3 and were below the WHO and NSDWQ acceptable limits. This finding does not agree with that of Adeoye *et al.* (2013) in their study conducted in Kwara State, Nigeria, where over 70% of the water samples analysed had physico-chemical and bacteriological parameter values higher than WHO and NSDWQ limits. The water is fairly acidic, agreeing with what is known about borehole water in Calabar and neighboring Local Government Areas such as Akamkpa and Akpabuyo which borehole water is acidic (Ibid).

**5. Conclusion**

Water quality control within the permissible limits have become a top priority in Nigeria. This is significantly due to the spread of water-borne diseases affecting mostly the vulnerable populations. The World Health Organization expects that water meant for household use should be free from pathogenic microbes or any form of contamination from source to point of use. Findings in the current study observed that less than 50% of respondents had access to improved drinking water source and more than one third do not treat their water before use. While the pH for all water samples were below the WHO and NSDWQ acceptable range for pH in drinking water, microbiological analysis showed that total bacterial count, total coliform count and faecal coliform count for all water samples exceeded WHO and NSDWQ limits for drinking water. It is recommended that, to improve access to potable water and water quality, effective synergy between the host communities, implementing partners, and the government should be established.

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