

Original Research Article

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Bacteriological Assessment of Drinking Water Sources in Imo State, Nigeria

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ABSTRACT

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Drinking water sources in the three geopolitical zones; Owerri, Orlu and Okigwe zones of Imo state, Nigeria were assessed using standard bacteriological techniques to determine their bacterial profile and counts. The result showed that the levels of bacterial counts were high compared to the recommended standard of the World Health Organization. The total bacterial count was found to be very high with an average count of 487.58 CFU/100ml. Okigwe zone had the lowest count for all the microorganisms assessed while Owerri zone showed higher counts than Orlu zone in most of the organisms encountered except on total faecal count. This study has highlighted the need for urgent intervention in the provision of potable water for domestic consumption in Imo State.

Introduction

Water is considered to be the second most essential need of all life (man, animals, plants and microorganisms), after air. It forms two-thirds of the human body. It is formed by the bonding of one atom of oxygen to two atoms of hydrogen (DWSQC, 2000; USGS, 2004). Water-borne diseases are those diseases which occur when water contaminated particularly by pathogens from human excreta are consumed. Worldwide, the lack of sanitary waste disposal and lack of clean water for drinking, cooking and washing can be identified as the cause of over 12 million

deaths annually (Davidson *et al.*, 1992; USAID, 1990). Water-borne diseases include cholera, typhoid, shigella, polio, meningitis, and hepatitis A and E, amoebic and bacillary dysentery, plus over 30 species of parasites that infect human intestines, of which seven are globally distributed and cause serious illnesses such as amoebiasis, giardiasis, taeniasis, ascariasis, trichuriasis, strongyloidiasis, etc.

Human beings and animals can act as host to the bacterial, viral and protozoan organisms that cause these diseases. Millions of people have little access to sanitary waste disposal or

to clean water for personal hygiene. An estimated 3 billion people lack a sanitary toilet. For example over 1.2 billion people are at risk because they lack access to fresh water (Osunwa, 2011; Khan, 1997; UN, 1997; Warner, 1998; WHO, 1997).

Where proper sanitation facilities are lacking, water-borne diseases have the propensity to spread rapidly. Untreated excreta carrying disease organisms wash or leak into freshwater sources, contaminating drinking water and food. The extent to which disease causing organisms occur in specific freshwater depends on the amount of human and animal excreta that they contain (Bauman, 1994).

Materials and Methods

Study area

The area of study is Imo State. The state is named after the Imo river. The geo-political zones in Imo State are Okigwe, Orlu and Owerri. It has Owerri as its capital and largest city. Situated in South Eastern Nigeria, and covering an area of 5,530 square kilometres. Imo State derives its name from Imo River, which takes its course from the Okigwe/Awka upland. It lies within latitudes 4°45'N and 7°15'N, and longitude 6°50'E and 7°25'E. Imo State has many rivers. The main rivers in the state are Imo, Otamiri and Njaba. The major lakes are in Oguta and Abadaba in Obowu Local Government Area.

Sample collection and analysis

Water samples used for this study were collected from the different water sources (Rivers, Streams, Lakes, Springs, Rainwater, Tap-water, Boreholes, Storage Tanks, Mosques etc.) available in the selected study areas. Thirty eight Water samples, with an average of 12 water samples per zone were collected.

Water samples were collected in 1-litre sterile bottles and plastic cans and processed according to the standard of Baker (1971), Cruickshank *et al.*, (1975), NWRI (1997), Cheesebrough (2004), and transported to the laboratory for analyses. Samples were transported in ice-packs and ice-boxes where delays were envisaged.

Samples were assessed bacteriologically by Membrane Filtration Technique (MFT), using 0.45µm and 0.65µm for bacteria respectively (Cheesebrough, 2004). Total heterotrophic counts (bacterial counts), total coliform counts and more specifically, *Escherichia coli* counts for each water sample for samples from the Boreholes, Run-off from ablution, Streams and rivers, and wells where residents washed, bathed and defecated, were determined.

Results and Discussion

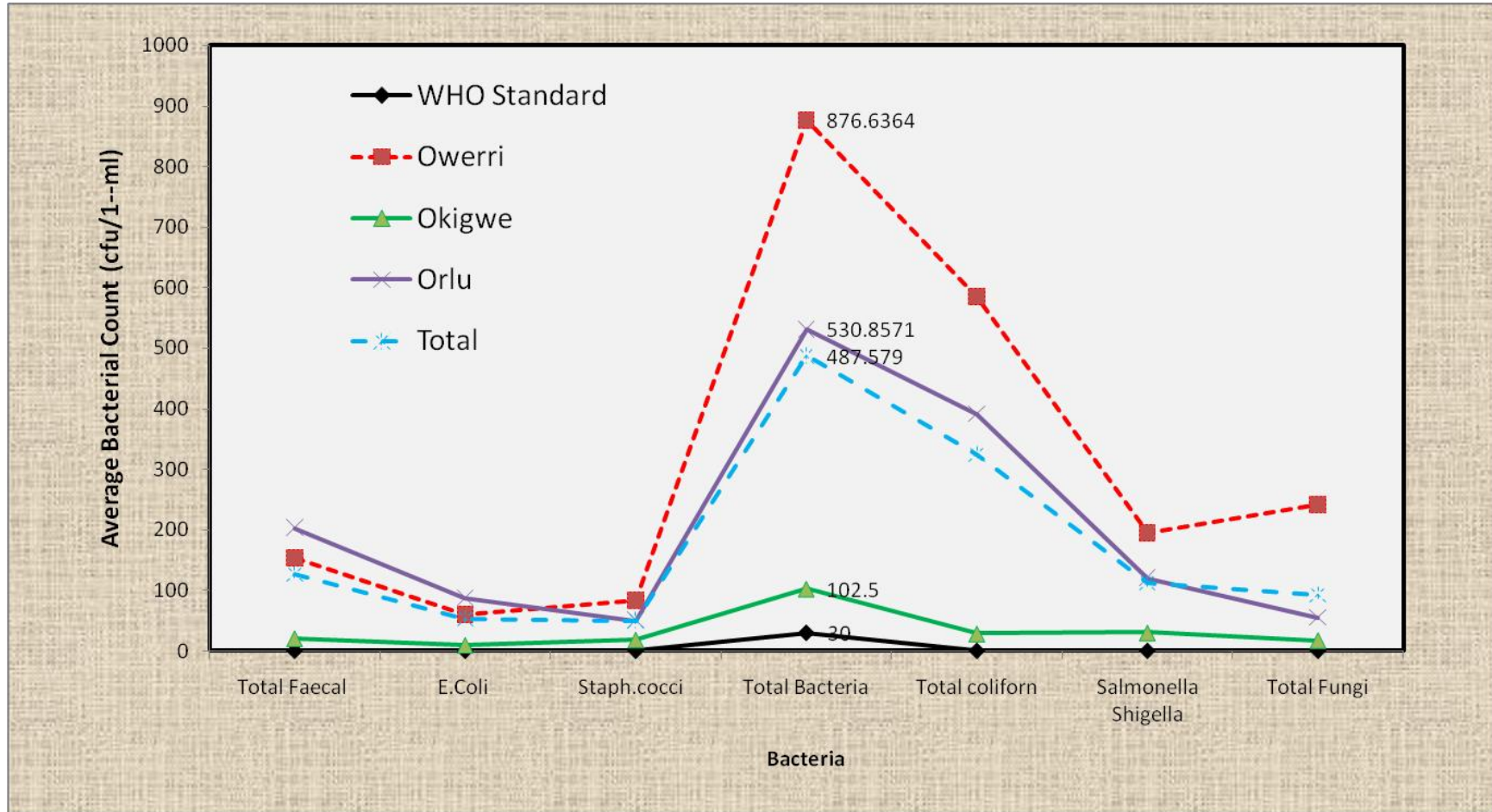
The assessment for microbial organisms contained in water samples taken from the drinking water sources in Imo State, Nigeria indicated that there were several bacterial counts observed in the water samples. Clearly, the levels of bacterial counts were observed to be quite high on each of the microbial organism assessed, in comparison with the recommended standard of the World Health Organization (WHO).

The highest of the microorganisms found in the water samples in Imo state was the total bacteria count with the average count of 487.58 cfu/100ml, at a standard deviation of 908.40cfu/100ml for the bacteria count. Total coliform was also found to be very high with an average count of 324.66 cfu/100ml (Owerri zone = 585.36 cfu/100ml, Okigwe zone = 27.86 cfu/100ml and Orlu zone =391.21 cfu/100ml).

Table.1 Average count for microbial organisms in water samples in Imo state

Parameters	WHO Standard	OWERRI		OKIGWE		ORLU		TOTAL		Sig
		Average	Std. Dev	Average	Std. Dev	Average	Std. Dev	Average	Std. Dev	p-value
Total Faecal Count, cfu/100ml	0	153.727	365.042	19.857	29.573	203.143	362.608	127.079	297.877	0.160
Total <i>E.coli</i> Count, cfu/100ml	0	59.364	117.699	8.857	17.978	87.571	152.070	52.816	114.443	0.103
Total <i>Staphylococcus aureus</i> count, cfu/100ml	0	83.272	120.773	17.786	18.861	50.071	69.126	49.947	79.655	0.113
Total Bacteria count, cfu/100ml	30	876.636	1326.793	102.5	196.077	530.857	828.055	487.579	908.395	0.079
Total coliform count, cfu/100ml	0	585.364	897.710	27.857	17.150	391.214	650.702	324.658	646.974	0.064
Total Salmonella Shigella count, cfu/100ml	0	194.727	438.614	29.571	61.362	120.714	247.223	112.316	281.012	0.311
Total Fungicount, cfu/100ml	0	241.2	528.967	16.857	17.4526	54.6428	115.823	92.459	289.067	0.151
WHO Vs Average (Total)	p-value = 0.017, t = -2.778, df = 12									

Figure.1 Line graph for the average count for microbial organisms in water samples in the zones of Imo state along with WHO standard



The lowest count found in water samples was in the test for *Staphylococcus* species with an overall mean count of 49.95 cfu/100ml (83.27 cfu/100ml in Owerri zone, 17.79 cfu/100ml in Okigwe zone = and 50.07 cfu/100ml in Orlu zone). Table 1 shows the average count for each micro-organism tested and the corresponding standard deviations for Imo state (total) and for each of the three zones of the state.

Okigwe zone had the lowest count for all the microorganisms assessed, while the Owerri zone showed higher count than the Orlu zone in most of the organisms (Figure 1). The Orlu zone was only higher than the Owerri zone on total faecal count (Orlu zone = 203.14cfu/100ml, Owerri zone =153.73 cfu/100ml) and for *E.coli* (Orlu zone =87.57cfu/100ml, Owerri zone = 52.82 cfu/100ml)

While the minimum tolerance level by the WHO standard for the total bacterial count is 30 cfu/100ml, the overall average total bacterial count found in Imo state was (487.58 cfu/100ml), which is far above the WHO standard. However, the average total bacterial count was highest in water samples from Owerri zone (876.65 cfu/100ml), while it was lowest in Okigwe zone water samples (102.5 cfu/100ml). On average, the test on samples from Orlu zone recorded the total bacterial count of cfu/100ml in the water samples taken from the zone.

Statistical test at 5% significant level shows that significant difference was found between the level of bacteria count found in Imo state and the WHO tolerance standard with probability values (p- value) of 0.017 (which is less than 0.05). On the other hand, no significant difference was found among the three zones of Imo state on the count for each of the microorganisms (all p-values were not less than 0.05).

The result indicates that *Serratia* spp was positive on VP, catalase, urease, citrate, indole, gas and glucose, which in all gives the rate of *Serratia* spp found in Imo state as 35%. Similar result was found for *Salmonella* spp, *Klebsiella* spp, *Enterobacter* spp (all at 35% each). They were found to be 41% each on *Proteus* spp and *Escherichia coli*, and 47% for *Citrobacter* spp respectively (Table 2).

At Okigwe zone, 14 (93%) out of 15 water samples taken tested positive for the bacteria. Each of the microorganisms was found positive in all except at one water source. The result on table 3 shows that the only source not found positive is the Paddies Sachet Water.

There were 10 (83.3%) out of 12 positive loadings for each of the microorganisms for the water samples taken at Orlu zone. The only two that were found to be free from bacteria were the Borehole Okporo Orlu and the Borehole Orlu.

For Owerri zone, all the 11 water samples taken tested positive for the bacterial load. Table 6 indicates that the bacterial load for the water samples were 100% for each of the microorganism.

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