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Full Length Research Article

ASSESSMENT OF THE POTABILITY OF WATER SOURCES IN SOME RURAL COMMUNITIES IN ILORIN EAST, KWARA, NIGERIA

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ABSTRACT

Sources of water at Oke - Ose, Abantan and Idi - Igba communities in Ilorin, Kwara, Nigeria were evaluated for potability. A total of 21 wells and 6 boreholes were sampled in these communities. The sanitary survey, total viable bacterial count, total coliform and faecal coliform counts as well as some physicochemical parameters of the water were assessed. The total viable bacterial counts of the well water and the borehole water ranged from 0.4×10^2 – 3.8×10^2 CFU/mL and 0.5×10^2 - 1.4×10^2 CFU/mL respectively. Furthermore, the range of total coliform counts of the well water and borehole water were 3 – 150 MPN/100ml and 3 – 28 MPN/100 mL respectively. Faecal coliform was not isolated in all the water samples. Only 50% and 42.9% of the boreholes and wells had sanitary score of less than 80%. All the water samples were within the limit of the physicochemical parameters allowed by Nigerian standard for drinking water quality (NSDWQ) for turbidity, total solid, dissolved solid, chloride, nitrate, and electrical conductivity. All the water samples did not meet up with the permissible limit of 100mg/l of sulphate. The bacteria isolated in this study include *Budvicia aquatica, Enterobacter agglomerans, Myroides odoratus, Burkholderia cepacia, Pseudomonas aeruginosa, Aeromonas hydrophila, Listeria* sp. and *Corynebacterium* sp. It was concluded from this study that 19.0% of the wells water and 16.7% of the borehole water supplies satisfied bacteriological qualities of potable water. It is recommended that the resident of these communities need to be enlightened on the need for hygienic environment and measures of protecting their water supplies from contamination.

Keywords: Potability, water, bacteriological characteristics, communities

INTRODUCTION

Access to potable water is a fundamental human need and it is therefore, a basic human right. Potable water is that which possesses the quality that renders it fit and safe for drinking. It must be free of pathogens, lack undesirable taste, smell, colour, turbidity and must contain no harmful chemicals (NSDWQ, 2007).
Water is used for an array of activities chief among these being for drinking, food preparation, as well as for sanitation purposes. In as much as safe drinking water is essential to health, a community lacking a good quality water will be saddled with a lot of health problems which could be avoided. In spite of the proliferation of wells and boreholes in many communities, the joint report on water and sanitation by WHO-UNICEF reveals that Nigerian and many sub-Saharan African countries are lagging behind in achieving potable water and good sanitation (Ohwo and Abotutu, 2014). Although the country is blessed with abundant water resources, governments at all levels have not been able to successfully harness these resources to ensure sustainable and equitable access to safe, adequate, improved and affordable water supply and sanitation to the populace (Muta'ahellandendu, 2012).
The development of rural water resources in Kwara State, North Central is a typical example. The major sources of water supply to most rural communities were hand – dug wells, streams, together with rainfall harvest, majority of which are highly unreliable during the dry seasons (Makoni *et al*., 2004). Despite the investments in the provision of potable water to local dwellers by government and non-governmental organizations, there is still a long way to go (Gay *et al*., 2007). Improving access to safe water source and sanitation services is a preventive intervention which will have an outcome of reducing number of diarrhea cases and a proportionate reduction in number of deaths (Majuru *et al.,* 2011).
This research is necessitated by the need for ensuring the consumption of wholesome water by all, particularly in the study areas. This work focused on the water sources used by the people of Oke - Ose, Abantan and Idi - Igba communities in Ilorin East Local Government Area, Kwara State, Nigeria.
The objectives of this study were to assess the potability of water sources such as hand dug wells and bore holes within Oke- Ose , Abantan and Idi - Igba communities in Ilorin, Nigeria; identify the sources of pollution or contamination of the water sources; determine the physicochemical characteristics of the water samples; and suggest remedial measures for ensuring the potability of the water sources.

MATERIALS AND METHODS

Study Area

The study areas were Oke - Ose, Abantan and Idi - igba communities all located in Ilorin East, Kwara, Nigeria. These communities have a total populations: Oke - Ose (2,330), Abantan (1,520) and Idi - Igba (2,288) (Adeoye *et al*., 2013).

Sanitary survey and sanitary scores of the water sources

A direct observation of the conditions of individual water sources was made to ascertain any possible sources of contamination that may affect the quality of the water using some of the parameters given by WHO (2013). The sanitary score of each water source in percent was obtained by dividing the number of "yes" scores by the total number of parameters assessed and multiplying the result by 100 (Sule *et al*., 2011).

Interviews on the users' perception of water quality

At each sampling sites, three regular users of the Well and Borehole water samples were interviewed. They were asked about what they use the water for, their perception on the quality of the water, as well as if they had experienced any illness in connection to the use of the water.

Collection of water samples
The period of water sample collection stretched between January and March, 2016. Samples were collected using standard methods (WHO, 2013). All the samples were collected in the early hours of the day (7.00 – 9.00am) and taken to the laboratory immediately for analysis.

Bacteriological counts of the water samples
The water sample was serially diluted by introducing 1 mL of it into a test tube containing 9 mL of sterile distilled water. This formed 10^{-1}dilution. The total viable bacterial count was determined by plating 0.1mLof aliquot from 10^{-1}dilution into sterile plate followed by the addition of sterile molten nutrient agar; swirled and allowed to set. This was incubated at 37°C for 24 h (Fawole and Oso, 2007). Total coliform was determined using multiple tube fermentation technique. This involved introducing different volumes (10, 1 and 0.1 mL) of the water sample into sterile MacConkey broth containing Durham tube for each volume. Three broths were used for each volume making a total of 9 broths per sample. The broths were incubated at 37°C for 48 h in order to determine presumptive total coliforms. The number of tubes positive for acid and gas for each set was subcultured into sterile Brilliant Green Lactose Bile broth to determine confirmed total coliforms. The results from here was used to determine the MPN/ 100 mL of the water. The faecal coliform count was determined using spread plate technique. Aliquots (0.1mL) of the raw water and 10^{-1}dilution was introduced and spread on sterile eosin methylene blue agar (EMB). The EMB plates were incubated at 44.5°C for 48 h so as to isolate faecal coliforms. Colonies with greenish metallic sheen were taken tentatively as faecal coliforms (APHA, 2013). Colonies gotten from the media were subcultured using nutrient agar; incubated at 37°C for 24 h and stored in the refrigerator at 4°C for further use.

Characterization and identification of Bacterial Isolates
The Gram positive bacteria were characterized and identified based on their colonial, cellular, and biochemical properties (Olutiola *et al*., 2000; Cheesbrough, 2006). Microbact biochemical identification kit 24E was used for the identification of Gram negative bacteria. It can identify both oxidase positive and oxidase negative bacteria. The kit has 24 wells with each well containing reagent for biochemical tests such as lysine, ornithine, H_2S, glucose, mannitol, xylose, indole, urease, citrate, gelatin, malonate, inositol, sorbitol, rhamnose, sucrose etc. One to three colonies from the young culture (18-24h) were picked; emulsified in 5ml of sterile normal saline and shaken thoroughly to form a homogenous suspension. Using a sterile Pasteur pipette, 4 drops of the emulsified suspension was added aseptically into each well. After inoculation, wells 1, 2, 3 and 24 were overlaid with mineral oil for oxidase positive bacteria while wells 1, 2, 3, 20 and 24 were also overlaid with mineral oil for oxidase negative bacteria. The inoculated kit was incubated for 24-48 h (Oxoid, 2016). Results were read as stipulated in the kit manual after which the eight or nine digits code obtained was run on the Microbact offline identification software in order to get the most probable identity of the Gram negative bacterial isolate.

Physicochemical Analysis
The pH, electrical conductivity, turbidity and total hardness, total solids, suspended solids, dissolved solids, nitrate, sulphate and chloride contents were determined using the standard methods (Ademoroti, 1996; Fawole and Oso, 2007; Mwendera, 2006; APHA, 2013).

RESULTS

Sanitary Survey
The sanitary survey of the water sample ranged from 20 – 100% based on the parameters assessed. The borehole water sites had a better sanitary score than the well water sites (Table 1).

Interviews on users' perception on the water quality
From the interactions made with the users of the water, the water is being used for laundry, bathing, cooking and drinking. Some of the observed effects of the usage of the water and the users' conclusion on the quality of the well and bore hole water samples are presented in Table 2.

Bacteriological analysis of the water samples

Total viable bacterial counts
The viable bacterial counts of the well water ranged from 0.4×10^2 - 3.8×10^2 CFU/mL and 1.1×10^2 – 1.4×10^2 CFU/mL for Oke – Ose and Idi - Igba communities respectively. Similarly, the total viable bacterial counts of borehole water samples at Oke-Ose and Abantan communities ranged from 0.8×10^2 – 1.4×10^2 CFU/mL and 0.5×10^2- 0.6×10^2 CFU/mL respectively (Table 3).

Coliform counts
The total coliform counts of the well water samples at Oke-Ose and Idi-Igba ranged from 3-150 MPN/100ml and 11 -12 MPN respectively. For the borehole water samples at Oke-Ose, the total coliform counts ranged from 3–20 MPN/100ml while the same value of 28 MPN/100mL was obtained for the two borehole water samples at Abantan community. There was absence of faecal coliform in all the water samples (Table 3).

Identification of the bacterial isolates
The bacterial isolates were characterized based on their colonial, cellular and biochemical characteristics. The probable identity of the bacterial isolates were *Listeria* sp., *Corynebacterium* sp., *Budvicia aquatica, Enterobacter agglomerans, Myroides odoratus, Burkholderia cepacia, Pseudomonas aeruginosa* and *Aeromonas hydrophila*.

Physicochemical characteristics of the water samples
The turbidity, pH, total solids, dissolved solids, suspended solid, total hardness, sulphate, chloride, nitrate, and electrical conductivity of the well water samples across the three communities of Oke-Ose, Idi-Igba, and Abantan ranged from 0.4 – 0.6 NTU, 4.7 – 6.8, 202- 263 mg/l, 175 – 248 mg/l, 3 – 27 mg/l, 56 – 280 mg/l, 511 – 598 mg/l, 44 – 240 mg/l, 10.0 – 16.0 mg/l, and 485 – 643 mg/l respectively. Furthermore, the turbidity, pH, total solids, dissolved solids, suspended solid, total hardness sulphate, chloride, nitrate, and electrical conductivity of the borehole water samples at Oke-Ose and Abantan communities ranged from 0.4 – 0.5 NTU, 5.0 – 5.5, 198- 206 mg/l, 183 – 198 mg/l, 3 – 20 mg/l, 60 – 288 mg/l, 549 – 596 mg/l, 52 – 104 mg/l, 10.0 – 11.9 mg/l, and 456 – 630 mg/l respectively (Table4).

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Table 1: Sanitary scores of the water sampling sources of three communities in Ilorin East, Kwara, Nigeria

Water Sources	Sanitary parameters I	II	III	IV	V	Sanitary Score (%)
W_k1	N	N	Y	N	N	20
W_k 2	Y	N	Y	Y	Y	80
W_k 3	Y	Y	N	Y	Y	80
W_k 4	N	N	N	Y	N	20
W_k 5	Y	Y	N	Y	Y	80
W_k 6	N	Y	N	N	N	20
W_k 7	Y	N	Y	Y	Y	80
W_k 8	Y	Y	Y	Y	Y	100
W_k 9	Y	Y	Y	Y	Y	100
W_k 10	Y	Y	Y	Y	Y	100
W_k 11	N	Y	Y	Y	Y	80
W_k 12	Y	Y	Y	Y	Y	100
W_k 13	Y	N	N	Y	N	40
W_k 14	N	Y	Y	N	Y	60
W_k 15	Y	N	N	N	N	20
W_k 16	N	Y	N	N	N	20
W_k 17	N	Y	Y	Y	Y	80
W_k 18	Y	N	N	Y	Y	60
W_k 19	N	Y	Y	N	Y	60
W_d20	Y	Y	Y	N	Y	80
W_d21	N	Y	Y	Y	Y	80
BH_k1	N	Y	Y	Y	Y	80
BH_k2	Y	Y	Y	Y	Y	100
BH_k3	N	N	Y	Y	Y	60
BH_k4	Y	N	Y	Y	Y	80
BH_t5	Y	N	Y	N	Y	60
BH_t6	N	Y	N	Y	Y	60

Key: I=Water does not accumulate near the water sources; II=Is the sampling points not in close vicinity to a septic tank?; III=Is the sampling point not in close vicinity to uncleared bushes?; IV=Is the sampling point not in close vicinity to a refuse dump?; V=Cover slab; Y=Yes; N=No; W_k (1-19)=Water from wells at Oke Ose community; W_d (20-21)=Water from wells at Idi-Igba community; BH_k (1-4)= Water from boreholes at Oke-Ose community; BH_t (5-6)= Water from boreholes at Abantan community

Table 2: Users' perception of the quality of the well and borehole water samples

Water sources	Uses of water	Observation from usage	Remarks
W_k1	Laundry, bathing and cooking.	Lathers well but forms plaque in plates.	Good for laundry and bathing.
W_k 2	Laundry, bathing, cooking and drinking.	Lathers well with soap, tastes like tap water.	Good for laundry, bathing, cooking and drinking.
W_k 3	Laundry, bathing, cooking and drinking.	Lathers well with soap, tastes like tap water.	Good for laundry, bathing, cooking and drinking.
W_k 4	Laundry, bathing and cooking.	Wastes a lot of soap.	Not good for laundry and bathing but good for cooking.
W_k 5	Laundry, bathing and cooking.	Wastes a lot of soap.	Not good for laundry and bathing but good for cooking.
W_k 6	Laundry, bathing, cooking and drinking	Lathers well with soap but few reported stomach upset after drinking for the first time.	Good for all purposes except for drinking.
W_k 7	Laundry and bathing.	Lathers well with soap.	Good for bathing and cooking
W_k 8	Laundry, bathing and cooking.	Wastes soap and leaves hole in cooking utensils.	Not good for laundry and cooking.
W_k 9	Laundry, bathing, cooking and drinking	Lathers well with soap but sometimes causes skin rashes.	Good for laundry and cooking but not good for bathing and laundry.
W_k 10	Laundry, bathing, cooking and drinking	Lathers well with soap but sometimes causes skin rashes.	Good for laundry and cooking but not good for bathing and laundry.
W_k 11	Laundry, bathing and cooking.	Lathers well with soap.	Good for all purposes.
W_k 12	Laundry and bathing.	Lathers well but wastes soap.	Not good for laundry.
W_k 13	Laundry and bathing	Lathers well but wastes soap.	Not good for laundry.
W_k 14	Laundry, bathing, cooking and drinking	Lathers well and tastes like tap water.	Good for all purposes.
W_k 15	Laundry, bathing, cooking and drinking	Lathers well and tastes like tap water.	Good for all purposes.
W_k 16	Laundry, bathing, cooking and drinking	Lathers well and tastes like tap water.	Good for all purposes.
W_k 17	Laundry, bathing, cooking and drinking.	Wastes soap and causes occasional skin rashes.	Not good for laundry and bathing
W_k 18	Laundry, bathing and cooking.	Wastes a lot of soap.	Not good for laundry and bathing
W_k 19	Laundry, bathing and cooking.	Wastes a lot of soap.	Not good for laundry and bathing.
W_d20	Laundry, bathing and cooking.	Wastes soap especially detergent.	Not good laundry but good for cooking.
W_d21	Laundry, bathing, cooking and drinking	Lathers well and tastes like tap water but few reported stomach upset.	Good for all purposes except for drinking.
BH_k1	Laundry, bathing, cooking and drinking	Lathers well and tastes good.	Good for all purposes.
BH_k2	Laundry, bathing, cooking and drinking	Lathers well and tastes good.	Good for all purposes.
BH_k3	Laundry, bathing, cooking and drinking	Lathers well and tastes good.	Good for all purposes.
BH_k4	Laundry, bathing, cooking and drinking	Lathers well and tastes good.	Good for all purposes.
BH_t5	Laundry, bathing, cooking and drinking	Lathers well and tastes good.	Good for all purposes.
BH_t6	Laundry, bathing, cooking and drinking	Lathers well and tastes good.	Good for all purposes.

Key: W_k (1-19) = Water from wells at Oke Ose community; W_d (20-21) = Water from wells at Idi-Igba community; BH_k (1-4) = Water from boreholes at Oke-Ose community; BH_t (5-6) = Water from boreholes at Abantan community

Table 3: Bacteriological counts of the water samples of three communities in Ilorin East, Kwara, Nigeria

Water sources	TVC (CFU/mL) x 10^2	Total coliform counts (MPN/100ml)	Faecal coliform count (CFU/mL)
W_k1	2.5	120	0
W_k 2	1.0	11	0
W_k 3	2.0	28	0
W_k 4	3.2	120	0
W_k 5	1.5	21	0
W_k 6	3.8	150	0
W_k 7	1.0	11	0
W_k 8	0.7	3	0
W_k 9	0.6	3	0
W_k 10	0.4	3	0
W_k 11	1.6	11	0
W_k 12	0.8	3	0
W_k 13	1.5	28	0
W_k 14	1.0	28	0
W_k 15	2.7	93	0
W_k 16	3.0	93	0
W_k 17	1.1	11	0
W_k 18	1.6	28	0
W_k 19	1.8	28	0
W_d20	1.1	21	0
W_d21	1.4	11	0
BH_k1	1.4	9	0
BH_k2	0.9	3	0
BH_k3	1.0	20	0
BH_k4	0.8	11	0
BH_t5	0.6	28	0
BH_t6	0.5	28	0

Key: W_k (1-19) = Water from wells at Oke Ose community; W_d (20-21) = Water from wells at Idi-Igba community; BH_k (1-4) = Water from boreholes at Oke-Ose community; BH_t (5-6) = Water from boreholes at Abantan community

Table 4: Physicochemical characteristics of the well and borehole water samples from three communities in Ilorin East, Kwara, Nigeria

Water sources	Turbidity (NTU)	pH	Total solids (mg/l)	Dissolved solids (mg/l)	Suspended solids (mg/l)	Total hardness(mg/l)	Sulphate (mg/l)	Chloride (mg/l)	Nitrate (mg/l)	Electrical condtuctivity (µs/cm)
W_k1	0.4	4.7	207	187	20	108	545	88	10	564
W_k 2	0.5	4.9	209	197	12	68	559	160	10.5	605
W_k 3	0.4	4.7	205	193	12	56	538	84	10.3	532
W_k 4	0.4	6.3	203	183	20	180	550	76	16.0	506
W_k 5	0.6	6.6	263	248	15	160	594	96	10.8	614
W_k 6	0.5	6.8	224	232	13	148	546	52	10.6	536
W_k 7	0.5	6.5	238	226	12	176	536	44	10.8	504
W_k 8	0.4	6.7	210	207	3	160	514	60	10.0	487
W_k 9	0.5	6.6	215	199	16	180	584	64	10.8	643
W_k 10	0.5	6.4	206	191	14	168	563	72	10.7	584
W_k 11	0.4	6.5	208	203	5	200	598	48	10.2	563
W_k 12	0.5	6.8	210	205	5	216	586	0.88	10.0	493
W_k 13	0.5	6.6	208	196	12	84	531	120	10.1	503
W_k 14	0.5	6.2	206	202	4	64	511	100	10.2	482
W_k 15	0.5	6.5	207	193	14	100	545	102	10.4	639
W_k 16	0.4	6.0	204	191	13	72	560	108	10.3	574
W_k 17	0.5	6.5	205	178	26	196	580	56	10.0	536
W_k 18	0.4	6.3	203	191	12	100	582	96	10.6	606
W_k 19	0.4	6.5	202	191	11	108	543	60	10.9	535
W_d20	0.4	6.8	204	190	14	100	546	52	11.0	536
W_d21	0.4	6.6	202	175	27	280	545	240	11.1	485
BH_k1	0.4	5.4	202	198	4	96	560	104	10.4	552
BH_k2	0.4	5.4	198	194	4	108	550	92	10.0	489
BH_k3	0.4	5.0	201	198	3	288	596	56	10.5	456
BH_k4	0.5	5.2	206	190	16	60	556	52	11.3	630
BH_t5	0.4	5.3	203	183	20	112	549	72	10.0	579
BH_t6	0.4	5.5	203	185	18	160	559	60	11.9	561

Key: W_k (1-19) = Water from wells at Oke Ose community; W_d (20-21) = Water from wells at Idi-Igba community; BH_k (1-4) = Water from boreholes at Oke-Ose community; BH_t (5-6) = Water from boreholes at Abantan community

DISCUSSION

The sanitation survey revealed the possible sources of contamination of the well and borehole water supplies in the communities of Oke-Ose, Idi-Igba, and Abantan. The poor sanitary conditions found in some of the sites include proximity of the water source to soak away, dirty gutter, refuse dump, bushy surrounding, and lack of cover for the wells. Hence, 42.9% of the wells and 50% of the boreholes had sanitary scores less than 80%. There was a clear link between the sanitary scores and the bacteriological quality of the water samples. For instance, locations that had sanitary score of 100% conform with the NSDWQ bacteriological requirements in term of total viable bacterial count, total coliform and faecal coliform counts. In a study on the bacteriological and physicochemical quality of water supply to some restaurants at University of Ilorin by Sule *et al.* (2013) sanitary scores that ranged from 60 to 90% were obtained.

The borehole water samples had lower bacterial counts than the well water samples. The well water (33.3%) and borehole water (83.3%) samples had bacterial counts ≤100 CFU/mL. The total coliform counts of the borehole water samples were also lower than that of the well water samples. Three well water samples and one borehole water sample representing 14.3% and 16.7% satisfied the permissible limit of total coliform (10 CFU/mL) according to NSDWQ (2007). In relation to WHO (2013) which specified that potable water should have zero total coliform in any given sample, none of the water sample satisfied this requirement. All the water samples were devoid of faecal coliform but they were however not free from total coliforms which are probably from the environmental sources and are non-faecal in origin. Eniola *et al*. (2007) obtained bacterial count in the range of 5.0×10^2 - 7.0×10^2 CFU/mL for stored borehole water. Also, Erah *et al*. (2002) in a study conducted on the quality of ground water in Benin, Nigeria found unacceptable levels of aerobic bacteria and fungi in borehole water of Teboga District of Benin city. Rogbesan *et al*. (2002) and Akinyanju (1987) also reported higher incidence of bacteria and coliforms in shallow well waters.

It was also observed that the water sample with the highest viable bacterial count also had the highest total coliform count and the lowest sanitary score of 20%. Agbabiaka and Sule (2010) in their work on bacteriological assessment of selected borehole water samples in Ilorin Metropolis also obtained a similar trend where sampling point with the highest bacterial count of 2.3 x 10^2 CFU/mL had the highest coliform load of 16 MPN/100 mL.

Most of the bacteria isolated in this study were Gram negative rods. This result is in conformity with the results obtained by Allen (1981) where Gram negative rods dominated their isolates. The Gram negative rods encountered in these water sources were *Budvicia aquatica, Enterobacter agglomerans, Myroides odoratus, Burkholderia cepacia, Pseudomonas aeruginosa,* and *Aeromonas hydrophila* while the Gram positive rods were *Listeria* sp. and *Corynebacterium* sp. These isolates are non-faecal in origin and they are of little significance in water. However, some of these isolates have been reported to cause opportunistic infections.

Fernandez *et al*. (2000) reported that *Aeromonas hydrophila* can produce cytotoxins and enterotoxins that is associated with gastroenteritis and wounds infections in man. Furthermore, Caskeys *et al*. (2018) reported the occurrence *P. aeruginosa* in water and its association with increased morbidity and mortality in patients with cystic fibrosis. Therefore, there is need for caution when using this contaminated water for any purposes.

All the water samples whether wells or boreholes were within the limit allowed for turbidity, dissolved solids, total solids, chloride, nitrate and electrical conductivity. The values obtained for these physicochemical parameters were less than the limit allowed by NSDWQ (2007). Contrary to this, all the water samples did not meet up to the limit of sulphate 100mg/l allowed by the same agency. Furthermore, two well water samples representing 9.5% did not conform to the limit of 25 mg/l allowed for suspended solids.

Only one well and one borehole water sample representing 4.8% and 16.7% can be regarded as soft water since their hardness were within 0 -60 mg/l (De Zuane, 1997; USGS, 2020). However, if NSDWQ (2007) is used eleven of the well water samples and four borehole water representing 52.4% and 66.7% were within the permissible limit of 150mg/l for total hardness. Majority of the water in this study can be classified as being moderately hard (61- 120 mg/l) or hard water (121-180mg/l) or very hard >180 mg/l (USGS, 2020).

The well water samples (61.9%) were within the range of allowed limit of pH 6.5 – 8.5 whereas all the borehole water samples fell below this range. Olorunfemi *et al.* (2014) obtained pH range of 4.2 - 6.8 for drinking water sources from some rural communities in Ughelli, Delta State. Turbidity in drinking water is as a result of particulate matters such as clay, silt, fine organic matter and so on. These particulates can shield microorganisms from the effects of disinfection and can stimulate the growth of bacteria (Hunter *et al.,* 2009). These materials can provide adsorption sites for chemicals that may be harmful to health or cause undesirable tastes or odour (Adekunle *et al.,* 2007; (Katsi *et al.,* 2007). Total hardness is determined by the amount of calcium, magnesium and potassium in water sources. Graciana (2010) also reported that large concentration of calcium may affect the taste of water and also leads to soap wastage if used for washing. High concentration of nitrate in ground water can probably be as a result of poor sanitation and latrine construction, fertilizer and other agrochemical use. High nitrate concentration in drinking water points towards contamination (Gupta *et al.,* 2001). Chloride may occur naturally but may also be present due to the local use of de-icing salt or saline intrusion (GHWP, 2009).

From the results obtained, especially the bacteriological analysis of the water sources, it has been clearly shown that most of the water sources in these communities, especially their hand dug wells were of poor quality. Ryan (2008) and WHO (2013) reported that about 80% of the health problems in developing country can be linked to inadequate water and sanitation.

Conclusion

This study has shown that 19.0% of the well water and 16.7% of the borehole water supplies satisfied the Nigerian Standard for drinking water quality in terms of bacteriological qualities and these sampling sites correspond to those locations with sanitary score of 100%.

Recommendation

Reducing the occurrence of bacterial contamination of water sources within these communities should be a collaborative effort. The Government in collaboration with civil society groups and non-governmental organizations should come to the aid of these communities to provide potable water supplies. There is also a need to create awareness on the hazards of drinking contaminated water and the residents of the communities should be enlightened on how contamination of water sources can be prevented. Lastly, they should be trained on simple household water treatments such as boiling or adding water guard before using these water sources for domestic purposes.

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