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BACTERIOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF BOREHOLE WATER IN NIGER STATE POLYTECHNIC, ZUNGERU CAMPUS

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ABSTRACT

Bacteriological and physico-chemical analysis of borehole water from the staff school, science department and the female hostel boreholes in Niger State Polytechnic Zungeru Campus were conducted. The fecal coliform counts obtained from the female hostel boreholes was 5cfu/100ml while that of the staff school and the science department were negative. The bacteria isolated from the female hostel borehole were: *E. coli*, *Klebsiella*, *Salmonella* and *Serratia*. The physico-chemical parameters determined were: Temperature with a value of 26.3^{0}C from the science department as well as that of female hostel borehole. While the staff school borehole have a temperature of 26.4^{0}C. Dissolved oxygen with a value of 6.24mg/l from the staff school, 5.52mg/l from the science department bore hole and 7.21mg/l from the female hostel bore hole .Has pH value of 7.51, staff school bore hole, 7.34 science department and 7.60 from the female hostel borehole which all lies within the NIS permissible limit. Total hardness with a value of 108 staff school bore hole, 210 science department bore hole and 310 female hostel bore hole, lies within NIS permissible limit while that of the science department and the female hostel boreholes were above the permissible limit which characterize them as hard water. Iron content from the staff school bore hole was 0.07mg/l, 0.20mg/l science department bore hole and 0.27mg/l from the female hostel boreholes and all are within the NIS permissible limit. Chloride with a value of 17.70mg/l from the staff school borehole, 35.40mg/l from the science department boreholes and 44.30mg/l from the female hostel borehole and they all lie within the NIS permissible limit.

KEYWORDS : Bacteriological, Physicochemical, Borehole Water

Water is a colorless, transparent, odorless, tasteless liquid that forms the seas, lakes, rivers, and rain fall as well as the basis of the fluids to living organisms (Michael, 2000). Water is a combination of hydrogen and oxygen atoms, with a chemical formula H_2O and known to be the most abundant compound (70%) on earth's surface (Osei, 2005).

However, for water to be potable it must be microbiologically safe and in order to achieve this, an approach that will eliminate pathogenic organisms from the source of water supply must be ensured. Retra (2002), described water in its pure form as a substance that has a pH value of 7.0, freezing point of 0^{0}C and boiling point of 100^{0}C at 760mmHg. Water is capable of dissolving other substances more than any other known solvent and therefore, it is called a universal solvent. Water is useful to man in many ways, for example, it serves as a source of transportation (in bringing goods from one country to another i.e., seas, oceans and rivers), recreation such as sporting activities, (Swimming, skating). It is also used for generating electricity, for domestic purpose such as washing, cooking bathing e.t.c. Since the beginning or recorded history, water has been recognized as a potential carrier of germs and diseases Retra (2002). Ground water sources, wells, boreholes and springs; that are properly located produce water of a very good quality.

The majority of the infections that is associated with the lack of accessibility to portable water suPly and poor environmental sanitation especially in developing countries. The following are micro-organisms associated with water; *Pseudomonas aeroginosa, Salmonella, Mycobacteria, Escherichia coli Proteus, Shigellasonnei, Klebsiella, Cyanobacteria* (Chris, 2004). Water borne diseases are caused by pathogenic microorganisms which are directly transmitted when contaminated water is consumed. Cholera is a good example of water borne disease and it is endemic in some parts of Nigeria. In 1991, more than 16,000 people died worldwide from half a million case of cholera. Improved treatment has reduced the death rate dramatically, but it is still a serious disease (UNPE, 1997).

Diarrhea is the world's second leading killer of children under the age of five after Pneumonia, claiming about 1.5million children a year more than AIDS and measles combined. In many places, parents still don't know what to do when their children get infected with diarrhea

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(UNPE, 1997). Diarrhea diseases are caused by waterborne bacteria, viruses, toxins and parasites. Important factors in controlling the disease includes: i) The availability of health services ii.) Effectively use of prevention strategies (proper sanitation and nutrition): iii) effectively use of vaccines.

Determining the bacteriological and physico-chemical quality of borehole water in Niger State polytechnic Zungeru Campus.

To ascertain the biological and chemical standard for these boreholes water for consumption.

MATERIALS AND METHODS

Sterilized petri dishes, hand lens, absorbent pads, water samples, membrane filtration apparatus, marker, Bunsen flame, hot plate, forcep, distilled water, incubator, autoclave, filter paper (0.45µm), wire loop, membrane lauryl sulpahte broth, eosin methylene blue, nutrient agar, bijou bottles, microscope, clean grease free glass slides, spatula, weighing balance, kovac's reagent, incubator, autoclave, porcelain evaporating dish 100cm^3 capacity, desiccators, drying over for operation at 103^{0}C to 105^{0}C, Analytical balance (Matler Toledo) capable of weighing to 0.lmg, glass fibre filter (what man GF/C), Filtration setup.

Sample Collection

Three (3) samples of boreholes water used for the analysis were collected from Niger State Polytechnic Zungeru Campus. Niger State Polytechnic is located at latitude 90^0 28'N and 90^0 37'N and longitude 60^0 23'N and 60^{0}29'E of Niger state.

The water samples were collected into three different screw cap sterile 200ml plastic containers which were labeled appropriately and they were taken to the microbiology laboratory for analysis.

The three samples of borehole water used for the analysis were sources of water from the staff school, science department and the female hostel boreholes.

MEDIA PREPARATION

Eosin Methylene Blue

A clean spatula was used to measure 37.5gm of EMB in a weighing balance and it was suspended in 1litre of distilled water. It was allowed to boil to dissolve completely, then it was allowed to cool to 60^{o}C and the medium was suspending the precipitate which is an essential part of the medium. It was sterilized by autoclaving at 121^{o}C for 15minutes.

Nutrient Agar

A clean spatula was used to measure 28g of Nutrient Agar powder in a weighing balance and it was suspended into 1litre of distilled water and it was allowed to boil to dissolve completely. It was sterilized by autoclaving at 121^{o}C for 15minutes (Bridson, 1998).

Membrane Lauryl Sulphate Broth Agar

A clean spatula was used to measure 76.2grams of Membrane Lauryl Sulphate Broth Agar in a weighing balance. It was dissolved in 1litre of distilled water and then it was distributed into final containers i.e. 100ml screw cap bottles. It was sterilized and autoclaved at 121^{o}C for 15minutes.

ANALYSIS

Membrane Filtration Technique

The sterile membrane filtration apparatus was placed in position and it was connected to a source of vacuum pump with the stopcock turned off. An absorbent pad was placed into a sterile Petri dish then 2ml of membrane lauryl sulphate broth was poured into it. The funnel of the membrane filter was removed and a filter paper composed of cellulose esters, with pore size 0.45µm was placed on the base of the porous disc of the filter paper with the aid of a forcep.100ml of the sample was filtered through the membrane such that the organisms to be enumerated were retained on the surface of the membrane which was placed with the grid lines faced upward on the absorbent pad saturated with membrane lauryl sulphate broth in the petridish. The procedure was repeated for the other samples and they were incubated at 30^{o}C for 4 hours at a room temperature and then transferred into an incubator and were incubated at 44^{o}C for 18-24 hours after which all yellow colonies were counted.

Inoculation and Incubation

The positive filter paper gotten from the faecal coliform count using the membrane technique was inoculated into the prepared eosin methylene blue agar in a

petri dish using a sterile wire loop for picking and streaking on the media in the petri dish. The petridish was transferred into an incubator for 24 hours at 37°C for growth. The isolate was sub-cultured on a nutrient agar slant in order to get a pure isolate and then it was placed close to a bunsen burner to avoid contamination and further transferred into an incubator for 24hours at 37°C for growth.

Biochemical Test

Indole Test

One percent tryptophan broth in test tube was inoculated with the bacteria colony. The formation of red coloration at the layer indicates positive and yellow coloration indicates negatives.

Citrate Utilization Test

This was carried out by inoculating the test organism in test tubes containing Simmon's citrate medium and this was inoculated for 24 hours to 72 hours at 37°C.

Urease Test

In this test the various test organisms were incubated on urea agar slops and incubated at 37°C for 24 to 48 hours.

MR-VP Test (Methyl Red, VogesProskauer)

Five millilitres (5ml) of MR VP broth was inoculated with the test organism and incubated for 48 to 72 hours at 37°C, after which, lml of the broth was transferred into a small tube.. The development of a red colour staring from the liquid-air interfaced within 1 hours indicated a VP positive test while no colour change indicated a VP negative test.

Triple Sugar Iron Agar Test (TSI)

This medium contain 3 sugar namely glucose, lactose and sucrose.

Gram Staining

A smear was prepared and allowed to dry for gram staining.Crystal violet, grams iodine, acetone and safranin was used. Gram positive bacteria appear blue-black/purple colour. Gram negative bacteria appear red or pink colour.

Determination of Physico-Chemical Properties of Water

pH

After calibrating the Wegtech JMP kit (WG pH scan 3) instrument with PH buffers 4,7 and 10 in accordance with the manufactures instruction manual, pH measurement were carried by dipping the electrode into 100ml beaker containing the test sa mple(Apha, 1995).

Suspended Solids (Gravimetric Method)

Filters were dried, cooled in a desiccator and weighed using standard method (Apha, 1995).

Turbidity

Determine the turbidity values of the sample after calibrating the meter with turbidity calibration standard (0.02, 20.0,100, 800 NTU commercially prepared by Wagtech), as describe in the equipment operations manual (WE 140 JMP kit I turbidity meter manual), (Apha, 1995).

Electrical Conductivity

The wagtech H198311 water proof EC/TDS meter was calibrated in accordance with the manufactures instruction manual using Wagtech HI7031 calibration solution (14413µS/cm). (Apha, 1995).

Cation

Iron (Total) Phenanthroline Method

Intensity was measured photo metrically at 510nm and then the absorbance of the blank was subtracted from that of the sample to determine the net absorbances (Adams, 1995).

Potassium

The concentration of the element in the unknown sample was calculated by reading the sample concentration from the calibration curve and multiplying it by the dilution factor (Adams, 1995).

Alkalinity

It is determined by titration with a standard solution of strong mineral acid to successive bicarbonate and carbonic acidr (Adams, 1995).

Chloride (Argentomeric Method)

Presence and concentration of Chloride was examined using Argentomeric method(Apha, 1995).

Total Hardness (EDTA Trimetric method)

Total Hardness was determined using EDTA Trimetric method (Apha, 1995).

Calcium and Magnesium Hardness

Calcium and magnesium hardness was determined by slowly titrated with EDTA disodium salt solution (0.01M) (Apha, 1995).

Table 1: Biochemical Characterization of Bacteria Isolated From Borehole Water

Isolate No	Gram Reaction	Lactose	Glucose	Sucrose	Citrate	Motility	Indole	Urease	H_2S	Gas	MR	VP	Bacteria	Frequency of occurrence
3	GNR	+	+	+	+	+	+	+	+	+	+	+	*Escherichia coli*	*****
3	GNR	+	+	+	+	+	+	+	-	+	-	-	*Klebsiella pneumonia*	**
3	GNR	-	+	+	+	+	-	-	-	+	-	+	*Serratiamarcescens*	*
3	GNR	-	+	-	-	+	-	-	+	-	+	-	*Salmonella typhi*	**

Key: GNR: Gram Negative Rods; -: negative; +: positive

RESULTS

The results obtained from the water analysis carried out are shown in table 1 and 2 i.e., the bacteriological and the physico-chemical analysis.

These results were compared with that of the Nigeria Industrial Standard values for drinking water and it shows clearly that the values gotten all lies within the Nigeria Industrial Standard(NIS) except that of the female hostel in which coliform bacteria are present. The results obtained from the biochemical tests are shown in table 1.

Table 2: Physico-chmeical Analysis of Borehole Water Samples Analysed

Parameters	Result				
	Staff School	Science Department	Female Hostel	Source	NIS 554:2007
Temperature (^{0}C)	26.4	26.3	26.3	Borehole	25-32
DO_2 (mg/l)	6.24	5.52	7.21	Borehole	-
pH	7.51	7.34	7.60	Borehole	6.5-.5
Alkalinity (mg/l)	10	9.5	9.5	Borehole	-
Conductivity (s/cm)	222	423	689	Borehole	1000
Suspended Solid (mg/l)	84	57	56	Borehole	-
Total hardness	108	210	310	Borehole	150
Magnesium hardness (mg/l)	13.18	35.62	64.90	Borehole	-
Calcium hardness (mg/l)	21.64	51.30	17.64	Borehole	-
Iron (mg/l)	0.07	0.20	0.27	Borehole	0.30
Potassium	18.1	8.95	10.1	Borehole	-
Chloride	17.70	35.40	44.30	Borehole	200
Turbidity	63.4	60.8	79.4	Borehole	5
Faecal coliform count (cfu/100ml)	0	0	5	Borehole	Nil

Key: DO_2: Dissolved oxygen

NIS: Nigeria Industrial Standard

DISCUSSION

The result of bacteriological analysis of the female hostel borehole water has been found not meeting the standard requirement and harboring micro organisms. Enterobacteria isolated were: *E. coli, Salmonella, Klebsiella* and *Serriatia.* The occurrence of these microorganisms may be s a result of the nature of soil, or process of handling. This is in accordance with the findings of Chapelle (1992) that gram negative pathogenic bacteria are extensively found in underground water system where

they constitute about 6% to 7% of the isolates recovered.

The presence of *E.coli* in water is of significance, which may be as an indication of fecal contamination (pollution) or environmental changes. Tortora (2003) made similar observation and stated that *E. coli* is the most frequently used indicator organisms of faecal pollution of water. Greenberg (1985) also reported that coliforms are frequently used as microbial indicators, because their presence in water is solely the consequence of fecal pollution. Tortora (2003) made similar opinion that coliforms do not always represent faecal pollution because the organism may persist in soil and water for long periods of time and occasionally multiply outside the animal body.

From the results of the physico-chemical analysis of borehole water samples analysed, the temperature ranges of the science department borehole and that of the female hostel are of the same value (26.3^0C) while that of the staff school is a little bit higher (26.4^0C). Water from the female hostel borehole is at neutrality to alkaline level due to its high concentration in pH compared to that of the staff school and that of the science department, Though all falls within the Nigerian Industrial Standards for drinking water as observed Molden (2007). Generally, the value of the electrical conductivity and that of iron concentration for all the samples falls within the Nigeria Industrial Standard for drinking water which gives a desirable taste to the water but high concentration will lead to an undesirable taste. It may also be due to the application of N.P.K fertilizer which have ability to seep into ground water, this makes the water to be hard and causes soap wastage.

The brownish colour of borehole waters may be due to the presence of carbonates and its high turbidity respectively. The high temperature range of 26.3 to 26.4^0C may be due to chemical and biochemical reaction on the ground water.

CONCLUSIONS

It has been established that among the three different borehole water analyzed, the borehole located at the female hostel did not meet the standard and haboured number of pathogenic organisms including coliforms.

RECOMMENDATION

Hence, these boreholes serve as the major source of drinking water for the inhabitants of the community, it is recommended that bacteriological and physiochemical examination of these boreholes should be carried out periodically so as to assess the suitability of the water for consumption.

Boiling of water before drinking would also go a long way in reducing the incidence of contracting pathogenic organisms and their diseases.

REFERENCES

Adams V.G., 1995. Water and Waste Water Examination Manual. Lewis Publisher Co. Washington D.C: 67-63.

Apha, 1995. Standard Method for Examination of Water and Waste Water. 19th Edition, Published by E and FN Poan, Washington D.C.: 2-56.

Bridson. E., 1998. The Oxoid Manual, (8th Edition), Published by Oxoid Limited, Wade Road, Basingstike, Hampshire, England, **2**:146-161.

Chapelle F., 1992. Ground Water Microbiology and Geo Chemistry. John Wiley and Sons Publihsers, New York :152.

Chris N., 2004. Comprehensive Biology for Senior Secondary Schools. A Johnson Publishers Limited, Surulere, Lagos, New Edition : 111.

Greenberg A.E., 1985. Standard Methods for the Examination of Water Waste Water, (16^{th} edition). American Public Health Association, Washington, D.C.: 108.

Micheal K., 2000. A new mainstream text for the new specifications. Advanced Biology, Oxford University Press, New York : 20-23.

Molden D., 2007. Water for food, Water for life: A Comprehensive Assessment of Water Management in Agriculture. Earthscan/IWMI.

Osei Y., 2005. New School Chemistry for Senior Secondary Schools. African First Publishers Ltd, Onitsha. Third Edition : 292.

Retra D., 2002. International Water Resources Association. Water International Journal Germany, **27**:3, .

Tortora .G., 2003. Microbiology an Introduction (6th Edition) McGraw Hill, New York : 210.

United Nations Environmental Programme, UNEP, 1997. Protecting Private Drinking Water Supply Available at VRL:http://www.epa.gov/dgwdn /wot/whatdo/html.