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Prevalent Microbes in Domestic Waters of Iwochang Community, Akwa Ibom, Nigeria

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Abstract: Water is an important constituent of the living organism. Although, one of the most abundant resources to man, yet it is source of microbial transfers which serves a potential health problem in many rural communities. An evaluation study was undertaken to evaluate boreholes, wells and river waters from Iwochang community of Akwa Ibom was evaluated for microbial quality identifying the prevalent microbes. The result of the evaluation showed *Bacillus spp*, *Fusarium spp* and *Penicillum spp* to be the most prevalent in the community with 100% occurrence in all samples studied. Analysis also showed more of fungi colonies than bacterial. Boreholes water samples however had more bacterial and fungi than the well water. Comparison with the National Agency for Food and Drugs Administration and Control and the World Health Organization standard limits indicated most of the borehole samples beyond the microbial standard limits. These waters are potentially unsafe for drinking.

Keywords: Water; Microbes; Bacteria; Fungi; Akwa Ibom; Nigeria

1. Introduction

Water is one of the most abundant and essential resources of man, and occupies about 70% of earth's surface. About 97% of this volume of earth's surface water is contained in the oceans, 21% in polar ice and glaciers, 0.3-0.8% underground, 0.009% in-inland freshwaters such as lakes [1].

Man requires a regular and accessible supply of water which forms a major component of the protoplasm and provides an essential requirement for vital physiological and biochemical processes [2]. Batmanghelid [3] earlier reported that since the water man drink provides for cell function and its volume requirements, the decrease in our daily water intake affects the efficiency of cells and other body activities. In addition to human consumption and health requirements, water is also needed in agriculture, industrial, recreational and other purposes which includes basic household activities [4].

Water is essential to sustain life and a satisfactory supply of drinking water must be made available to all consumers [5]. However, despite water being a source of sustenance to life as a whole, it has also become a source of detriments to life itself. The potential of water to transfer microbial pathogens to a great number of people and subsequently causing illnesses have been well documented in countries at all levels of economic development. A numbers of outbreaks that have been reported throughout the world, Nigeria inclusive [6]. It has been reported that 80% of sicknesses and deaths among children in the world are caused by unsafe drinking water [7].

In Nigeria, especially in the rural and sub-urban communities, water for drinking and other domestic uses is mostly obtained from wells dug by inhabitants [8, 9], in addition to the water available in rivers and rivers in rural communities, and more recently boreholes. Akwa Ibom is located in the Coastal South Southern part of the country lying between latitude $4^{o}321$ and $5^{o}331$N and longitude $7^{o}251$ and $8^{o}251$E. Rural dwellers in Akwa Ibom State, among which Iwochnag community, Eket Local Government, obtain their water supplies from a variety of sources, including wells, rain water, rivers or rivers, lakes etc and recently boreholes. By and large, the quality of water from these sources proves grossly poor [10]. Public water supply in the area under study and many others in Akwa Ibom are grossly inadequate and the inhabitants have been compelled to depend majorly on wells and private borehole water supply whose quality are doubtful [11]. The microbial qualities of groundwater, pipe borne water and other natural water supplies in Nigeria, have been reported to be unsatisfactory, with coliform counts far exceeding the level recommendation by World Health Organization [12-14].

Hence, the need for microbiological quality evaluation of these waters is important not only to the consumers' knowledge but also to water regulators and public health authorities. The work was therefore carried out to identify

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the prevalent microbes and evaluate the level of microbial load in domestic water sources, especially the boreholes which was considered safest, therefore more relied upon in the Iwochang community of Akwa Ibom State,Nigeria.

2. Materials and Methodology

2.1. Sample Collection

Water samples for the study were collected from Iwochang community, Eket local Gevernment, Akwa Ibam State. Random samples were collected from boreholes (5) and wells (5) within the community. The boreholes were the most frequently used for domestic purposes. Well samples were less regularly used although it was their major source of water for domestic purposes before the advent of boreholes in the community. Samples were also collected from nearby river about 1km from the town and the ocean. Two samples from the river were collected at two major locations of frequent use for other domestic use like bathing, washing and coking.

Samples were designated BW for borehole water, WW for well water and RW for river water sources. Water samples were collected in 50 ml sterile vials that were fitted with screw caps. Sterilisation of the vials was performed by autoclaving at 121°C for 15 min prior to sampling. Samples were transported to the laboratory for evaluation for microbial presence within 8 h on the same day of collection.

2.2. Microbiological Determination

The following media which include Nutrient agar media (NAM), MacConkey agar (MCA), Salmonella Shigella Agar (SSA) and Potato Dextrose Agar (PDA) were used for the enumeration of microbial analysis. These media were prepared according to the manufacturer's instructions and sterilized in an autoclave at 121^{o}C for 15 min. They were allowed to cool prior to usage.

The pour plate technique was used to cultivate serially diluted portions of the liquid samples under investigation on NAM and PDA. Enumeration was further carried out on MCA and SSA. Triplicate plates of appropriate dilutions were prepared. The NA, SSA and MCA plates were incubated at 37^{o}C for 24 - 48 h for bacterial growth while PDA plates were incubated at room temperature (28 ± 2^{o}C) for 48 - 72 h for fungal growth. The developed microbial colonies were counted and computed as colony forming units per millilitre (cfu/ml) of each sample respectively. The colonies observed were isolated and purified for further identified with biochemical reactions which include gram's staining, coagulase test, catalase test and microscopy from which bacteria isolates were identified. Fungi colonies were identified with their morphology both on plate and under the microscope.

2.3. Data Analysis

The data generated from evaluations were analysed and expressed as mean values of three replicates of the sample treatments. Analysis of variance was performed on data generated from evaluation using STATISTICA software package and significant difference in men were separated using Duncan multiple range test.

3. Results

The mean microbial counts in each pooled sample replicates (n = 3) is indicated below (Table 1). Total bacteria counts (TBC) ranged from 0.96 to 2.30 x10^{2}cfu/ml while total fungi counts (TFC) ranged from 0.50 to too numerous to count (TNTC) x10^{2}cfu/ml in all the samples evaluated. Comparing the mean microbial counts observed in each sample with both the National Agency for Food and Drugs Administration for Nigeria and World Health Organization's standard allowable limits showed that all but 2 well samples (WW3 and WW4) had lower TBC when compared while all samples evaluated had TFC higher than the standard limits. River samples observed had the highest fungi counts (too many to count). This was followed by boreholes, each having >2.50 x10^{2}cfu/ml. Overall observation of the table 1 indicates the boreholes samples had more TBC and TFC than the well waters in the community

Analysis of the different colony isolates from all the water samples evaluated showed *Bacillus spp*, *Penicillum spp* and *Fusarium spp* to be the most prevalent microbes observed. *Mucor spp* was observed only in well waters and river samples. River samples were also observed to harbour all the microbes identified in the evaluation. Only two borehole samples (BW1 and BW4) contained *Salmonella spp. E. coli*, *Salmonella spp*, and *Triderma spp* were present in both river samples collected. *Mucor spp* was observed in all the well and river samples (Table 2 and Figure 1).

4. Discussion

The present study reveals all samples contaminated with bacteria and fungi microbes with the river samples having the most observed bacterial and fungi counts in the samples evaluated. The lowest counts of microbe was observed in well samples evaluated. Physical survey at the sites of collection (data not included) indicated that these wells were well covered and managed probably due to less frequent use and more frequent use of boreholes which is believed to safer for drinking and other domestic use. The less activities with regards to well use may have prevented the prevalence of these microbial build-up. Talabi and Ogundana [15] also added that well contamination from bacterial and fungi microbes may be through containers used for fetching water, which are often placed on the ground. The prevalence of TBC and TFC counts of high magnitude more standard limits in the borehole may be

attributed to microbes inhabiting the storage tanks apart from source contamination. Although, data on management of the water storage tanks used in borehole water collection sites were not taken during sample collection, this high prevalence especially in fungi counts maybe due to poor or lack of storage managements on the part of borehole owners in the community. Adriano and Joana [16] have also indicated that poor water treatment techniques of these boreholes may attribute to increased microbial load found in domestic waters especially those meant for drinking. Furthermore, since these boreholes are sited within residential areas, it is probably that poorly designed septic tanks, poor drainage, human waste water disposal and poor sanitation [5, 16] may also contribute to the high incidence of these microbes in rural domestic waters.

Frequent use of borehole water was observed to be high in the area of study as it is believed to be the safest water source compared to both well and river. However, microbial load of all borehole samples evaluated had mean values well above both the National Agency for Food and Drugs Administration and World Health Organization's limits for drinking water. In a similar study conducted by Eze and Madumere [17] in Uturu, a rural community in Abia State, reported microbial load in boreholes evaluated are well above permissible level when compared to World Health Organization's standard for drinking water. Talabi and Ogundana [15] also reported microbial range well above permissible limits virtually in all samples evaluated in a rural settlement in Ekiti state, Nigeria [15].

Microbial analysis of domestic waters from the present study of Iwochang community reveals more fungi microbes than bacterial with microbes, *Bacillus spp, Penicillium spp* and *Fusarium spp* being the most prevalent microbes in the community waters (100%, found in all samples of water evaluated). *E. coli* was the least found in this community waters (16.67%, found in only water samples from the river) thus an indication of contamination with faecal materials. Fungi evaluation from boreholes in a rural community located in Calabar showed *Fusarium spp, Penicillium spp, Trichoderma spp* and *Mucor spp* to be the most prevalent fungi in the samples evaluated [18]. Although, *Trichoderma spp* was not found in any borehole samples evaluated, their reports were similar to this present study which observed the prevalence of fungi like *Penicillium spp* (100%), *Fusarium spp* (100%) and *Mucor spp* (58.33%) in all samples evaluated (Figure 1). This high bacterial and fungi contamination may be attributed to groundwater pollution in the study area, a reflection of the poor sanitar**y** conditions of people in the study area [19]. In Nigeria, water borne diseases are one of the main problems in rural and urban communities. These diseases are as a result of microbial infection of water which includes bacterial and fungi. This high prevalence of both bacteria and fungi microbial species is an indication of a pending hazardous disease epidemic should a related disease outbreak be experienced in the community.

5. Conclusion

Most water screening methods in Nigeria are focused on the occurrence and significance of bacteria with little attention to other microorganisms such as fungi. This present study have revealed the possibility of more fungi load than bacterial in a community's major domestic water. The study also reveals an indication of the likely disease outbreak should the level of prevalence remain unchecked and unreduced in the community body system, as many of the individuals in this community preference of borehole water which housed most of the microbes identified in the evaluation signifies impending health danger. In compliance with the National Agency for Food and Drugs Administration and World Health Organization's microbe permissible limits, these waters especially boreholes which is the most relied upon in the community is not fit for drinking. There is therefore a need to raise a monitoring and regulation body charged with responsibility of monitoring and assessment check on these water sources especially the boreholes. There is also a need for the community education and awareness on health implications of the presence of these microbes and probable causes of their presence in the water as continued dependence on these waters without effective treatments may lead to a major health hazards.

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Appendix

Figure 1. Percentage prevaence of microbes identified in sample waters evaluated from Iwochang community, Akwa Ibom, Nigeria

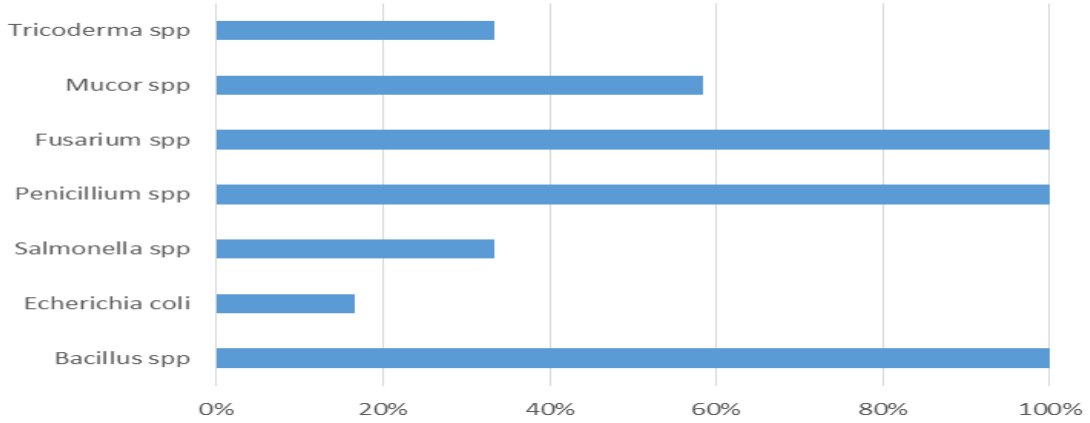

Plate-1. Plate samples showing fungi colonies in (a) Borehole water (b) Well water (c) River water; and (d) bacteria colonies; microscopy showing rod like bacteria at organism magnification $x10^3$

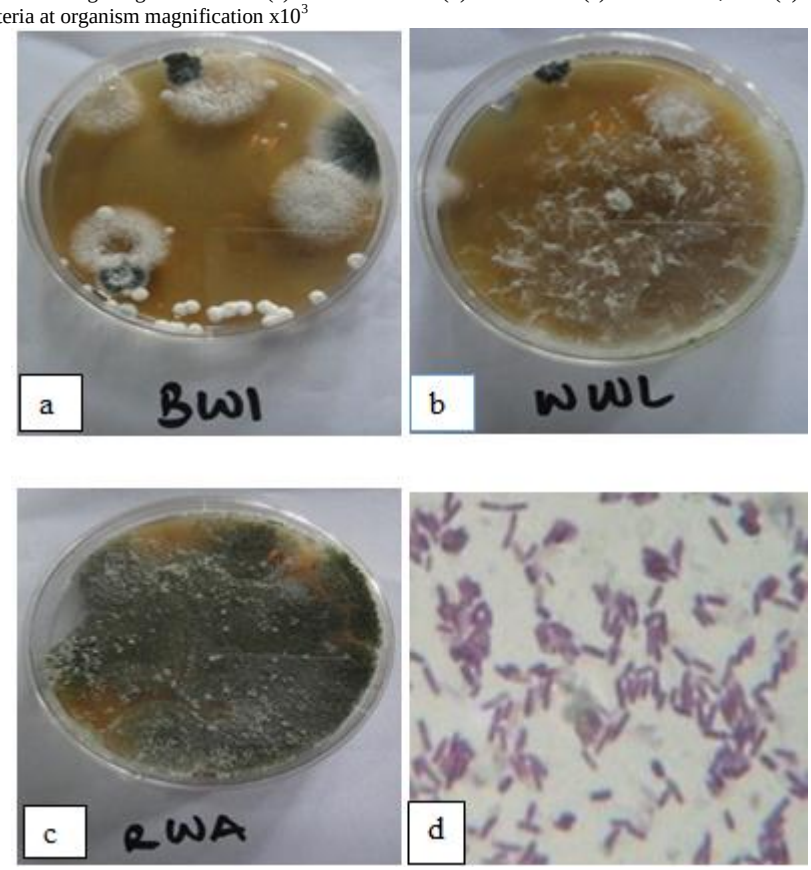

Table-1. Mean microbial counts of samples replicates per water source evaluated

Samples	TBC	TFC
	$x10^2$cfu/ml	
BW1	2.10c	3.10b
BW2	2.00b	3.00b
BW3	1.98b	3.13b
BW4	2.12c	2.99b
BW5	2.04b	2.98b
WW1	1.20a	0.55a
WW2	1.10a	0.50a
WW3	0.96a	0.67a
WW4	1.00a	0.62a
WW5	1.15a	0.53a
RW1	2.30c	TNTC
RW2	2.90c	TNTC
NAFDAC	1.00	0.00
WHO	1.00	0.00

TBC: Total bacterial counts; TFC: Total fungi counts; TNTC: Too numerous to count; NAFDAC: National Agency for Food and Drugs Administration; WHO: World Health Organization; Values are presented as mean (n = 3) followed with different letters (within column), are significantly different at $P < 0.05$

Table-2. Prevalence of microbes in sample water source evaluated

Organisms	BW1	BW2	BW3	BW4	BW5	WW1	WW2	WW3	WW4	WW5	RW1	RW2
Bacillus spp	+	+	+	+	+	+	+	+	+	+	+	+
Escherichia coli	-	-	-	-	-	-	-	-	-	-	+	+
Salmonella spp	+	-	-	+	-	-	-	-	-	-	+	+
Penicillium spp	+	+	+	+	+	+	+	+	+	+	+	+
Fusarium spp	+	+	+	+	+	+	+	+	+	+	+	+
Mucor spp	-	-	-	-	-	+	+	+	+	+	+	+
Tricoderma spp	-	-	-	-	-	-	-	+	-	+	+	+

+ Present (if found in at least a replicate); - Absent (if absent in all replicates);
BH: Borehole water; WW: Well water; RW: river water

Table-3. Biochemical identification of observed bacteria colonies

Sample Isolate	Gram's stain	Oxidase test	Catalase test	Indole test	Citrate test	Lactose Ferment test	H_2S test	Nitrate test	Urease test	Morphology	Remarks
1	+	-	+	-	-	+	-	+	+	Rod like	***Bacillus spp***
2	-	-	+	+	-	+(gas)	-	+	-	Rod like	***E. coli***
3	-	-	+	-	-	-	-		-	Rod like	***Salmonella spp***

+ Positive reaction; - Negative reaction

Table-4. Macro- and Micro-identification of observed fungi colonies

Sample colony	Macro-observation	Micro-observation	Remarks
Colony 1	Greenish surface	Round chainlike conidia, non-septate	*Penicillium spp*
Colony 2	White fluffy surface	Canoe/sickle shaped conidia, septate	*Fusarium spp*
Colony 3	Blackish brown cottony surface	Round conidia, non-septate	*Mucor spp*
Colony 4	Dark green cottony surface	Round conidia, septate	*Tricoderma spp*