Original Article

BACTERIOLOGICAL ASSESSMENT OF SELECTED BOREHOLE WATER SAMPLES IN ILORIN METROPOLIS

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ABSTRACT

This study is about the microbial risk assessment of different borehole water samples within Ilorin Metropolis. Ten different samples of borehole water used for domestic purposes and drinking were collected from different borehole water points namely Sanni Mai Tea, Korolekeleke, Abayawo, Alore, Ita-Merin, Ita-Nmo Market, Ita-Kudimo, Abemi, Popogbona mosque and Agbaji, all within Ilorin Metropolis. The physicochemical parameters analyzed were pH, temperature, colour and turbidity. Temperature range of the water samples was found to be 22 – 28^{0}C while turbidity of the samples ranged from 2 – 5 NTU, and colour range were from 2 – 6 TCU. The pH of the water samples ranged from 6.4 – 7.4. These water samples were analyzed for the presence of micro-organisms. Total plate counts, total coliform counts and faecal coliform counts were enumerated using Nutrient Agar, MacConkey broth and Eosin Methylene Blue (EMB) Agar respectively. The total count of the water samples ranged from zero to 2.30 x 10^2 cfu/ml occurring in only four of the samples analysed. The MPN coliform index per 100 ml of water samples ranged from zero to 16 . However, no faecal coliform was isolated from all the samples. Three bacterial species were isolated and identified in the four samples found to be unwholesome. The organisms encountered were: *Enterobacter aerogenes*, *Micrococcus* sp.and *Klebsiella* sp. These organisms are of public health significance. Sanitary surveillance reveals that four of the sampling points were littered with either animal and fowl droppings, or solid waste dump sites were near the sampling points. The surrounding environments near the four boreholes were unkept and dirty.

Key words: Borehole water, risk assessment, total plate count, total coliform count and faecal coliform.

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INTRODUCTION

In many developing countries, availability 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 (Okonko *et al.*,

2008). Increase in human population has exerted an enormous pressure on the provision of safe drinking water especially in developing countries (Umeh *et al.*, 2005).
Unsafe water is a global public health threat, placing persons at risk for a host of diarrheal and other diseases as well as chemical intoxication (Hughes and Koplan, 2005).

Unsanitary water particularly has devastating effects on young children in the developing world. Each year, more than 2 million persons, mostly children less than 5 years of age, die of diarrheal disease (Kosek *et al.*, 2003; Parashar *et al.*, 2003). For children in this age group, diarrheal disease accounted for 17% of all death from 2000 to 2003 ranking third among causes of death, after neonatal causes and acute respiratory infections (WHO, 2005). Nearly 90% of diarrheal-related deaths have been attributed to unsafe or inadequate water supplies and sanitation conditions affecting a large part of the world's population (WHO, 2004; Hughes and Koplan, 2005). An estimated 1.1 billion persons (one sixth of the world's population) lack access to clean water and 2.6 billion to adequate sanitation (WHO, 2005; Hughes and Koplan, 2005).The principal objectives of municipal water are the production and the distribution of safe water that is fit for human consumption (Lamikanra, 1999; Okonko *et al.*, 2008). Recently in Nigeria, drinking water is commercially available in easy-to-open 50–60ml polyethylene sacks known as sachet water (Umeh *et al.*, 2005). Conformation with microbiological standard is of special interest because of the capacity of water to spread diseases within a large population. Although the standards vary from place to place, the objective anywhere is to reduce the possibility of spreading water-borne disease in addition to being pleasant to drink, which implies that it must be wholesome and palatable in all respects (Edema *et al.*, 2001; Okonko *et al.*, 2008). A collaborative, interdisciplinary effort to ensure global access to safe water, basic sanitation, and improved hygiene is the foundation for ending cycle of poverty and diseases (Hughes and Koplan, 2005).

In line with objective of MDG (Millennium Development Goals) adopted by the Federal Republic of Nigeria is the provision of safe potable water and because of the limitation of funds for this provision and others, Kwara State of Nigeria adopted the provision of safe borehole water to augment that of treated water in all parts of the state including Ilorin metropolis.

High level of chlorine in treated public water supply could react with organic matters to form organochlorine compounds which has been found to be carcinogenic when consumed over a long period of time. Hence, a high percentage of people are turning to the use of borehole water for domestic chores and drinking even though Sule *et al.* (2009) in a recent research found out that stressed bacterial cells reactivate faster in dechlorinated water than in chlorinated water.

The objectives of this study are to determine the bacteriological quality of water produced by these boreholes; the safety and potability of the water from the boreholes; and the physicochemical parameters of the water from the boreholes.

MATERIALS AND METHODS

Collection of Water Samples

Ten water samples were collected from ten boreholes within Ilorin metropolis using sterile sampling bottles. The samples were from Sanni Mai Tea, Korolekeleke, Abayawo, Alore, Ita-Merin,Ita-Nmo market, itakudimo, Abemi,Popogbona mosque and Agbaji, all within Ilorin Metropolis of Kwara State,Nigeria using standard methods as described by APHA (1985).

Bacteriological Quality Determination: Total Bacterial Count

The total bacterial count was determined by pour plate technique using standard methods (APHA, 1985). Nutrient agar medium was used for the enumeration of bacteria in the samples.

Total coliform Count

This was determined by MPN index method using 3-3-3 regimen. MacConkey broth was used and positive result was indicated by acid and gas production on incubation at 37^0C for 48 hours (Fawole and Oso, 2001).

Faecal Coliform Count

Faecal coliform count was determined using Eosin Methylene Blue medium using pour plate technique. Organisms with greenish metallic sheen were taken as positive for *E.coli.* This was further confirmed by the ability of the organism to ferment lactose at 44.5^0C.

Physicochemical Parameters

The pH readings of the borehole water samples were taken using pH meter Wag WT 3020. The pH meter was standardised with buffer 4, 7 and 9 before being used (Sule *et al.*, 2009).

Temperature of each sample was determined using mercury-bulb thermometer.

Both colour and turbidity for each of the sample was determined using WagWT3020 turbidimeter.

RESULTS

All the water samples maintained normal temperature range of $22\text{-}28^0$C. Their colour and turbidity on Wag WT 3020 Turbidimeter had a range of 2 – 6 True Colour Unit (TCU) and 2 - 5 Nephelometric unit (NTU) respectively (Table 1). The pH of the borehole water samples ranged between 6.4 - 7.4.

Only four of the borehole water samples had the presence of bacterial counts. The total bacterial count ranged from zero to 2.3×10^2 cfu/ml. Similarly, the total coliform count of the borehole water samples also ranged from zero to 16 MPN index of coliform/100 ml of the water samples. All the water samples had zero count of faecal coliform (Table 2). The occurrences of the different bacterial species are shown in Table 3.

The sanitary survey of the borehole site for solid waste dump and animals and fowls dropping are presented in Table 4. Three borehole water samples contained both solid waste dump, and animals and food droppings,

Table 1: Physicochemical parameters of Borehole water samples

Sample	pH	Temp. (°C)	Colour (TCU)	Turbidity (NTU)
A	6.5	25	3	5
B	6.4	27	5	5
C	6.8	22	6	3
D	7.1	26	4	2
E	7.3	25	3	4
F	7.4	24	5	5
G	6.7	28	4	3
H	7.3	27	5	4
I	7.0	23	2	5
J	7.2	24	5	5

A, Sanni Mai Tea; B, Korolekeleke; C, Abayawo; D, Alore; E, Ita Merin; F, Ita-Nmo; G, Ita-Kudimo; H, Abemi; I, Popogbona Mosque; J, Agbaji.

Table 2: Bacteriological Counts of the Borehole Water Samples

Borehole samples	Total Bacterial Count (cfu) x 10^2	Total Coliform Count (MPN/100ml)	Faecal coliform count (cfu/ml)
A	0	0	0
B	2.3	16	0
C	0	0	0
D	0.43	6	0
E	0	0	0
F	1.3	13	0
G	0.62	9	0
H	0	0	0
I	0	0	0
J	0	0	0

A, Sanni Mai Tea; B, Korolekeleke; C, Abayawo; D, Alore; E, Ita Merin; F, Ita-Nmo; G, Ita-Kudimo; H, Abemi; I, Popogbona Mosque; J, Agbaji.

Table 3: Occurrence of Bacterial species in the Borehole Water Samples

Borehole Water Sample	*Klebsiella sp.*	*Micrococcus sp.*	*Enterobacter aerogenes*
A	-	-	-
B	-	-	+
C	-	-	-
D	+	-	+
E	-	-	-
F	+	+	-
G	+	+	+
H	-	-	-
I	-	-	-
J	-	-	-

A, Sanni Mai Tea; B, Korolekeleke; C, Abayawo; D, Alore; E, Ita Merin; F, Ita-Nmo; G, Ita-Kudimo; H, Abemi; I, Popogbona Mosque; J, Agbaji.

Table 4: Sanitary Surveillance of Borehole Sampling Points

Borehole Water Sample	Solid Waste Dump	Animals and Fowls Droppings
A	-	-
B	-	+
C	-	-
D	+	+
E	-	-
F	+	+
G	+	+
H	-	-
I	-	-
J	-	-

A, Sanni Mai Tea; B, Korolekeleke; C, Abayawo; D, Alore; E, Ita Merin; F, Ita-Nmo; G, Ita-Kudimo; H, Abemi; I, Popogbona Mosque; J, Agbaji.

The rest borehole water samples, except one that had animals and food droppings, had neither the solid waste dump or animals and food droppings.
Six of the borehole water samples did not contain any *Klebsilla sp*, *Micrococcus sp and Enterobacter aerogenes.* One had all the three bacteria and, in one only Enterobacter *aerogenes* was isolated.

DISCUSSION

The pH of the borehole water samples fell within the range of 6.4 – 7.4. This pH range is close to neutrality and would allow the growth of most bacterial species. Eniola *et al*. (2007) obtained similar pH ranges of 6.54 – 7.80 and 6.54 to 7.90 for borehole water samples stored indoor and outdoor in containers of different colours.

Colour is an important physical quality of water which will affects its acceptability by the consumers. Ninety percent of the borehole water samples were within the acceptable limit of 5TCU (WHO, 1985; NSDWQ, 2007). The mineral composition of the site could affect the colour of the water especially if iron compounds are present.

The turbidity of the borehole water samples ranged from 2-5NTU. This is also in conformity with the values allowed (WHO, 1985; NSDWQ, 2007). Turbidity results from the presence in the borehole water samples of particulate matters such as clay, silt, finely divided organic matter etc. These colloidal materials provide adsorption sites for chemicals that may be harmful to health or cause undesirable tastes or odours (Adekunle *et al*., 2007).

The temperature of any water body affects the rate of proliferation of micro-organisms (Pelczar *et al*., 2005). The temperature range of 22 – 28^{o}C could be said to be suitable for the growth of heterotrophic bacterial species when present in the sample.

The total bacterial counts of the borehole water samples ranged from zero to 2.3 x 10^2 cfu/ml with eighty percent of the samples having count within the limit of 100 cfu/ml allowed for potable water (NSDWQ, 2007). Erah *et al. (* 2002) in a study conducted on the quality of ground water in Benin City, Nigeria found unacceptable levels of aerobic bacteria and fungi present in borehole water of Teboga District of Benin City. In another similar work, Eniola *et al*. (2007) obtained a range of

5.0 x10^2 to 7.0 x 10^2 cfu/ml for stored borehole water samples.

All the borehole water samples were devoid of faecal coliform, they were however not free of total coliforms which are probably from the environmental sources and are non-faecal in origin. The total coliform contents of the samples ranged from zero to 16 MPN of coliform/ 100ml of the sample. WHO (1985) specified that potable drinking water should be devoid of total coliform in any given sample. The borehole water with the highest bacterial count also had the highest total coliform count. It is note-worthy to mention that 60% of the borehole water samples have zero total coliform counts. Results of total coliforms obtained in this study is similar to that of Rogbesan *et al*. (2002) who also obtained total coliform outside the range allowed by WHO.

The presence of *Klebsiella* sp., *Micrococcus* sp., and *Enterobacter aerogenes* in some of the borehole water samples are unacceptable from the public health point of view. These organisms could be pathogenic. Therefore, there is need for caution when using these contaminated borehole water sources for any purposes. Eniola *et al*. (2007) obtained some members of coliform in stored borehole water samples.

Sanitary survey of the borehole sites revealed the proximity of some of the boreholes to solid waste dump site and animal droppings being littered around them.

CONCLUSION

This investigation suggests that not all borehole water is fit for human consumption. Hence, tests have to be done in order to determine if they are potable. The sites of boreholes are very important as clean and hygienic environment promote safety of water. The geologist drilling boreholes have to be educated on the importance of ensuring that dump sites are not used for drilling of boreholes. Moreover, the populace need to be educated on the importance of maintaining clean and hygienic environment around the borehole to ensure the safety of water from such boreholes.

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