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Physicochemical and Bacteriological Analysis of Water Samples Used For Domestic Purposes in Idi Ayunre, Oyo State, Southwestern Nigeria.

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Abstract: *Diseases caused by contaminated water consumption and poor hygiene practices are the leading causes of death among children worldwide. Samples of water were collected from Idi ayunre Oyo state and the physicochemical and bacteriological analysis were determined using standard methods. The pH ranged from 5.2-7.1, temperature was from 26.1 to 27.50 ^{0}C, electrical conductivity ranged from 50 to 1120 uscm,$^{-1}$ total dissolved solids ranged from 183 to 559.33 mgl^{-1}, total hardness ranged from 58.97 to 345.67, nitrate ranged from 4.8 to 35.80, manganese ranged from 0.005 to 0.013, potassium ranged from 0.65 to 41.01, sodium ranged from 46.40 to 89.84, lead ranged from ND to 0.078, cadmium ranged from ND to 0.062, iron ranged from 0.030 to 0.394, copper ranged from ND to 0.005 and zinc ranged from 0.04 to 0.210. The bacteriological parameters analysed were total viable count which had values ranging from 2.02 x 10^2 to 6.08 x10^3cfu/ml. Bacteria isolates were identified as Bacillus sp, Escherichia coli, Pseudomonas sp, Salmonela sp, Aeromonas sp and Vibrio cholera. Though the physicochemical parameter studies revealed that water samples are within the WHO and EPA permissible limits but the total viable counts for all samples exceeded the WHO and EPA standards. The coliform counts for some samples were within acceptable limits but others exceeded the WHO and EPA permissible limit for drinking water, making the water unfit for drinking.*

Keywords: *Physicochemical, Bacteriological, Domestic purposes, Quality, Water-borne diseases.*

I. Introduction

Water management is the foundation for the prevention and control of water borne diseases and assessment of drinking water quality is important for sustainable development. Not only the shortages in quantity, but also the compromised quality of municipal tap water has become a major public health issue [1]. In many developing countries, avalaibility of water has become a critical and urgent problem and it is a matter of great concern to families and communities depending on non-public water supply system [2]. Water plays an indispensable role in sustenance of life and it is a key pillar of health determinant, since 80% of diseases in developing countries are due to lack of good quality water [3]. During last decade, it was observed that the ground water get polluted drastically because of increased human activities [4] and the growth of human population and rapid industrialization has led to increasing use of urban waters as sewers, compromising other uses [5]. Contamination of drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases [6]. Diseases contacted through drinking water kill about 5 million children annually and make 1/6th of the world population sick [7]. Throughout the world, about 2.3 billion people suffer from diseases linked to water related problems which continue to kill millions of people yearly. The quality of drinking water is a powerful environmental determinant of health [1]. Water quality monitoring is implemented by regulating agencies like the FMENV (formerly known as FEPA) provide guidelines and standards which can be used to detect unusual amounts of pollutants in the environment and it involves physicochemical and bacteriological analyses of water samples from various sources. Serious ill health can be caused by water contaminated from faeces being passed or washed into river, stream, pool or being allowed to seep into well or borehole [3]. Consequently, water borne diseases such as cholera and typhoid often have their outbreak especially during dry season [8, 9]. High prevalence of diarrhoea among children and infants can be due to the use of unsafe water and unhygienic practice [10, 11]. Thus, many infectious diseases are transmitted by water through faecal oral contamination. For most communities the most secure source of safe drinking water is pipe-borne water from municipal water treatment plants. Often, most of water treatment facilities do not deliver or fail to meet the water requirements of the served community due to corruption, lack of maintenance or increased population. The scarcity of piped water has made communities to find alternative sources of water hence ground water sources has been a ready source [12].

In Nigeria, majority of the rural populace do not have access to potable water and therefore, depend on well, stream and river water for domestic use. The bacterial qualities ofgroundwater, pipe borne water and other natural water supplies in Nigeria, have been reported to beunsatisfactory, with coliform counts far exceeding the level recommendation by W.H.O [13, 14]. Throughout Ibadan, people are facing health problems resulting from water contamination.This study aims at determining the sanitary quality and physiochemical characteristics of domestic water collected from wells from a town in Ibadan, Oyo state, Nigeria. Idi ayunre, a town in Oyo state depends on wells for its domestic water supply and bacteriological and physicochemical analysis were determined.

II. Materials And Methods

Sample collection

Water samples were collected in sterilized bottles from four wells in different locations within Idi ayunre,Ibadan, Oyo state, Nigeria.

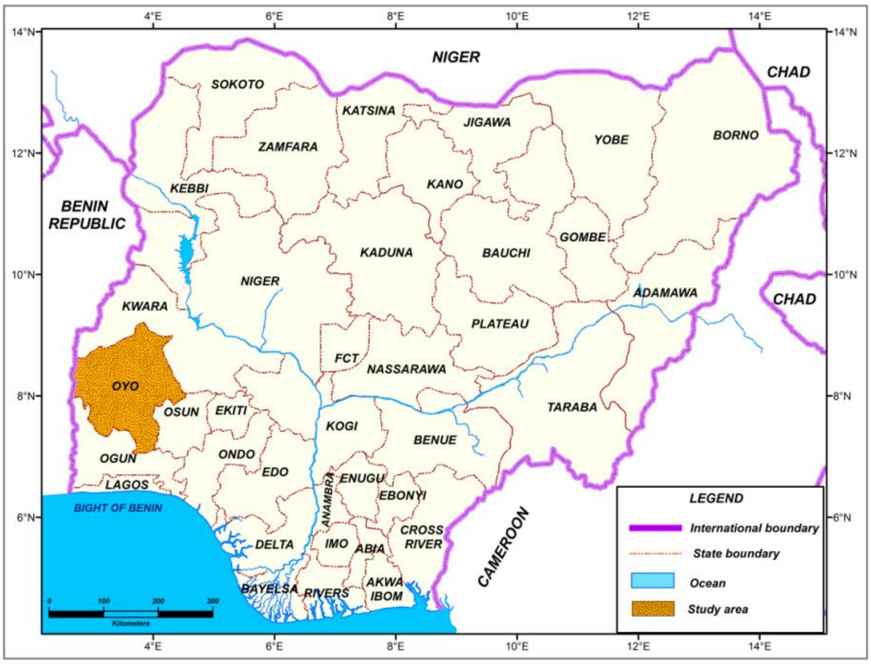

Figure a: Map of Nigeria Showing Oyo State and Location of Ibadan

Physicochemical analysis

The procedure for analysis followed "Standard Methods of Analysis of Water and Wastewater11" (APHA). The physicochemical characteristics of water were analyzed to determine the quality of drinking water in this area as described by [15]. The physical variables such as temperature, pH and electrical conductivity were analyzed at the site. The other tests included the determination Total dissolved solids, total hardness, Ca^{2+} hardness, Mg^{2+} hardness, nitrate, manganese, potassium, sodium, lead, cadmium, iron, copper and zinc. Chemicals used for the analysis were of analytical grade and instruments are of limit of precise accuracy.

Determination of some heavy metals

The water samples were acid digested with nitric acid and the heavy metals determined spectrophotometrically at the appropriate wavelengths using the Atomic Absorption spectrophotometer (AAS), Unicom model fitted with air- acetylene atomizer [15].

Bacteriological analysis

The membrane filteration method of water analysis was employed. Membrane filters of 0.45µm pore size with diameter of 47mm were used in line with recommendations by APHA – AWWA, 1998. 100mls each of water samples, from different locations, were filtered and the bacteria isolated and identified using the methods described by [3, 15].

Isolation of microorganisms

Membrane filtration technique was used to isolate the microorganisms present in the water samples. The funnel of the membrane filtration unit has a capacity of 50ml and the funnel was mounted one receptacle fixed to the vacuum pump which allows the water to flow over the porous sterile membrane filter (0.45µm). Aseptically, the membrane filters were placed on each microbial growth medium using sterile forceps after passage of 100ml of water sample. The following media (Baired Parker agar, McConkey agar, Plate count agar, Potato dextrose agar and Pseudomonas agar base) were prepared and autoclaved at 121°C for 15 minutes at 15Ib before being inoculated with membrane filters.

III. Results

Table 1: Physicochemical parameters of water samples in Idi ayunre, Oyo state.

Parameters	W1	W2	W3	W4	WHO	EPA
Temperature(°C)	27.50 ± 0.10	26.63 ± 0.23	27.10 ± 0.06	26.10 ± 0.08	NS	NS
pH (mgl^{-1})	6.8 ± 0.25	5.2 ± 0.01	7.0 ± 0.30	7.1 ± 0.20	6.0-9.2	6.5-8.5
Conductivity ($uScm^{-1}$)	223 ± 5.75	50 ± 2.28	1120 ± 12.50	328 ± 3.25	NS	NS
TDS (mgl^{-1})	380.0 ± 2.10	202 .67 ± 1.70	559.33 ± 1.10	183.0 ± 2.12	500	500
Total Hardness (mgl^{-1})	345.67 ± 2.30	101.12 ± 1.50	210.56 ± 1.20	58.97 ± 2.00	500	500
Calcium Hardness	44.75 ± 5.25	5.15 ± 0.75	43.78 ± 0.50	18.82 ± 0.16	100	75
Magnesium Hardness	1.33 ± 0.00	0.86 ± 0.01	12.76 ± 0.028	3.03 ± 0.04	50	50
Nitrate(mgl^{-1})	4.8 ± 0.01	9.03 ± 0.02	35.80 ± 0.01	10.40 ± 0.01	45	100
Cadmium(mgl^{-1})	0.046 ± 0.01	ND	0.062 ± 0.01	0.04 ± 0.02	0.05	0.01
Iron(mgl^{-1})	0.034 ± 0.00	0.394 ± 0.00	0.030 ± 0.00	0.089 ± 0.01	0.3	0.3
Zinc(mgl^{-1})	0.016 ± 0.00	0.040 ± 0.00	0.210 ± 0.00	0.018 ± 0.00	5.0	5.0
Lead(mgl^{-1})	ND	ND	0.062 ± 0.01	0.078 ± 0.00	0.05	0.05
Copper(mgl^{-1})	0.001 ± 0.00	0.005 ± 0.00	ND	0.005 ± 0.00	0.001	NS
Manganese	0.009 ± 0.00	0.013 ± 0.00	0.008 ± 0.00	0.005 ± 0.00	0.1	0.05
Sodium	60.70 ± 0.75	46.40 ± 2.14	62.79 ± 1.20	89.84 ± 0.26	200	200
Potassium	0.88 ± 0.00	0.65 ± 0.00	41.01 ± 0.28	14.18 ± 0.06	12	NS

Results of triplicate determinations
NS = No standard ND= Not detected

Table 2: Bacteriological analysis of water

Water sample codes	Total viable counts (cfu/ml)	Total coliform counts (cfu/ml)
W1	1.80×10^3	3.2×10^2
W2	2.02×10^2	6.7×10^3
W3	6.08×10^5	2.9×10^5
W4	3.1×10^4	1.6×10^3
WHO standard	1.0×10^2	Zero per 100ml
EPA standard	1.0×10^2	Zero

Results of triplicate determinations

Table 3: Microbial isolates from the well samples

Organisms isolated	Well 1	Well 2	Well 3	Well 4
Bacillus sp	+	+	+	+
Pseudomonas sp	+	+	+	+
Salmonella sp	-	-	+	-
Escherichia coli	+	+	+	+
Aeromonas sp	+	+	+	+
Vibrio cholera	-	-	+	+

\+ Present
\- Absent

IV. Discussion

Water is vital for life, however it also serves as the commonest route of transmission of a number of infectious diseases. Contaminated water is a global public health threat placing people at risk of a host of diarrhoeal and other illness as well as chemical intoxication [2]. The major risk to human health is faecal contamination of water supplies. Groundwater are found to be contaminated due to improper construction, shallowness, animal wastes, proximity to toilet facilities, sewage, refuse dump sites, and various human activities around the well [16]. Water quality can be determined using different physical, chemical and biological parameters, they are very useful to evaluate pollution trends [17].

The physicochemical parameters assesed were pH, temperature, electrical conductivity, total dissolved solids, total hardness, Ca^{2+}hardness, Mg^{2+} hardness, nitrate, manganese, potassium, sodium, lead, cadmium, iron, copper and zinc. The result as presented in table 1 showed that the pH range for this study was 5.2 to 7.1 and are within the permissible limit of EPA and WHO except well 2 which has a lower pH (5.2). Hence consumption of this water sample is acidic and not safe and can cause gastrointestinal disorders like hyperacidity, ulcers and burning sensation. Conductivity was highest in W3 thereby suggesting that the dissolved solids are mostly mineral salts. The summation of calcium hardness and magnesium hardness is regarded as the total hardness of water and is defined as the sum of calcium and magnesium both expressed as $CaCO_3$ in mg/l. Each of the samples had normal values of calcium and magnesium ions and these values are acceptable for domestic use and agricultural purposes. Furthermore hard water is not useful for domestic as well as agriculture purpose and this is predominantly caused by cations such as calcium and magnesium. All the water samples are within the acceptable limit with standards. Also people with kidney and bladder stones should avoid high content of calcium and magnesium in water. The WHO has suggested a limiting value of 500mg/L of TDS for potable water. In the present study samples complied with this limit with W3 having the highest value which could be due to the fact that the well did not have concrete rings. The sodium and potassium ions in the sample complied with the standards. Also excessive amount of nitrite from microbial action on agricultural fertilizer, when ingested nitrite compete for oxygen in the blood [10] but the nitrate level from all the water samples were observed to be in agreement with WHO/EPA values. The sources of metal contaminants of the underground water are uncertain though it may be due to natural process and anthropogenic activities [18]. Therefore water containing toxic metals may either have acute or chronic health effect like nausea, lung irritation, skin rash, vomiting, dizziness, cancer, birth defects, organs damage, disorder of the nervous system and damage to the immune system are usually more common [18]. For heavy metals analysis, lead was not detected in sample 1 and 2 while, cadmium was not detected in sample 2 but other samples had the heavy metal present in trace amounts. Lead may produce adverse health effect which include interference with red blood cell chemistry, delay in normal physical and mental development in babies and young children, slit deficit in attention span, hearing and learning abilities of children and slight increase in blood pressure in some adults. Although, presence of copper above the standard set by WHO/ EPA may cause gastrointestinal distress with a shorter term exposure, while a long term exposure may experience liver or kidney damage [19]. It was observed that W1 had no copper but W2 and W4 contained a high amount of copper thereby making them unfit for drinking.

Furthermore, serious ill health can be caused by water contaminated from faeces being passed or washed into river, stream, pool or being allowed to seep into well or borehole [3]. Results of bacteriological analysis of water sample is presented in Table 2. The total viable count for all water samples were quite high ranging from 2.02×10^2 to 6.08×10^3cfu/ml thereby exceeding the standard WHO and EPA limits [20]. High microbial counts in water are undesirable because of the increased likelihood that pathogens may be present, the possibility that these organisms will find access to foods and drink when used for domestic purposes.The well 3 had the highest viable count and this may be due to contamination. The total coliform counts of all the water samples were generally high. They exceeded the standard requirement for zero total coliform count per 100 ml for WHO and EPA standard [21]. The coliform ranges from 3.2×10^2 and 2.9×10^5. High total coliform counts vividly indicate that the water from the wells is faecally contaminated. The water sample from Well 3 had the highest total coliform count (290,000 MPN per 100 ml). This findings is not surprising considering the high population and close proximity of the well to pit latrines. The sewage could seep slowly into underground water, thereby polluting it. The reason for contamination of well water accounts for why the microbial load of well water close to refuse disposal site have higher microbial count than the one far away from refuse disposal site [22]. We observed that all the bacteriological analysis of the water from the wells fall short of the WHO recommended guideline standard for drinking water. It requires that water intended for drinking should not contain any pathogen or microorganisms indicative of faecal contamination. However, the decteted E. coli in all the water samples indicate that all the water samples are not free from recent faecal contamination. The ability to detect faecal contamination in drinking water is necessary, as pathogenic microorganisms from human and animal faeces in drinking water pose the greatest danger to public health. The bacteria isolation from water samples include Bacillus sp, Pseudomonas sp, Salmonella sp, Escherichia coli, Aeromonas sp and Vibrio cholera. The Faecal coliform and the E. coli counts exceeding acceptable limits are indicative of pollution from domestic wastes from several informal settlements located in the community. This study therefore recorded high number of coliform counts in water samples analyzed, thus making it unsafe for drinking and require further treatment.

V. Conclusion

The study revealed that groundwater in Idi ayunre does not provide safe (coliform free) water and must be treated before consumption. The coliform counts for some samples were within acceptable limits but others exceeded the WHO and FAO permissible limit for drinking water < zero cfu/100ml). Hence the monitoring of drinking/domestic water in this locality was investigated so as to prevent the spread of water borne diseases and to protect the health of the community. It is therefore recommended that inhabitants of Idi ayunre should not use their water supplies for drinking unless after proper boiling or appropriate treatment measures are employed. Furthermore, water sanitation and hygiene education programs should be in place so as to educate the people of this locality of water borne diseases and it effect on health.

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