Bacteriological analysis of some well water in Idah, Kogi State

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Abstract
The analysis of the bacteriological and some important physicochemical properties of well water in Idah, Kogi State was done in this research work. Samples were taken from three different private wells and three different community wells. From the analysis carried out it was observed that the pH values of the water samples (which were within the range of 7-8) are within the limits set by WHO (6.5-8.5).The total dissolved solids (120.00, 119.40, 139.80, 183.20, 166.40, 184.08) was also found to be below the limits set by WHO (500mg/L).The nitrate concentrations tested (6.89, 6.21, 9.30, 10.15, 12.78, 12.90) were also found to be below the WHO standard limit of 50 mg/L. However, the bacteriological analysis using the multiple tube fermentation technique, which tests for indicator organisms, gave values of 36, 22, 50, 110, 76, and 150 per 100 ml. This is against the WHO standard as it stipulates that no microbial contamination should be detected in 100 ml sample of water. Organisms such as *Escherichia coli, Klebsiella spp,* and *Salmonella spp* were isolated with *Escherichia coli* been the most frequent isolate. This research work showed that the tested well water in Idah are not fit for consumption due to the increased incidence of fecal contamination as evidenced by the MPN test results.

Key words: Bacteriological analysis, Private well water, Community well, Idah town

1. Introduction

The role of water in life is indispensable as it sustains life and it is a key pillar of health of human. It has been estimated that about 80% of diseases in developing countries are due to lack of good quality water (Okonko,*et al.*,2009). Natural groundwater is usually of good quality however, the quality can deteriorate due to inability of man to adequately protect the source and essentially poor resource management. Groundwater changing mechanisms and the natural weakening capacity also result from type of soil and geomorphologic characteristics. Groundwater contamination may result from improper dwelling of well and methods of disposal waste (Nkuma, 2010).

Microbial and chemical contaminants have been reported in ground-water. Contamination sources are numerous. It ranges from improper land disposal of sewage effluents to sludge and solid waste. It also includes effluents from septic tank, urban runoff and agricultural mining and industrial practices. The use of untreated and poorly treated ground water have accounted for a wide range of water borne diseases some of which are cholera, gastroenteritis, hepatitis, typhoid fever, and giardiasis. In most cases the causative agents are bacterial, viral pathogens and protozoan parasites. Compared to chemical hazards that also pollute groundwater with its consequences on public health in terms of time, microbiological pollution of groundwater effect is spontaneous and its effect on number of people is quite large (Pritchard,*et al.*,2008). Pritchard,*et al.*(2008) has also reported contamination of groundwater resulting from hydrocarbons, metals, cyanide, various synthetic substances, soluble form of nitrate, phosphorus and organic matter

One of the most common ground water contaminants in rural area is nitrate. It can be from natural and anthropogenic source (fertilizer usage). There is high degree of necessity to monitor the level of nitrate in drinking water since high level may result to serious illness and eventually death. Nitrate also been reported to cause shortness of breath, methemoglobinemia or blue baby disease, among other diseases like hemorrhage at the spleen (Pritchard, *et al.*, 2008). Issues related to public health due to contamination of ground-water have severe implications particularly in small communities and developing countries where the only source of water supply is groundwater drinking, cooking and washing. Therefore there is need to conform to physiochemical and bacteriological standards to reduce the outbreak and spread of water borne

disease. This is very important however, from region to region the standards varies but the main, objective in the world is to avoid the spreading of water borne diseases and if it cannot be avoided totally it must be reduce to the barest minimum (EPA, 2012).

Public water supply to Idah town is sourced from Inachalo stream, a tributary of the river Niger. There are however, few boreholes owned privately. The Water Board, which is charged with the responsibility of supplying water to the public, is of limited capacity and have gone comatose. The G.R.A and Igalaogba which are neighbourhoods connected to the pipe system can hardly boast of supply twice a week. The residents cannot say with certainty if the irregular supplies are well treated. Government and other social bodies have not be able to provide this basic need hence people turn to alternative source and groundwater or well water. The physicochemical and bacteriological quality of water has become a major concern to consumers, regulators and public health experts. Diseases contacted through drinking contaminated water is reported to kill about 5 million children annually and make $1/6^{th}$ of the world population sick (WHO, 2004). The world over, about 2.3 billion people suffer from diseases linked to water related problems and this has led to the death of millions of people yearly. The quality of drinking water is thus a powerful environmental determinant of human health (WHO, 2010). The aim of this research work is to determine the bacteriological load of well water in Idah town a highly populated town with a Polytechnique, School of Health Technology and many secondary schools and to inform the authority concern of any potential harm involved in the consumption of such water.

2. MATERIALS AND METHOD

Study Area

Idah is a town in Kogi State, Nigeria, on the eastern bank of the river Niger in the middle belt of Nigeria. It is often referred to as the headquarters of the Igala kingdom, and a head quarter of a Local Government area. The town is estimated to have a population of over 79,815 an official growth rate of 2.9% going by the 2006 census. The town is a major food supplier of Kogi State. It has commercial routes on the river Niger linking Lokoja, the Kogi state capital; to the north of the country and Onitsha in Anambra state) to the south, Agenebode Edo State across the Niger to the west. Its population is primarily Igala. The surface area is made up of low angle hills, slopes and lower ground. The climate is typically the savannah type. Based on its location, it is

supposed to have denser vegetation than the derived savannah found presently. Water samples from seven wells from four different locations of varying socioeconomic and demographic status are randomly collected in Idah for bacteriological analysis. Well water constitutes a source of drinking water in these areas. Most of the wells under study are owned by individuals and are accessible to the general public. Drawing of water from these wells is done by the use of 5-7 litre containers, which usually is tied directly to the well cover. In some cases individuals usually come with their own small bucket to draw water. Very few of the wells are constructed with concrete and are on average five meters deep. Water samples were collected from private well and community well.

Collection of Water Samples

Water samples are collected in sterile bottle tied with a strong string to a piece of metal(all sterile). The bottle cap is aseptically removed and the weighted bottle lowered into the well to a depth of about 1-2 meters. The bottle is brought up to the surface and covered with a screw cap. Samples were carefully collected without air bubble seen inside.

3. PHYSICO-CHEMICAL ANALYSIS

Physiochemical properties

The physiochemical parameters determined were pH, nitrate and total dissolved solids

The pH was done following Gillespie Claire, 2018 method. A glass electrode Testronic digital pH meter (Model 511) was used for the measurement. Determination of nitrate was performed according to the method described by Mulliken, 2002. EPA, 1999 method was employed in the determination of total dissolved solid (TDS)

TEST FOR INDICATOR MICRO ORGANISMS

This test is carried out to detect the presence of certain microorganisms such as *Escherichia coli,* coliforms and faecal *enterococci*

PRESUMPTIVE COLIFORM TEST

The multiple tube fermentation technique as described by Collins and Lynne, Mackie and Mc-cartney was used. In this method, varying amounts of water sample were added to double and single strength MacConkey broth in bottles containing inverted sterile Durham tubes as follows:

5 x 10ml of water to 10ml double strength medium

5 x 1ml of water to 10ml double strength medium

5 x 0.1ml of water to 10ml single strength medium

The bottles were incubated aerobically at 37^0C for 18-24 hours after which they were examined for production of acid and gas. Sterile distilled water was used as a control for each test batch. Presumptive coliform count was obtained by the most probable number (MPN) of coliform per 100ml of water sample, making reference to the McCrady's probability table after combination of various positive and negative results.

IDENTIFICATION OF ISOLATES

Positive tubes of the presumptive test were sub cultured on Eosin Methylene Blue agar for the enumeration of *Escherichia coli* and other enteric coliforms. All the inoculated media were incubated aerobically at 37^0C for 24 hours. The isolates were further characterized by a combination of colonial and morphological characteristic on solid media.

4. RESULTS AND DISCUSSION

The physicochemical result is given in Table1. pH values vary from neutral to alkalinity. Two of the private well Eteh and Sabon gari have neutral pH (7) value. Ofuloko well and all the community wells all had similar pH of 8 value. Edimeh *et al*. (2011) and Aremu *et al*. (2011) have also reported similar result in their separate work. According to EPA the standard limits of well water should be in the range of 6.5 – 8.5. The range of total dissolved solids for the private well ranged from to 119.40 mg/L to 139.80 mg/L while the community well ranged from 166.40 mg/L to 184.08 mg/L. The level of total dissolved solids in the community wells is higher than the private wells. However, all the values are lower than 500 mg/L as recommended by the National Guideline and Standards for water quality in Nigeria Federal Ministry of Environment, 1992 and the WHO specification limits (1000 mg/L) for drinking water (Edimeh et al., 2011). Total dissolved solids in water have been reported to vary from one geological region to another due to the solubility of different minerals (Durocher, 1990). The TDS of this study is

significantly lower than 1048.67 mg/L reported by Aremu *et al*., 2011 in Eggon, Nasarawa State, Nigeria. The high value reported was attributed to organic matter residue. The level of nitrate in private well ranged from 6.21 mg/L to 9.30 mg/L while corresponding values for community well ranged from 10.15 mg/L to 12.90 mg/L. Values obtained were all lower than 50 mg/L for drinking water (WHO, 2008). This therefore indicates that Idah town well water will have no serious effect on public health as far as nitrate is concern. Drinking water with nitrate excess of 50 to100 mg/L can cause methaemo- globinaemia. However, Robert (2006) has reported that the effect of nitrate to older children and adults is not as serious as it affects infants. High nitrate level in drinking water is therefore of a concern particularly in the community wells.

5. BACTERIOLOGY

The total viable bacterial counts obtained are shown in Table 2. Private well water value ranged from 0.1 x 10^4 cfu/ml in Sabon gari to 2.8 x10^4 cfu/ml in Ofuloko. The total viable bacterial counts obtained from public community wells 3.1 – 6.5 x 10^4 cfu/ml. The highest total viable bacterial counts (6.5 x 10^4 cfu/ml) was obtained at Kano road well, a community well. All the values obtained in community well were higher than the values obtained from privately owned well. The openness of community well permit free access of particles especially when it rains may have contributed to the high values recorded.

The values obtained exceeded (<500 cfu/ml) the standard limit. This therefore exposes a larger population to drinking contaminated water because results have shown high level of microbial contaminants. It thus becomes a threat to public health. The total bacteria count in public wells is higher than in private wells possibly due to its openness and hence susceptibility to various microbial contaminations. This may also be due to the poor sanitary conditions in which these wells were dug and maintained.

The presumptive coliform count obtained as the most probable number (MPN) per 100 ml, carried out through the multiple tube fermentation technique is given in Table 3. The MPN per 100 ml for the well water varied widely. The values ranged from 22 to 150 for the well sampled.

Table 1: Physicochemical result of well water

Type of well	Well Sampled	pH	Total dissolved solids (mg/L)	Nitrate concentration (mg/L)
Private wells	Eteh	7	120.00	6.89
	Sabon gari	7	119.40	6.21
	Ofuloko	8	139.80	9.30
Community wells	Edeh lokpa	8	183.20	10.15
	Ubi igah	8	166.40	12.78
	Kano road	8	184.08	12.90

Table 2: Total bacterial counts of well water samples from Idah

Type of well	Location	Total bacterial count (cfu/ml)
Private wells	Eteh	1.7×10^4
	Sabon gari	0.1×10^4
	Ofuloko	2.8×10^4
Community wells	Edeh lokpa	3.1×10^4
	Ubi igah	4.8×10^4
	Kano road	6.5×10^4

All the values obtained for private and community wells exceeded the standard limit set by the World Health Organization (WHO, 1985). The results indicate the presence of higher pathogenic bacteria contamination in public wells than in privately owned wells. This could be due to poor hygienic conditions in such communities ranging from lack of a proper drainage system, over-crowding, improper waste disposal to little or absence of well drained toilet systems to the sites to which these wells are located. Other reasons could be poor maintenance of these wells on the part of the community members themselves as everybody property is nobody property.

Table 4 shows the type of bacterial pathogens isolated from well water samples from different locations. Results indicate that 83.4% of the well water samples tested contains two or more species of bacterial pathogen. Although there is high incidence of *Escherichia coli* and *Klebsiella*, the presence of *Salmonella typhi* in some public wells further epitomize the poor sanitary conditions of these wells probably due to poor socio-economic and hygienic conditions of these communities.

TABLE 3: Total Coliform Count of Well Water Samples From Idah

	Private well									Community well								
	Eteh			Sabongeri			Ofuloko			Edeh lopa			Ubi Igah			Kano road		
Quantity of water used (ml)	0.1	1	10	0.1	1	10	0.1	1	10	0.1	1	10	0.1	1	10	0.1	1	10
Number of inoculated tubes	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Number of positives	1	4	4	2	2	5	2	4	5	1	3	5	0	4	5	2	4	5
MPN	36			22			50			110			76			150		

MPN: Most probable number

The results of the species determined are given in Figure 1. The observed species shows that *Escherichia coli* was predominant (65%) in the well water samples, followed by *Klebsiella spp* (30%) and *Salmonella typhi* (5%). These are pathogenic organisms mainly of faecal origin. The predominance of *Escherichia coli* could be attributed to its ability to grow at elevated temperatures. Idah town temperature is very high and this must have had an impact. The spread of diseases through faecal contamination of water sources particularly in developing and underdeveloped countries are a common phenomenon that has been well reported (Olowe *et al*., 2005).

In Idah as well as most part of Nigeria, availability of treated pipe-borne water is rare and restricted, where it exist, to urban and semi-urban areas. Even in these areas, public portable water supply is quite irregular. Consequently rich individuals dig boreholes as alternative water sources. The poor or average classes which constitute more than 80% of the population which cannot afford the high cost of borehole drilling are forced to dig wells as alternative source of water supply for drinking and sanitary purpose.

Table 4: distribution of bacterial pathogens in well water

Type of well	Well sampled	Identified isolates
Private well	Eteh	*Escherichia coli, Klebsiella spp.*
	Sabon gari	*Escherichia coli*
	Ofuloko	
Community well	Edeh lokpa	*Escherichia coli, Klebsiella spp.*
	Ubi igah	*Escherichia coli, Klebsiella spp.*
	Kano road	*Escherichia coli, Klebsiella spp, Salmonella spp.*

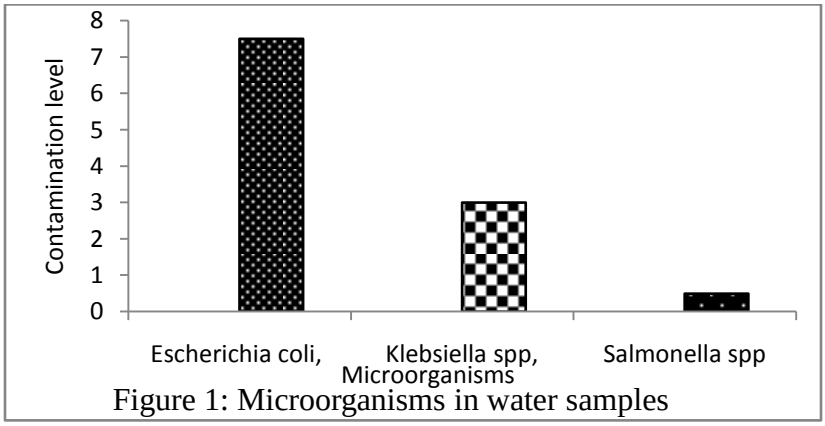

Figure 1: Microorganisms in water samples

The sanitary quality of potable water is determined primarily by the kinds of microorganisms present rather than by the microbial count per see (Bonde, 1977). Any water source used for drinking, cleaning and recreation purpose should be free from any organism of faecal origin (Akeredolu, 1991). The presence of enteric coliforms especially Escherichia coli makes the water samples unsuitable for human consumption according to the guidelines set by WHO for the evaluation of bacteriological quality of drinking water (Enujiugha *et al*., 1994).

Salmonella typhi was observed only in some public wells but was not isolated from any of the privately owned water samples. This may not be unconnected with good and proper household hygiene envisaged. This is not unconnected with the calibre of people living in this area, as well as absence of overcrowding which is the case in other locations under study. Apart from environmental hygiene and population density, the presence of *Salmonella typhi* in some of the public wells in those areas may also be attributed to drainage and flooding from contaminated surface water into unprotected well shafts. Findings from this study clearly highlight the non-conformity of well water samples studied with the WHO standard recommendation for safe potable water (Le-chevalier *et* al., 1987), a guideline that has been adopted world over including Nigeria.

The isolation of enteric pathogens of water consumed by humans is a serious problem which calls for vigilance on the part of the authorities. This is necessary because it can lead to outbreak of water borne diseases. Such disease outbreak may spread widely within the community and eto neighboring communities.

6. CONCLUSION

This study has shown incidence of contamination of well waters by pathogenic organisms and it should be of concern. There is need therefore of high sanitary and hygienic conditions with a lot of sensitization from the authority saddle with such responsibility. To reduce the widespread incidence of contamination of well water, it is advocated that wells dug must be deep, in highly sanitary and hygienic locations and covered adequately.

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