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Physico-chemical and microbiological assessment of borehole water in Okutukutu, Bayelsa State, Nigeria

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ABSTACT

The concern over exposure to drinking water contaminants and the resultant adverse effect on human health has prompted several studies evaluating the quality of drinking water sources. Treated water samples were collected from all twenty one (21) functional boreholes in Okutukutu using standard techniques. $P^{H,}$ Turbidity, Iron, Nitrate, Chlorine, Calcium, Magnesium and E. coli, in the water samples were determined using standard procedures. One household for each borehole by simple random method was selected and stored water from the borehole was bacteriologically assessed. World Health Organisation acceptable limits for drinking water were used in the evaluation. All physico-chemical parameters in borehole water samples were within recommended standards. Residual chlorine at the sample tap was less than recommended amount of 0.2mg/l in 61.9% of the boreholes. All borehole samples tested negative for E. coli. 66.7% of stored borehole samples in household tested positive for E. coli but was negative for all other enterococci bacteria.This study has shown that water from the boreholes in Okutukutu community in Yenagoa Local Government Area in Bayelsa state, (judging from the physico – chemical and microbiological variables measured in this study) is safe for drinking and other uses. The microbiological analysis of stored borehole water showed that 14(66.7%) of stored house hold water was contaminated with E.coli. Hence there is need for improved hygiene and regular hygiene education.

Key words: Bacteriological, E.coli, Bore-hole, treated water and, Okutukutu.

INTRODUCTION

Water is of the most important of all natural resources. It is vital for all living organisms. Accessibility and availability of fresh clean water is a key to sustainable development an essential element in health, food production and poverty reduction. As important as water may be, it's economic importance as a medium of water related disease, which constitutes a significant percentage of the diseases that afflict human, must not be over-looked. An estimated 1.2 billion around the world lack access to safe water [United Nations Non Governmental Liaison Services (NGLS).Third World Water Forum on water, 2003].

Every 20 seconds, a child dies from a water-related disease [WHO 2009]. Diarrhea remains the second leading cause of death among children under five globally. Nearly one in five child deaths – about 1.5 million each year – is due to diarrhea. It kills more young children than AIDS, malaria and measles combined. [WHO 2009]

The quality of groundwater is a function of natural processes as well as anthropogenic activities. Nitrate compounds, heavy metals pesticides etc that are contained in our drinking water can also constitute undesirable pollutant when they are not within World Health Organization (WHO) guidelines for drinking water [WHO, 1996].

From environmental stand point, there is a need to ascertain the level of water quality of a locality to avoid or reduce some of these health hazards. Based on these, this study was carried out in Okutukutu, a community in Yenagoa the capital of Bayelsa State, Nigeria.

MATERIALS AND METHODS

There are only twenty one functional boreholes in Okutukutu community and for each borehole by simple random sampling method, one household was selected and stored water from the borehole was bacteriologically assessed.

Cotton wool soaked in 70% ethanol was used to sterilize the nozzle of the borehole from which samples were collected. The tap was allowed to run for two minutes before sterile 250ml screw capped plastic bottle was carefully uncapped and filled with water and recapped. Water samples were transported to the laboratory in a cooler with ice for bacteriological analysis within three hours of collection.

Traditional methods for detecting presumptive Escherichia coli and streptococci was adopted following standard laboratory precautions to assess the microbiological quality of the bore hole water samples collected.

Physico-chemical assessment: This involved visual assessment of the external features of the water samples, which includes specific odour, and appearance (colour, turbidity and presence of floating particles, or extraneous materials). Parameters such as total hardness, presence of minerals (such as magnesium, chlorine, calcium, iron and Nitrate) were determined by methods described by Kegley and Andrews (1998); Foster and Leslie (1978).

RESULTS AND DISCUSSION

TABLE 1 Summary of physical and chemical parameters of boreholes

Parameter	N	Minimum	Maximum	Mean	Std.deviation
P^H	21	6.63	7.31	6.9714	0.24017
Turbidity	21	0.10	0.54	0.3286	0.11757
Iron	21	0.00	0.30	0.0590	0.09439
Nitrate	21	0.00	0.00	0.000	0.00000
Magnesium hardness	21	7.90	21.00	13.4790	4.05359
Calcium hardness	21	30.00	90.00	55.8095	18.25546
Total hardness	21	37.90	111.00	69.2886	22.13055
Residual chlorine	21	0.00	0.32	0.1267	0.11599
Total chlorine	21	0.00	4.70	1.5800	1.51242

Key; N = No of boreholes.

Health is determined by many factors which include income, environmental conditions like access to adequate sanitation and safe drinking water supplies, behavior change and availability of health services [Thompson and Khan, 2003]. The provision of sanitation facilities and the use of clean portable water should ensure the reduction of water related illness and dramatically improve the quality of life. In most cities throughout the world, providing access to piped water and sanitation for the urban poor continues to be a challenge for a number of reasons. Some of the challenges include difficulties with land tenure, irregular crowded street patterns and the prohibitive high cost of installing household connections for poor families. However, these two basic facilities are in inadequate supply especially in urban squatter settlements. As a result ground water and surface water sources are being grossly polluted resulting into outbreaks of diarhoea, cholera, and dysentery, which continues to claim many lives [UNEP, 1999].

The results of various physical and chemical and parameters of borehole water from tap are tabulated in table 1.

Odour and appearance of the water samples were found to be unobjectionable and clear. Odour in water is usually caused by volatile substances associated with organic and inorganic chemical materials such as algae and hydrogen, respectively [La Dou 2004].

P^H of the collected water sample

The pH values in the study areas are confined mostly in the range from 6.63to 7.31indicating the slightly acidic to slightly alkaline (near neutral) nature of the ground waters and are well within the limits prescribed for various uses of water including drinking water supplies [WHO 2009].

Total Hardness (Calcium and Magnesium (Mg2+))

It is known that calcium and magnesium along with their carbonates, sulphates and chlorides naturally confer temporary and permanent hardness. A 300 mg/l has been recommended as a desirable limit and 600 mg/l as the maximum permissible limit for potable water [Bureau of Indian Standard, 1991]. The water samples were soft to moderately hard [Freeze and Cherry 1979]. The magnesium and calcium concentrations were within recommended limits of 30mg/l and 75mg/l, except Esowe, Amasamana, Wombu, and Zambdest boreholes with calcium concentrations of 77mg/l, 85mg/l, 90mg/l, and 78mg/l.

Calcium, which is essential for nervous system and for the formation of bones, is commonly present in all water bodies where it usually comes from the leaching of rocks [Agunwamba, 2000]. On the other hand Magnesium is usually less abundant in water than calcium, perhaps due to the fact that magnesium is found in the earth's crust in much lower amounts as compared to calcium [UNEP 1999]. High concentration of magnesium in drinking water gives unpleasant taste to the water [WHO, 1996]. Calcium and magnesium concentrations in water have been linked to outcomes in heart diseases [Lucie, 2004]. There is epidemiological evidence to suggest a lower incidence of heart disease in communities with hard water (high calcium and magnesium content) [Frantisek, 2003, Anderson and Le Riche, 1971].

Chlorine

Chlorine distribution in the samples used in this study indicated that free chlorine concentration of sixty one percent (61%) of the samples lie below the desirable limits (0 .2mg/l) recommended for drinking water. A limit of 100 mg/l of chloride has been recommended as maximum permissible limit for drinking water [WHO, 1996]. This limit has been laid down primarily based on taste considerations. However, no adverse health effects on humans have been reported from intake of water containing even higher concentrations of chloride [Jim, 1995].

Iron

Most groundwater supplies contain some iron because iron is common in many aquifers and is found in trace amounts in practically all sediments and rock formations. The iron content of groundwater is important because small amounts seriously affect water's usefulness for some domestic and industrial purposes. The World Health Organization recommends that the iron content of drinking water should not be greater than 0.3mg/L because iron in water stains plumbing fixtures, stains cloths during laundering, incrusts well screens and clogs pipes [Deutsch, 2003]. In Yenagoa metropolis, the State Water Board recommends 0.3mg/l of iron as the maximum expected limit. All the boreholes analysed in Okutukutu falls within the range 0.1mg/l to 0.3mg/l.

Nitrate

Nitrogen enters the ground from several sources. Certain plants such as legumes fix atmospheric nitrogen and transfer it to the soil where it is used by plants. Some of the surplus nitrogen is removed in solution by downward percolating soil water. Other sources of soil nitrogen are decomposing plant debris, animal waste, household solid waste and nitrogen fertilizers. Additional nitrogen may enter groundwater from sewage discharge on land. Also, many industrial solid wastes contain high concentrations of nitrogen. Natural nitrate concentrations in groundwater range from 0.1 to 10mg/l [Adeyemo, Ayodeji, and Aiki-Raji, 2002]. Nitrate in concentration greater than 45mg/l is undesirable in domestic water supplies because of the potential toxic effect on young infants. Methemoglobinemia is a disease caused by nitrate, which is converted to nitrite in the intestines [Adeyemo, Ayodeji, and Aiki-Raji, 2002]. The safe nitrate limit for domestic water is set at 45mg/l [WHO, 1984]. Nitrate cannot be removed from water by boiling but must be treated by distillation. Nitrate was absent in all the boreholes in Okutukutu.

An important indicator of water quality is the number of bacteria present in the water. Though it would be difficult to determine the presence of all bacteria in a sample, certain types of microorganisms can serve as indicators of pollution. Chief among these are the coliform bacteria which survive better, longer and are easier to detect than other pathogens [Kegley and Andrew, 1998, Agunwamba, 2000]. E. coli is regarded as the most sensitive indicator of faecal pollution. Faecal indicator bacteria have been used to measure water quality and personal hygiene standards in a variety of settings [Gent and Strauss 1997]. In this study, the bacterial faecal indicator E. coli was used to provide an insight into the water quality from source. Water samples taken directly from borehole taps in this study yielded neither coliforms nor E. coli. This agrees with Howard that boreholes as low cost technology option for developing countries are generally considered as safe sources of drinking water when properly constructed and maintained, they provide consistent supplies of safe and wholesome water with low microbial load and little need for treatment of the drinking water [Deutsch, 2003].

CONCLUSION

Any civilised society should consider the provision of safe drinking water a priority. This is so because safe drinking water is a basic need to human development, health and well-being. Microbiologically and chemically contaminated drinking water has been linked with a great majority of health problems. For instance, cholera and typhoid fever are diseases associated with microbiologically contaminated drinking water [WHO, 2004]. Chemical contaminants of drinking water such as lead, cadmium, nitrate, nitrite and N-nitrosamines are also potentially harmful to man [Jain, Bhatia, and Vijay 1995, Frederick, 1990]. Besides the health aspect of contaminated drinking water, aesthetically unacceptable drinking water will undermine the confidence of consumers; lead to complaints and more importantly, possibly lead to the use of water from sources that are less safe.

The microbiological and physico-chemical characteristics of the drinking water supplied by the Boreholes in Okutukutu community were investigated. The investigation entailed assessment of the pH, turbidity, nitrate, iron, calcium, magnesium, chlorine and coliform count, in all twenty one (21) functional Boreholes in Okutukutu community. The assessment indicated that the borehole water is fit for drinking and other domestic applications.

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