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Microbiological Evaluation of Drinking Water Supplies in Uzuakoli, Bende L.G.A. of Abia State, Nigeria

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ABSTRACT

Aim: *This study was carried out to investigate the level of microbial contamination of the various water sources in Uzuakoli, Bende L.G.A. of Abia State. To determine the sanitary quality of the water sources under study and their suitability for human use and to determine the level of total and fecal coliform of the samples in the area.*

Methodology and results: *The microbiological evaluation of drinking water supplies was investigated using standard methods. A total of 240 water samples were collected from five streams and fifteen boreholes and analyzed for a period of six months covering the dry and rainy seasons. Total heterotrophic bacterial counts, coliform counts and faecal coliform counts were carried out on appropriate media. The coliform and faecal coliform count were determined using the most probable number (MPN) by the multiple tube fermentation technique. The total heterotrophic bacterial counts for the borehole samples during the dry and rainy seasons ranged from* 5.0×10^4 *cfu/ml to* 1.9×10^3 *cfu/ml. The total heterotrophic bacterial counts for the stream samples during the dry and rainy seasons ranged from* 7.1×10^6 *cfu/ml to* 3.1×10^4 *cfu/ml. The coliform count for the borehole samples during the dry and rainy seasons ranged from 3 MPN/100 ml to 9 MPN/100 ml and 2 MPN/100 ml to 9 MPN/100 ml, while coliform count for the stream samples during the dry and rainy seasons ranged from 8 MPN/100 ml to 14 MPN/100 ml. The highest and lowest faecal coliform counts for the borehole samples during the dry and rainy seasons ranged from 5 MPN/100 ml to 2 MPN/100 ml. The faecal coliform count for the stream samples for the dry and rainy seasons ranged from 9 MPN/100 ml and 2 MPN/100 ml. Seven (7) species of bacteria species were isolated. They were Staphylococcus aureus, Pseudomonas aeruginosa, Proteus sp, Streptococcus sp, Enterobacter aerogenes and Escherichia coli. The result shows a significant difference at* $(P \leq 0.05)$ *for the bacterial isolates.*

Conclusion, significance and impact of study: *This study revealed poor bacteriological quality for the borehole and stream water sources and should be treated before use to prevent health hazards.*

Keywords: Water supplies; Microbiological evaluation; Coliform; Faecal coliform; Uzuakoli.

INTRODUCTION

Human welfare and economic development generally depend on the use of water. In Nigeria, water resources management and utilization are crucial to the country's efforts to reduce poverty, grow the economy, ensure food security and maintain the ecological systems [1]. Water is a precious natural resource vital for life and provision of portable water to the rural and urban populations is necessary to prevent health hazards [2]. Water is a basic nutrient of the human body and very essential to living organisms, agricultural production and industrial processes. Population increase over the past century has resulted in increased pressures on water resources of the developed and developing countries. These pressures involve the contamination from domestic, industrial and agricultural wastes, climate change and other ecological disturbances [3]. Pollution of drinking water sources in rural areas may involve seepage from broken septic tanks, pit latrines and runoffs carrying fertilizers, pesticides, herbicides, fungicides and fecal matter. Contaminated water serves as a medium of transmitting infectious diseases such as dysentery, cholera,

diarrhea, typhoid, shigellosis, salmonellosis, and varieties of other bacterial as well as fungal, viral, and parasitic infections [4]. In Nigeria, majority of the rural populace do not have access to potable water and therefore, depend on well, stream, boreholes and river water for domestic use. The bacterial qualities of ground water, stream water and other natural water supplies in Nigeria have been reported to be unsatisfactory, with coliform counts far exceeding the level recommendation by W.H.O [5].

It is estimated by World Health Organization (WHO) [6], that 1.1 billion people lack access to improved water supplies and 2.6 billion people lack adequate sanitation. More than half of the world's population lives in villages in rural areas and most of those without access to safe drinking water supply. Worldwide, roughly 1.7 million people are said to die every year from water related diseases [7]. Diarrhea remains the second leading cause of death among children under five years globally. Nearly one in five child deaths, about 1.5 million each year is due to diarrhea [8]. In October 2010, about 29,115 cases involving 1,191 deaths of cholera were reported in just 15 out of the 36 states and Federal Capital Territory, the figures increased to 1,616 deaths in 2004. It was observed that the outbreak was still in existence in new areas due to continuous water pollution [9]. There is need for regular analysis to identify the physical, chemical and bacteriological characteristics of any water in order to ascertain its acceptability [10]. The role of sanitation and safe water in maintaining health has been recognized for centuries therefore, provision of water, sanitation and good hygiene services is vital for the protection and development of human resources [11,12].

MATERIALS AND METHODS

Study Area

Uzuakoli is in Bende Local Government area, of Abia State, Nigeria and has a long history dating back to the time of the slave trade when its market, Agbo Agwu, was a major center for slave exchange. It is in the northern region of Abia State. Uzuakoli lies between Latitude 5.6333 and Longitude 7.5667. The community is made up of five villages, Agbozu, Amamba, Amankwo, Eluama and Ngwu, each of the villages have their streams and boreholes.

Sample collection

The water samples were collected using sterile 500 ml containers which were first washed and properly sterilized to avoid contamination. The stream water samples were collected by unscrewing the cap of the container and holding the container near its base in the hand and plunging its neck downwards below the surface. The containers were turned until neck points slightly upwards and mouth is directed towards the current. When the water fills the containers, it was carefully removed and corked. In other to collect sample from borehole, cotton wool soaked in ethanol was used to disinfect the nozzle of the boreholes and then the tap was turned on to allow water to run for two minutes before sterile 500 ml screw capped plastic containers were carefully uncapped and filled with water and recapped. The samples were labeled with code names for proper identification. Thereafter the water samples were transported to the laboratory for analysis within six hours of collection [13].

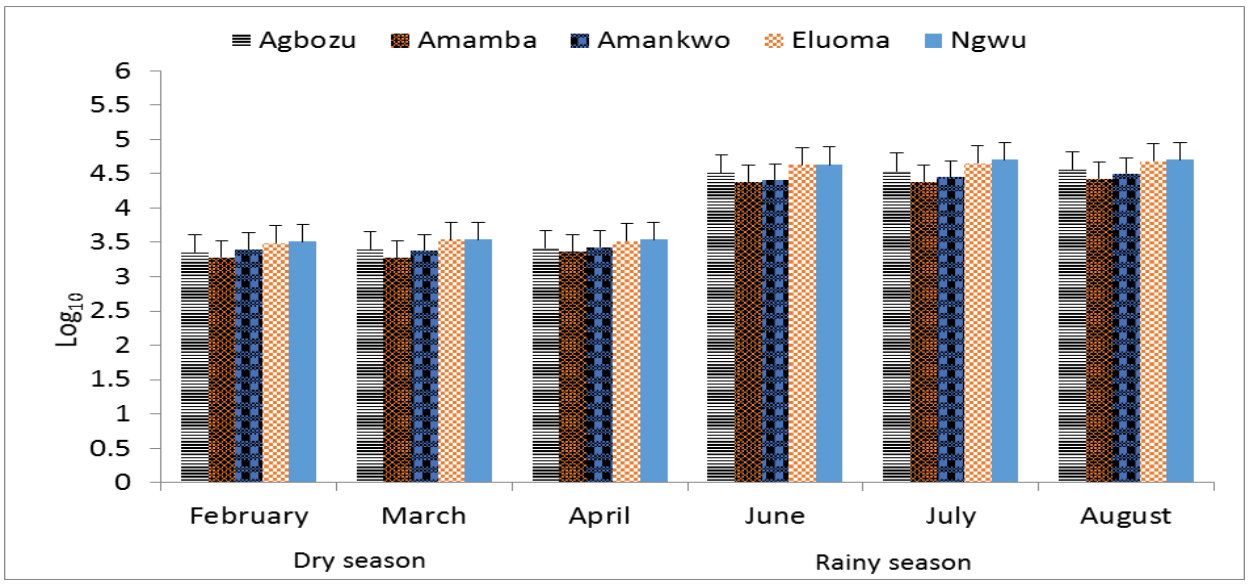

Figure 1: Heterotrophic counts in borehole water samples (cfu/ml).

Microbiological analysis

All glassware's, Petri-dishes and pipettes used were washed with detergent and sterilized in a hot air oven at 160°C for 1 hour. All media, chemicals and reagents were used according to manufacturer's specifications. The various culture media were sterilized using an autoclave at a temperature of 121°C for 15 minutes and pressure at 15 psi [14].

Inoculation and identification

Pour plate technique was employed in the enumeration of the bacterial isolates. Exactly 1.0 ml of water sample from the tubes was dispensed into sterile petri-dishes and a molten nutrient agar (oxoid), MacConkey agar (oxoid), mannitol salt agar (oxoid) and eosine methylene blue agar (oxoid) was separately poured into the petri-dishes. Each of the plates was swirled gently for easy mixing of the water (inoculum) and the media. All the plates were incubated aerobically at 37°C for 24 to 48 hours. All the bacterial counts were counted and recorded as colony forming units per ml (cfu/ml). The bacteria were identified based on Gram's reaction, motility and biochemical tests such as catalase test, coagulase test, oxidase test, urease test, triple sugar iron test, indole test, methyl red test, Voges Proskauer test, sugar fermentation test and citrate test. Microbial identifications were performed using the keys provided in the Bergey's Manual of Determinative Bacteriology [15].

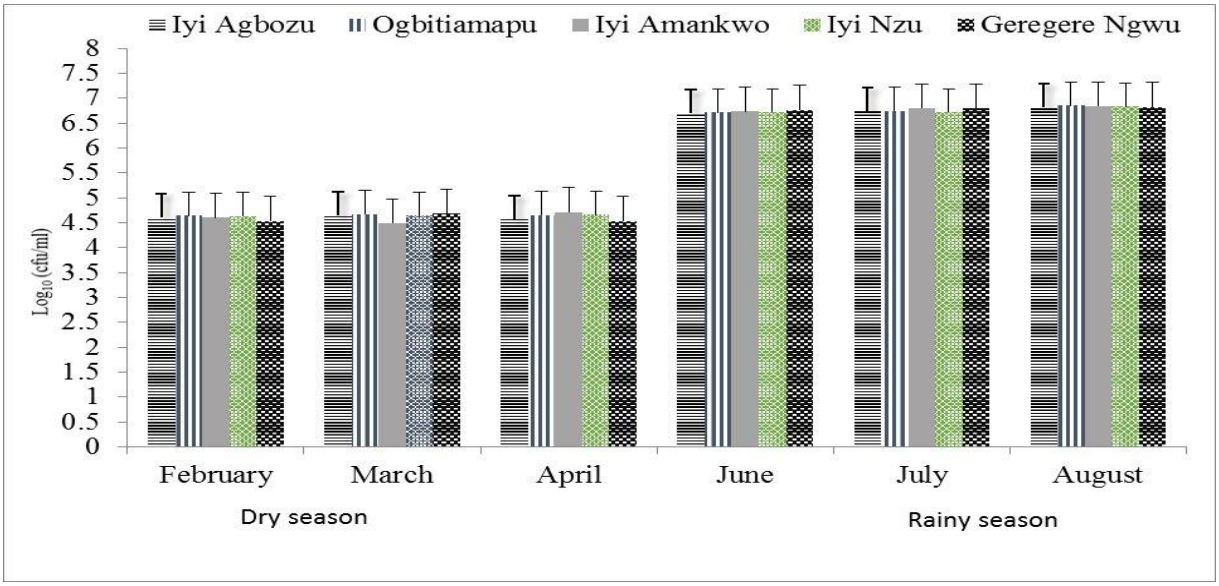

Figure 2: Heterotrophic counts in stream water samples (cfu/ml).

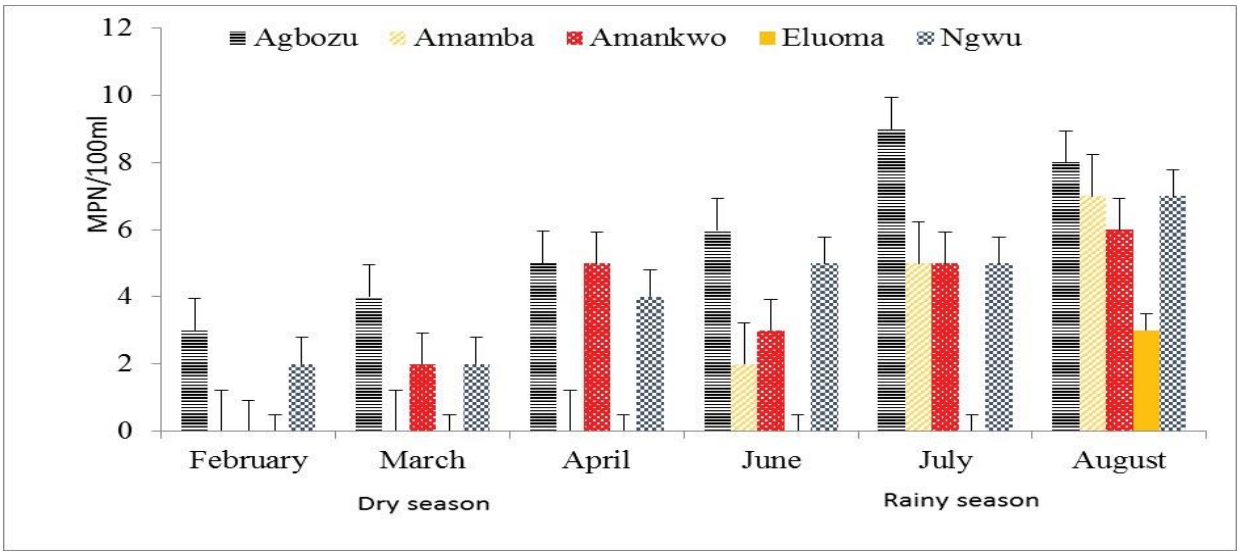

Figure 3: Coliform counts (MPN/100 ml) for borehole waters.

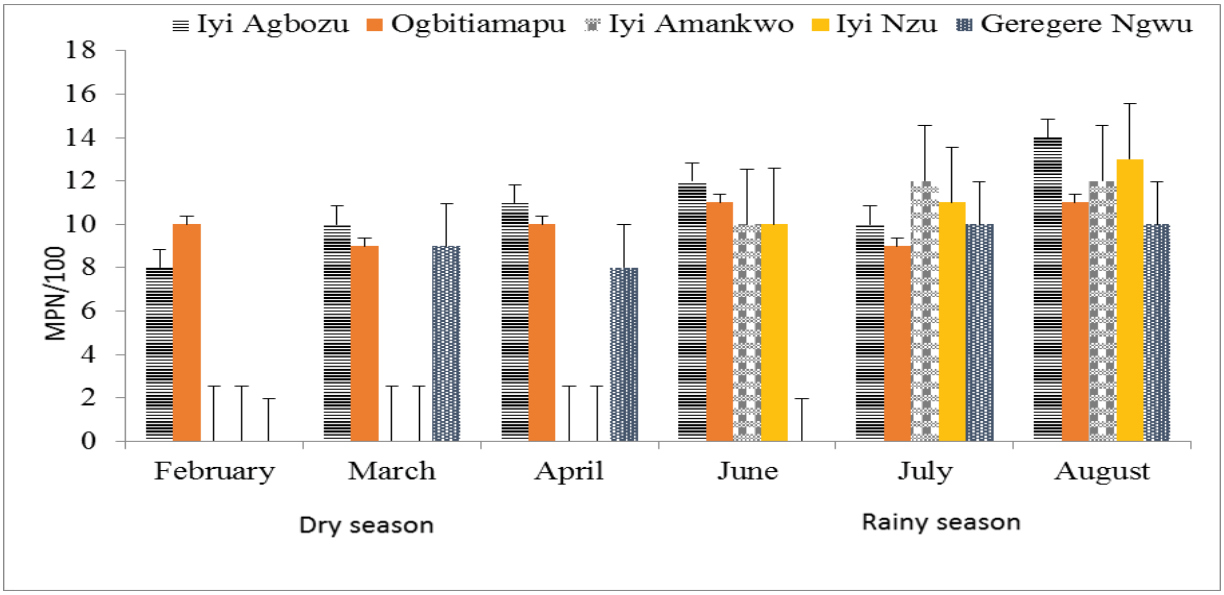

Figure 4: Coliform counts (MPN/100 ml) for stream waters.

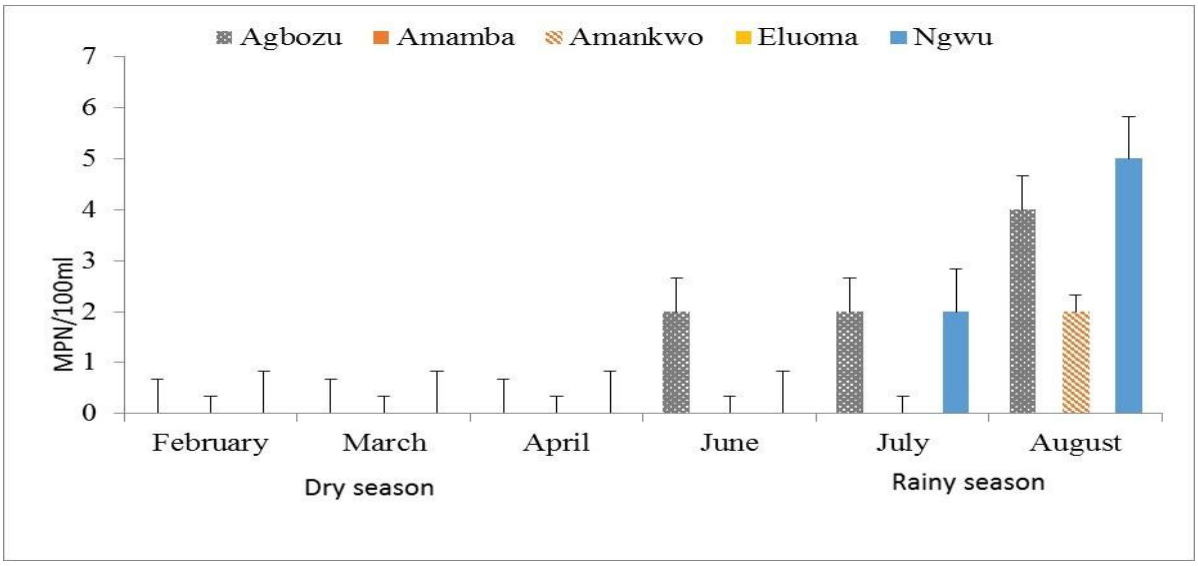

Figure 5: Faecal coliform counts (MPN/100 ml) for borehole waters.

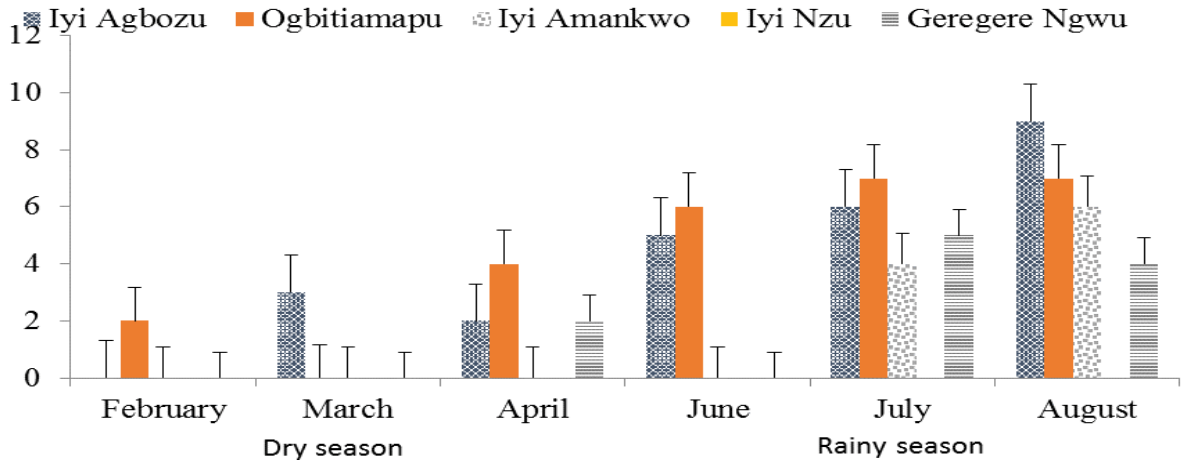

Figure 6: Faecal coliform counts (MPN/100 ml) for stream waters.

Multiple tubes fermentation techniques for coliform

The most probable number technique (MPN) was used to determine the coliform in the borehole and stream samples using the method of APHA [13]. The most probable number (MPN) of coliforms in the water sample was estimated by the number of positive tubes corresponding with standard MPN statistical table and recorded as MPN/100 ml.

RESULTS AND DISCUSSION

The results of the bacteriological analysis of the water samples are presented in Figures 1-6. The enumeration of total heterotrophic bacterial (THB) is shown in Figures 1 and 2. The borehole water sample in Ngwu in the month of July and August had the highest heterotrophic bacterial counts with 5.0×10^4 cfu/ml while borehole water sample in Amamba had the least heterotrophic bacterial counts in February and March with 1.9×10^3 cfu/ml. The Stream water sample from Iyi ogbitiamapu had the highest heterotrophic bacterial counts while stream water sample from Geregere Ngwu had the least heterotrophic bacterial counts during the dry season. During the rainy season stream water sample from Geregere Ngwu had the highest while Iyi Agbozu had the least heterotrophic counts. Coliform counts for borehole water samples during dry and rainy seasons ranged from 2 MPN/100 ml to 9 MPN/100 ml. The coliform counts for the stream water samples during the dry and rainy seasons ranged from 8 MPN/100 ml to 14 MPN/100 ml. There were no faecal coliform counts for the borehole water samples during the dry season. Faecal coliform counts during the rainy season ranged Agbuozu 2 MPN/100 ml to 5 MPN/100 ml. The faecal coliform for the stream water samples during the dry and rainy seasons ranged Iyi Agbozu 2 MPN/100 ml to 9 MP N/100 ml.

There were heterotrophic bacteria in all the water samples. The WHO standard for heterotrophic bacteria counts in potable water should not exceed 1.0×10^2 cfu/ml [16]. The presence of heterotrophic bacteria exceeding the WHO limits indicates that the water samples were contaminated with bacteria that could make the water unsafe for drinking [17]. This finding agrees with similar studies by Nwachukuwu and Ume [2,4,18,19]. The higher number of heterotrophic bacteria recorded during the rainy season in streams could probably be as a result of the increased surface area of the stream which exposes the water to runoffs. During dry season the heterotrophic bacteria could be caused by human activities like swimming, washing, dipping of dirty legs or hands and cans inside the stream while fetching water. Ground water which is believed to be the purest form of water because of the purification properties of the soil was found to be contaminated, due to improper construction, shallowness, animal wastes, proximity to toilet facilities, sewage, refuse dump sites, seepage or discharge from septic tanks, and various human activities [20].

The concentration of total coliforms obtained from the water samples generally exceeds WHO standard of zero coliform in every 100 ml of water respectively except those obtained from Iyi Amankwo and Iyi Nzu streams and Boreholes from Amamba, Amankwo and Eluoma during dry season and rainy season. However, according to WHO in 2004, drinking water can be graded into four (4) categories depending on their MPN value. Water with MPN of zero is excellent, MPN of 1-3 is satisfactory, MPN of 4-10 is suspicious and MPN above 10 is unsatisfactory. Water with MPN greater than 3 is not suitable for drinking. Hence the high coliform counts obtained may be an indication that the water samples were faecally contaminated [5,21]. With the presence of these microorganisms in some of the water samples, the water is unfit for human consumption [18].

CONCLUSION

The results obtained in this study suggests that the bacteriological quality of some of the streams and boreholes in Uzuakoli is poor and do not meet the WHO guideline for drinking water quality. Also it showed that there is seasonal variation in the level of microbial contamination of surface water and ground water sources. The presence of coliforms makes this water sources unacceptable and unfit for drinking. Organisms isolated in this study have been found elsewhere in the world. Reliance on these water sources without adequate water treatment, poses a possible serious public health risk especially since there are no other alternative water sources for most homes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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