Physico-chemical and bacteriological analysis of water samples used for domestic purposes in Imesi-ile, Osun State, Southwest Nigeria.

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Abstract: One of the Millennium Development Goals is reducing the proportion of people without access to safe drinking water by 50%. Majority of the rural populace in Nigeria do not have access to pipe borne water but depend on ground water for domestic uses. Samples of water used for domestic purposes were collected from wells from different locations in imesi-ile. The physico-chemical and bacteriological analysis were done using standard methods and the results were compared with WHO and FMENV standards for drinking water. The pH ranged from 5.2-7.1, temperature was 26.1^0C, electrical conductivity ranged from 49 to 1118μScm^{-1}, total dissolved solids ranged from 24 to 559 mgl^{-1}, total hardness ranged from 6.01 to 46.08, nitrate ranged from 2.6 to 20.8, manganese ranged from 2.6 to 20.8, potassium ranged from 0.783 to 39.51, sodium ranged from 56.4 to 72.79, lead ranged from ND to 0.04, cadmium ranged from 0.05 to 0.062, copper ranged from ND to 0.10 and zinc ranged from 0.04 to 0.016. The bacteriological parameters analysed were total viable count which ranged from 1.75×10^3 to 1.81×10^3 $cfuml^{-1}$. Bacteria isolates were identified as *Proteus sp, Bacillus sp, Escherichia coli, Pseudomonas sp, Salmonella sp,* and *Staphylococcus aureus*. Even though most of the physico-chemical parameters are within the FMENV and WHO permissible limits, the total viable count for all samples exceeded the WHO and FMENV standards. The coliform counts for some samples were within acceptable limits but others exceeded the WHO permissible limit for drinking water making the water unfit for drinking and other domestic purposes without prior treatment.
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1. Introduction.

Assessment of the quality of drinking water is important for sustainable development. In many developing countries, availability of water has become a critical and urgent problem for communities without access to pipe borne water (Okonko et al, 2008). There is need to control the pollution of surface and ground water since the public health of the people have a direct link with the availability of adequate quantity of good quality water (Alao et al, 2010). Potable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikanra, 1999). Majority of the rural populace do not have access to potable water but depend on wells, streams and river for domestic use. One of the Millennium Development Goals is to reduce the proportion of people without access to safe drinking water by 50%, yet rural communities are the furthest from meeting the 2015 MDGs drinking water target (The Millennium Development Goals Report). Rural settlements in Sub-saharan Africa have made the least progress in improved water sources since 1990, improving only by 9% in 2006.

In recent years, ground water has been under increasing threat of pollution due to increased human activities (Jameel, 1998).The cleanliness of lakes, rivers, oceans and ground water is one of the most pressing goals of environmental protection. The World Health Organization has recommended continuous surveillance of water supplies; this involves keeping a careful watch at all times, from public health point of view, over the safety and suitability of water supplies. The lack of safe drinking water and adequate sanitation measures can cause diseases such as cholera, dysentery, salmonellosis and typhoid, and every year they claim millions of lives in developing countries. Diarrhoea is the major cause of death of more than 2 million people per year world-wide, mostly children under the age of five (Anon 2000). Throughout the world, about 2.3 billion people suffer from diseases linked to water related problems (UN, 1997, WHO, 1997)

The scarcity of pipe-borne water has made many communities to find alternative sources of water: ground water sources being a ready source. For most communities the most secure source of safe drinking water is pipe-borne water from municipal water treatment plants. Often, most 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 (Adekunle, 2009). Water quality monitoring involves physicochemical and bacteriological analyses of water samples from various sources. Microbiological quality of water is of greatest importance especially in developing countries with low standard of sanitation. This aspect includes routine sampling and analysis of drinking water to ensure that it does not contain coliform bacteria an indicator of pollution with excreta. *Escherichia coli,* Faecal coliforms and *Aerobacter aerogens* are among the common indicators. In Nigeria, majority of the rural populace do not have access to potable water but depend on wells, streams and rivers for domestic water supply (Lamikanra, 1999). The bacterial qualities of groundwater and other natural water supplies in Nigeria, have been reported to be unsatisfactory, with coliform counts far exceeding the level recommended by W.H.O (Dada *et al*., 1999a, 1999b, Edema *et al*., 2001) Chemical investigation of the water quality of some Nigerian rivers.(Ajayi and Osibanjo, 1981; Adeniji and Mbagu, 1983; Imevbore, 1970; Asuquo, 1989) reveals that water that was once an abundant natural resource is rapidly becoming scarce in quantity and the quality is deteriorating in many places, owing to population. Imesi-ile, a town in Nigeria depends on wells for most its' domestic water supply. To the best of our knowledge, there are no reports on the sanitary quality of well water from this area. This study was undertaken to evaluate the physicochemical and bacteriological analysis of water used for domestic purposes in this area.

2. Material and Methods.

Study Area

The study area, Imesi-ile, Osun State, Southwest Nigeria. It is situated on Longitude 4° 49' 60 E and Latitude 7° 49' 60 N. Water samples were collected from wells in selected locations.

Quality Assurance Procedures

Samples analysed for DO (dissolved oxygen) and COD (chemical oxygen demand) were collected using glassware while heavy metals and other parameters were collected in plastic containers. The plastic and glass containers were soaked in 1M HNO_3 overnight (Onianwa, 2001) and washed with laboratory detergent, rinsed with tap water and finally with deionized water.

Physico-Chemical Analysis

The physico-chemical parameters analyzed in accordance to standard methods of [APHA, 1998] 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.

Bacteriological analysis

The membrane filtration 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. Each membrane filter was inoculated on sterile petri dishes containing media for culturing certain indicator bacteria. Baird Parker agar, Salmonella-Shigella agar, McConkey agar, Eosin methylene blue agar, Pseudomonas centrimide agar, Mannitol salt agar and plate count agar were used for enumeration of bacteria and the primary identification of some of the isolates. The media were prepared according to manufacturers' specification and sterilized in an autoclave at 121°C for 15 minutes. Pure culture of bacteria isolates obtained from inoculated plates was further subjected to morphological characterization tests to determine their identity in accordance with Bergey's Manual of Determinative Bacteriology. (Buchanan and Gibbon, 1974).

3. Results

Table1. Physicochemical parameters of water samples

Parameters	W1	W2	W3	W4	WHO	FMENV
Temperature (^oC)	26.1^0 C	26.1^0C	26.1^0 C	26.1^0 C		
pH (mgl^{-1})	6.5	5.2	7.0	7.1	6.5-8.5	6.5-8.5
Conductivity (μScm^{-1})	223	49	1118	328	300	
TDS(mgl^{-1})	120	24	559	163	500	500
Total Hardness(mgl^{-1})	105.67	101.12	210.56	58	100	100
COD	8	-	-	-	10	-
BOD	13	-	-	-	-	-
DO	3.2	-	-	-	5	-
Calcium Hardness	44.75	5.15	43.78	18.82	100	75
Magnesium Hardness	1.33	0.86	12.76	3.03	150	30
Nitrate(mgl^{-1})	2.6	5.03	20.80	10.40	10	10
Cadmium(mgl^{-1})	0.046	0.062	0.062	0.04	0.05	0.01
Iron(mgl^{-1})	0.034	0.394	0.030	0.089	0.3	0.3
Zinc(mgl^{-1})	0.016	0.040	0.040	0.016	5.0	5.0
Lead(mgl^{-1})	ND	ND	0.062	0.078	0.05	0.05
Copper(mgl^{-1})	0.01	0.005	ND	0.005	1	0.1
Manganese	0.009	0.013	0.008	0.003	0.1	0.05
Sodium	62.66	56.40	72.79	59.84	200	20
Potassium	0.838	0.783	39.514	14.118	12	-

W1, W2, W3 and W4 are water samples from wells from different locations.
WHO: World Health Organization, FEPA 1991/ FMENV: Federal Ministry of Environment (Nigeria)

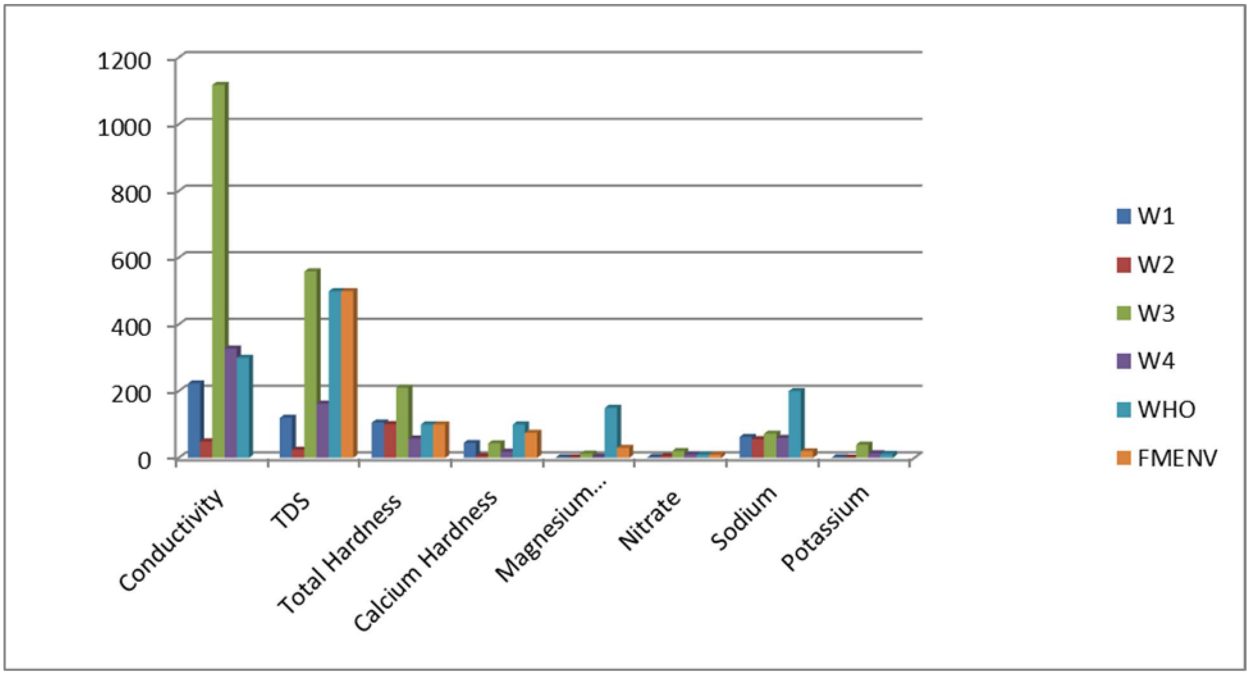

Figure 1. Physicochemical parameters of water samples

Table 2. Sample count after 48hours on incubation on the media.

Sample	TBC(cfu/ml)	Coliform count(cfu/100ml)	Pseudomonas count (cfu/ml)	EMB(cfu/ml)
W1	1.79×10^3	-ve	-ve	-ve
W2	1.78×10^3	1.1x10	2×10^2	3.1×10^2
W3	1.81×10^3	0.5x10	-ve	0.11×10^2
W4	1.75×10^3	-ve	-ve	-ve

Table 3. Morphological characteristics of isolates

Bacteria isolates	Characteristics	Probable organism
A	Gram positive rod with creamy colony on nutrient agar.Spore present	Bacillus species
B	Gram negative fat rod. Colony with entire margin with mucoid constituency. No spore. Gave metallic sheen colonies on EMB agar.Motile	E. Coli
C	Gram negative rod , non motile colonies appear translucent in on Nutrient agar with feather shaped margins	Proteus sp.
D	Gram negative rod with no spore.Rods are short. Appear colourless on Nutrient agar.Appeared with yelowish colony on Pseudomonas centrimide agar after 48 hours	Pseudomonas sp.
E	Gram negative rod with dark centered colony. Non endospore form grew on Salmonella Shigella agar	Salmonella sp.
F	Gram positive cocci with no spore or motility	S.aerus, staphylococcus sp.

4. Discussion

The results as listed in Table 1 showed that the pH, temperature, calcium, magnesium, sodium and potassium were within the permissible limits of WHO and FMENV. Nitrate concentration for sample 1 and 2 were within the WHO limits but sample 3 and 4 exceeded the limits. Nitrate contamination result from human activities such as agricultural fertilizer, animal waste or seepage from septic tank (Schubert et al, 1999). Conductivity was measured as µS/cm and ranged from 49 to 1118; sample 3 had the highest value, suggesting that the dissolved solids are mostly mineral salts. The WHO has suggested a limiting value of 500mg/L of TDS for potable water. In the present study samples complied with this limit except sample 3 which was 559. Total hardness for sample 3 and 4 exceeded the standards set FMENV and WHO. All the wells from which the samples were taken had concrete ring except for sample 3, making contamination by seepage from surrounding soil more likely. This probably explains why some of the parameters for sample 3 had higher values when compared with other samples. Dissolved oxygen present in drinking water adds taste and it is highly fluctuating factor in water. In this study dissolved oxygen for sample 1 was 3.2 which was within the WHO limits. The maximum allowed value of chemical oxygen demand (COD) is 10 mg/L in drinking water similarly for sample 1 the COD was 8 mg/L and this was also within the WHO permissible limit. Cadmium in sample 2 and 3 was higher than the WHO and FMENV permissible limits whereas the heavy metal concentration for the other samples were within the permissible limits.

Water from the wells fall short of the WHO (1997) recommended guideline standard for drinking water in terms of the coliform counts. Contamination of wells is due to improper construction, shallowness, animal wastes, proximity to toilet facilities, sewage, refuse dump sites, and various human activities around the well (Bitton, 1994). Water intended for drinking should not contain any coliform indicative of faecal contamination. The microbial load of well water close to refuse disposal site has higher microbial count than the one far away from refuse disposal site. (Shittu et al, 2008). Results of bacteriological analysis of water sample is presented in Table 2. The coliform count for sample 2 exceeded the WHO standard for untreated water while sample 2 was within the limit, this shows that the well from which sample 2 was taken may be located close to a refuse dump or septic tank. Also the total viable count for all water samples were quite high ranging from 1.75×10^3 to 1.8×10^3 $cfuml^{-1}$. This is higher than the WHO standard zero cfu /100ml, (WHO 2002) for drinking water. Bacteria isolates were identified as *Proteus sp, Bacillus sp, Escherichia coli, Pseudomonas sp, Salmonela sp, and Staphylococcus aureus* as shown in Table 2 and 3. These findings are in line with a previous study of Ali *et al*, 2007. The high bacteria count is suggestive of presence of organic matter (Olayemi, 1994). This makes the water undesirable because of the increased likelihood that pathogens may be present.

5. Conclusion

The study revealed that the quality of water samples was acceptable for majority of the physico-chemical parameters, but bacteriological analysis shows that the water is not coliform free and must be treated before it is used for domestic purposes. We therefore recommend that the inhabitants of Imesi-ile should not use their water supplies for drinking without boiling or appropriate treatment measures are employed, along with this there should be regular monitoring of groundwater quality. We also recommend that wells should be properly constructed and must not located close to septic tank, sewage or refuse disposal site.

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