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Microbiological Analysis of Groundwater and Selected Surface Water samples in Umueri and Environs, Southeastern Nigeria

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Abstract
Microbiological indicators of water quality were analyzed in eighteen water samples collected from the study area which lies between latitudes $6^0$16'N and $6^0$21'N and longitudes $6^0$49'E and $6^0$55'E, comprising Umueri, Umuoba Anam, Aguleri, Nando, Nsugbe and Nteje. Seven out of the eighteen samples were surface water and eleven samples are groundwater (dug wells and boreholes). The water samples were subjected to Species inventory to identify the microbial species that colonized the water sources and plate count to determine their respective population. The results revealed variations in quality of groundwater and surface water samples from different locations. The result showed that the E-coli and staphylococcus aureus were found in the samples analyzed which is indicative of fecal contamination and the presence of microbiological pathogens in water samples implied quality degradation. The findings suggested the need for proper site selection for boreholes and waste dumpsites, strict monitoring of open defecation around surface water bodies and treatment of water before use is suggested for drinking purposes, boiling and filtering offers best results.

Keywords: Microbiological, E- coli, Staphylococcus, groundwater, surface water

Introduction
Water is one of the most important constituents of life support system. It is indeed a wonderful chemical medium which has unique properties of dissolving and carrying suspensions of huge varieties of unwanted materials and chemicals, thus, it is easily contaminated. The growing demand for potable water supply has been the major problem of most urban and semi-urban centers in Nigeria. Potable drinking water is the basic need for any society to maintain a healthy and productive life and for industries and agriculture to flourish (Falkenmark et al., 1989). For water to be adequately utilized, it has to be reasonably free from contaminants. Otherwise, such waters could pose serious health and environmental risks to human and other living organisms that depend on them (Chiyem et al., 2014). Despite some strict regulatory control imposed by governments, sewage waste still accounts for almost a quarter of the serious water incidents in large surface water bodies in the study area. The microbiological qualities, in terms of total coliforms, total bacterial count or total plate count, staphylococcus aureus, E-coli and yeast of water samples from eighteen locations were analyzed. Coliform are organisms that are present in the environment and in the feces of all warm-blooded animals and humans. Coliform bacteria will not likely cause illness however, its presence in drinking water indicates that disease causing organism (pathogens) could be in the water system. Escherichia Coli (E-coli) is one of the major pathogens associated with water borne diseases, naturally, E-coli is a facultative anaerobic bacterium that inhabit the large gastrointestinal tracts of warm-blooded animals. The existence of E-coli in water normally signals recent fecal contamination or poor hygienic condition of water (Odonkor and Mahami, 2020). Total plate count or total bacteria count (TPC or TBC) generally refers to aerobic bacteria that are able to grow at average temperatures (e.g. 30 to 40^0C). Total bacterial counts (TBC) is used to determine the total coliforms. The presence of staphylococcus aureus in drinking water is a concern because of its potential to cause disease to man. Since the need to protect groundwater

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from pollution was recognized, this research has made progress in understanding the vulnerability of groundwater to contamination. Assessment of pollution potential and provision of better understanding of the actions required for effective groundwater protection against quality degradation will ensure sustainable water resources development. The study area comprises, Umueri, Umuoba Anam, Aguleri, Nando, Nsugbe and Nteje.

The study Area and Geology

The study area lies between latitudes $6^0$16'N and $6^0$21'N and longitudes $6^0$49'E and $6^0$55'E, it comprises, Umueri, Umuoba Anam, Aguleri, Nando, Nsugbe and Nteje and can be accessed through some minor roads, foot paths and river from Kogi State and other inland towns in Anambra West.

The area is situated within the Anambra Basin which is one of the sedimentary basins in Nigeria (Usman et al., 2015). It is located in the southern part of the regionally extensive northeast-southwest trending Benue Trough. The evolution of the basin followed the subsidence of a platform in the Southern Benue Trough, concurrent with the lateral translocation of the depocenter during the Santonian thermo-tectonic event that folded and elevated the Abakaliki region (Egboka and Nwakwo, 1985). Sediments derived from erosion of the Abakaliki anticlinorium and Niger River filled the Anambra Basin. The stratigraphy of the Basin shows six separate formations. Various lithostratigraphic units resulted from these depositional cycles of which Bende-Ameki group where the study area (Umueri and environs) lies. Bende-Ameki group consist of the Nanka Sand, Nsugbe Formation, and Ameki Formation (Nwajide, 1979). The lithologies of these formations range from shale, sandstone, lignite seam and shally- sandstone with small intercalations of calcareous limestone (Okoro et al., 2010).

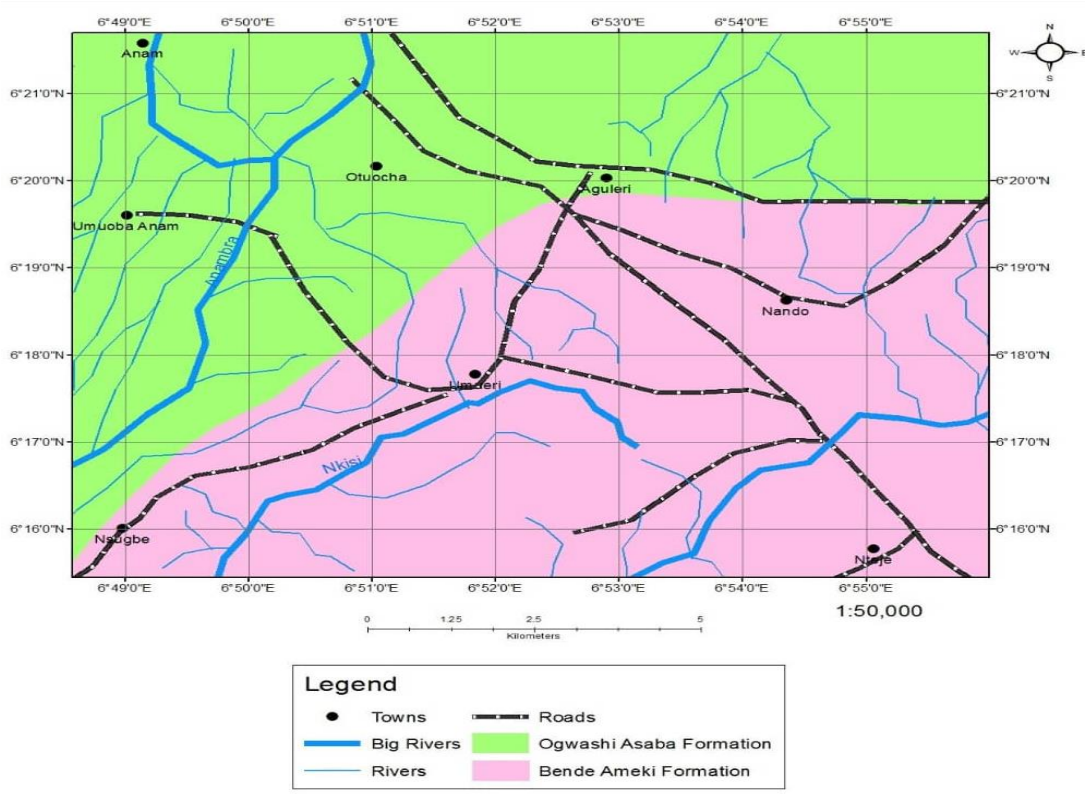

Fig. 1. Geologic and Drainage Map of the study area

Brief review of relevant Literatures

The following are few literatures mentioned but are not limited to this number. Chiyem et al (2014), in a research using 2D Electrical Resistivity Imaging of Unsaturated Zones for crude oil spillage at Agbarha in Ughelli area of Delta State, Nigeria and revealed that for water to be adequately utilized, it has to be reasonably free from contaminants otherwise such waters could pose a serious health and environmental risks to human and other living organisms that depend on them. Akanwa et al (2011) on Assessment of Groundwater Quality around Open Waste Dumpsites in Ngbuka Obosi in Anambra State recommended the use of another location where the geology and lithological characteristics of the area will not favour leachate migration. Ince (2010) presented a country report of the pilot project implementation of 2004 – 2005 on Rapid Assessment of Drinking Water Quality (RADWQ) –World Health Organization and UNICEF and noted that untreated groundwater represents about 75% of total water supply in Nigeria's urban centers and suggested that groundwater resources be protected adequately from increasing threat of contamination if they are to remain as important and dependable sources of water supply. Dean (2004) in his research on Chemical and Biological Examination of Groundwater in some Local Government Areas of Anambra State Nigeria revealed that clean drinking water and basic sanitation are necessary to prevent communicable diseases and to maintain a healthy quality of life. Amongst the literature reviewed little or no study had been done on the biological analysis of water resources of Umueri and environs, thus prompting this research.

Methodology

Raw water samples were collected from groundwater and surface water sources of water supply in the study area. The samples were cocked in a sterile bottle prewashed with the water from source before filling up. The samples were then placed in ice packed coolers en-route the laboratory. They were subjected to species inventory to identify the various species present. Total bacterial count was conducted using serial dilution method as described by Ibe and Okplenye (2005). A dilution was made from 10^{-3} (i.e. $^{1}/_{1000}$) tube and an aliquot of 0.1ml of each dilution was aseptically plated on nutrient agar in triplicate. The plates were incubated at 37^{0}C for 24hr and after incubation; the colonies formed were counted using the colony counter.

$$\text{TBC} = \frac{N \times V}{D}$$

where N = mean colony
D = dilution factor
V = volume of sample used

Total bacterial counts (TBC) were used to determine the total coliforms. Presumptive colonies were further confirmed by using lactose peptone water and tryptone water in tubes to determine fecal streptococci and Escherichia coli.

Bacterial colonies from TBC were sub cultured into tubes of lactose peptone water and tryptone water. Tubes were incubated at 44.5^{0}C for 24 and growth was indicated by the production of gas in the lactose peptone water tubes, which confirmed the presence of faecal streptococci. E. coli was confirmed by the addition of 0.3ml of kovais reagent to each tryptone water culture tubes, which showed production of a red colour indicating the synthesis of indole from tryptophan. This confirmed the presence of E. coli.

Results and Discussion

Water samples from eighteen locations were analyzed for their microbiological qualities, in terms of total coliforms, total bacterial count or total plate count, staphylococcus aureus, E-coli and yeast. The result of the samples is shown in table 1 below.

Table 1. Microbiological result of eighteen samples analyzed

S/N	Source	Coli form	E-coli	TPC/TVC or TBC	Staphylococcus aureus	Yeast
1	Surface water	7	+	1.2×10^4	+	-
2	Surface water	5	+	2.4×10^5	+	-
3	Well water	3	+	$1.10 \times 10_4$	+	-
4	Surface water	6	+	2.2×10^4	+	-
5	Surface water	8	+	1.68×10^5	+	-
6	Surface water	7	+	2.18×10^4	+	-
7	Borehole water	5	+	2.5×10^5	+	-
8	Well water	11	+	2.15×10^4	+	-
9	Borehole water	10	+	3.8×10^5	+	-
10	Borehole water	8	+	2.18×10^5	+	-
11	Borehole water	9	+	4.11×10^4	+	-
12	Well water	11	+	2.82×10^3	+	-
13	Surface water	7	+	4.0×10^4	+	-
14	Borehole water	8	+	3.32×10^4	+	-
15	Borehole water	11	+	6.4×10^5	+	-
16	Borehole water	6	+	4.5×10^6	+	-
17	Borehole water	12	+	7.8×10^3	+	-
18	Surface water	11	+	2.65×10^4	+	-

Key: + = positive (presence)

- = negative (absence)

Below is the graph showing TVC across samples.

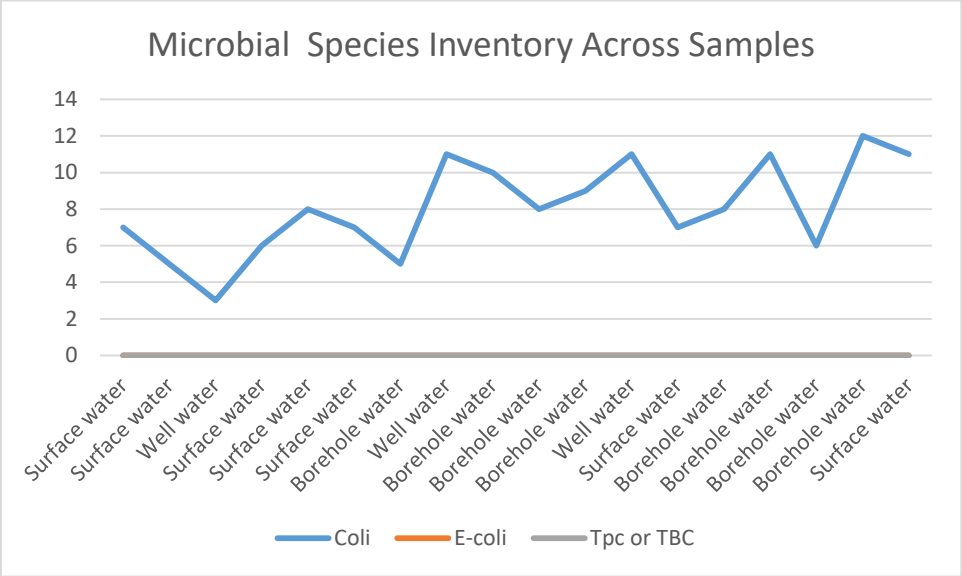

Fig. 2. TVC across samples in the study area.

Coliform

From the result shown in table 3, there is a significant presence of coliform in all the water tested, which means that both the groundwater and surface water are polluted by fecal contamination. Figure following sorted the TVC for coliform spp according to type of water source.

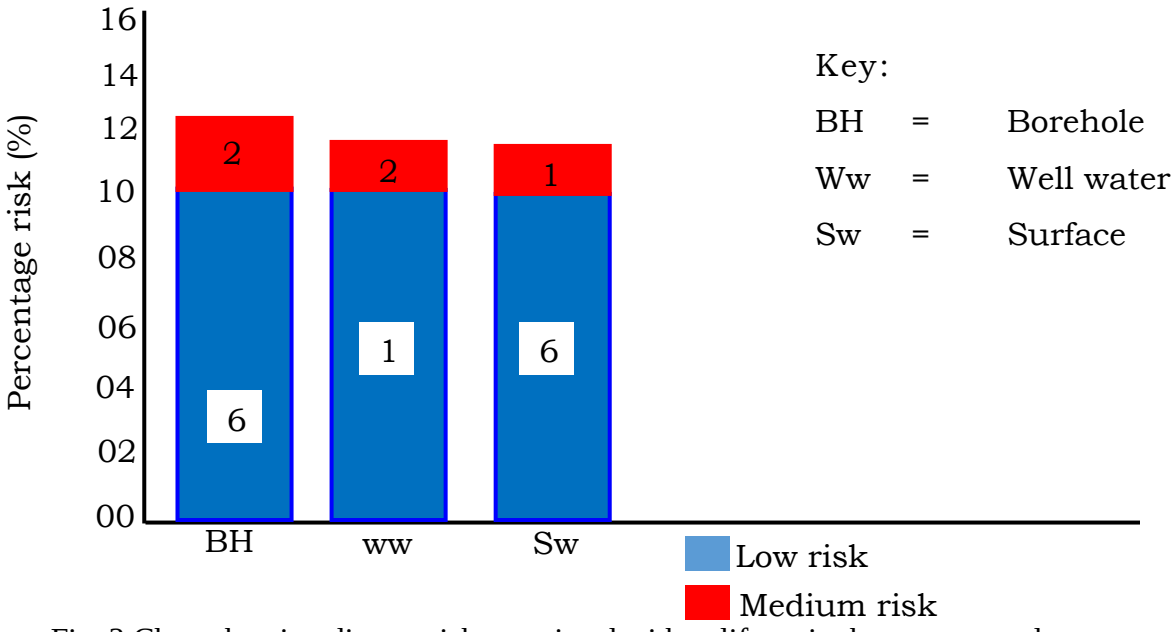

Fig. 3 Chart showing disease risk associated with coliform in the water tested.

With reference to figure 3, it is evident that about 90% of the samples tested was within low risk assessment by (WHO, 2011) which is 10, while about 10% of the samples tested have intermediate risk assessment by (WHO, 2011) which is above 10 with borehole and well samples having higher proportion.

E-coli

Results from table 3 show the presence of E-coli in all the samples tested, hence indicating possible fecal contamination of both the groundwater and surface water.

Total plate count (TPC or TBC)

There is presence of TPC in all the samples examined.

Staphylococcus aureus

In the result above, staphylococcus aureus is dictated in all the samples tested and implies contamination of the water sources.

Yeast

From the result of microbiological analysis, yeast was not dictated in all the samples examined.

Total plate count/total bacterial count (TBC)

Total bacterial counts (TBC) were used to determine the total coliforms. This confirmed the presence of E. coli.

In summary, high concentrations of microbiological results in all the samples revealed anthropogenic source for coliform, E-coli, Tpc, staphylococcus aureus and yeast. The present observation indicated that the groundwater samples and surface water samples are polluted when compared to WHO standard, hence it is considered unsafe for consumption and other domestic uses. In conclusion, there is need for proper site selection for boreholes and waste dumpsites, strict monitoring on open defecation around surface water bodies and finally treatment of water before use is suggested especially for drinking purposes, boiling and filtering offers best results.

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