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Bacteriological and Physiochemical Analysis of Oguta Lake Water, Imo State, Nigeria

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Abstract: Bacteriological and Physiochemical analysis were carried out on Oguta lake water from three guage stations; upstream, midstream and downstream used for drinking and recreational purposes in Imo State, South-Eastern, Nigeria. The results obtained were compared with World health organisation (WHO) and Environmental protection agency (EPA) standards for drinking and recreational water respectively. The following parameters; conductivity (30.8 us\cm), colour (90.67 pt\co), iron (0.47 mg\l), lead (0.18 mg\l), cadmium (0.08 mg/l), nitrate (0.9 ml) and odour (unpleasant) did not meet WHO standards while temperature (30.8°C), pH (5.71cpu), total dissolved solids (TDS) (73.87 mg/l), total solids (TSS) (7 mg/l), turbidity (17 ntu), phosphate (0.19 mg/l), sulphate (0.19 mg/l), manganese (0.1 mg/l) and appearance (clear) met the standards. None of the samples conformed to WHO and EPA bacteriological standards for total heterotrophic count of $1.0x10^{-2}$ in 100 ml of water, total coliform count and feacal coliform count of 1:100 ml of water for drinking and recreational water. *Samonella, Shigella* and *Vibro cholera* were not detected. The presence of coliforms in water for drinking and recreational purposes is of public health significance considering the possibilities of the presence of other bacteria, protozoa and enteric viruses that are implicated in gastro-intestinal water borne diseases and the low infectious dose of these water borne pathogens. Presence of chemicals in water is also of great concern, health effect from chemicals have been difficult to assess because the impact is not acute like that of pathogens, but often cumulatively resulting to cancer and sometimes death. The general public should be educated on dangers of contaminated water as well as prevention of indiscriminate dumping of domestic and industrial wastes into the lake.

Keywords: Water, Drinking, Recreational, Bacteriological, Physiochemical, Coliform

1. Introduction

Water is a clear colourless, odourless and tasteless liquid substance that falls as rain, fills lakes and rivers and is essential for life to exist [1, 2]. It is one of the important natural resources useful for domestic and developmental purposes in both urban and rural areas [2]. Water analysis is carried out to ensure a safe water supply for various purposes; drinking, bathing, swimming, domestic and recreational activities. There are various methods used in analyzing water samples collected from a water body. The most important methods used in small community water supplies are the bacteriological, physical and chemical test.

Bacteriological analysis of water involves isolation and count of indicator organisms whose presence indicates that disease causing pollution has occurred in water supply. These "indicator" organisms are bacteria called coliform bacteria [4]. Coliform bacteria describe a group of enteric bacteria that includes *Eschericia coli, Klebsiella* sp. and *Enterobacter* sp. They are Gram negative, facultatively anaerobic, non- sporing rods that may be motile. They are able to ferment lactose to produce acid and gas within 48 hrs at 35°C [5]. Although they are generally not harmful themselves, they indicate the possible presence of pathogenic bacteria, viruses and protozoa [5]. Bacterial agents of concern are those that cause diarrhoea and gastroenteritis namely *Salmonella* sp. *Shigella* sp., *Eschericia coli* (*E. coli*) and *Vibrio cholerae* [6]. Protozoan agents that cause diarrhoea are *Entamoeba histolytica, Glardia lambia, Balatidium coli* [7] and *Cryptococcus pervum* [8]. Enteroviruses causing various clinical ailments not necessarily diarrhoea, but transmitted by water include poliovirus,

rotavirus, Hepatitis A virus [9] and Hepatitis E. virus [10]. Coliform bacteria are easier to identify than other pathogens. Coliform levels are therefore used to determine the bacteriological quality of water.

Water bodies are contaminated through runoffs, sewage and agricultural wastes. These are usually high in organic matter and nutrient. Hence they could cause increase in the microbial flora of the water bodies, thereby resulting in high heterotrophic bacteria counts [11].

Physicochemical characteristics are vital for water quality monitoring [12]. The physiochemical tests include the determination of odour, appearance, taste, temperature, pH, turbidity, conductivity, total dissolved solid and total suspended solids [2, 12].

Oguta lake is located at Oguta in Imo state, Nigeria. Its source from Njaba river while it discharges into Urasi river. People in this area depend on this lake for drinking, fishing, bathing and recreational activities. It is evident that human and even natural activities within and around the lake have the potential to alter its resource status and usefulness.

Aim and Objective of Study

This study was aimed at determining the bacteriological and physiochemical quality of Oguta lake, with a view to assessing its usefulness as portable/ recreational water and to recommend control measures where necessary.

2. Materials and Method

2.1. Sample Collection

Waters samples were collected with carefully washed and sterile non- reactive, transparent glass bottles of 500 ml capacity. Samples were taken from the lake by holding the bottle near its base in the hand and plunging its neck downward below the water surface to a depth of 15 to 30 cm. This was done at three gauge stations; the upstream (being the source of the river, Point A), midstream (Point B) and downstream (where the water and other debris are discharged, Point C). The sampling bottle was not filled up to the brim, 20 mm to 30 mm space was left for effective shaking of the bottle [12]. The bottles were then labeled appropriately as follows;

Sample A – Up stream
Sample B – Mid stream
Sample C – Down stream

2.2. Bacteriological Analysis

These were carried out as described by [12, 13] as follows:

2.2.1. Total Heterotrophic Count

An aliquot (0.1 ml) of the serial dilutions of 10^{-5} and 10^{-6} of each sample was inoculated in duplicates onto well labeled nutrient agar plates. Hockey stick which has been sterilized by dipping into alcohol and flaming was allowed to cool and used to spread the sample evenly on the respective agar surface.

2.2.2. Total Coliform Count

Aliquots, 0.1 ml of 10^{-5} and 10^{-6} of each of the samples were inoculated in duplicates on each of the well labeled Mackonkey agar plates using the spread plate method. The plates were incubated at 37°C for 24 hrs.

2.2.3. Samonella Shigella Count

Aliquots (0.1 ml) of 10^{-5} and 10^{-6} of each of the samples were inoculated in duplicate onto well labeled Salmonella Shigella agar plates using the spread plate and incubated at 37°C for 24 hrs.

2.2.4. Vibro Count

Aliquots (0.1 ml) of 10^{-4} and 10^{-5} each of the samples were inoculated in duplicates onto well labeled thiosulfate citrate bile salt-sucrose agar using the spread plate method. These were incubated at 37°C for 24 hrs.

2.2.5. Feacal Coliform Count (Membrane Filtration)

This method is based on the use of highly porous cellulose membrane which will allow fairly large volume of water (e.g. 100 ml) to pass through rapidly under pressure but prevents passage of bacteria. The bacteria which remain on the surface of the membrane are then cultured on Eosine methylene blue (EMB) agar plate. The viable count gives the presumptive number of coliforms in the 100ml water sample.

2.3. General Isolation and Characterization of Bacteria from the Respective Water Samples

Isolation and enumeration of bacteria from the respective samples was done using standard microbiological protocols on appropriate culture media; nutrient agar, mackonkey agar, eosine methylene blue agar, Salmonella Shigella agar, thiosulphate citrate bile salt sucrose. The pour plate method was used for culture. All plates were incubated at 37°C for 24 hrs. The colonies were counted and recorded as colony forming units per mililitre (cfu/ml). Subsequently the isolates were characterized and identified based on cultural/ morphological characteristics, Gram reactions and other standard biochemical tests as described by [13].

2.4. Physiochemical Analysis

The physiochemical tests included the determination of odour, colour, appearance, taste, temperature, pH, total dissolved solids, total suspended solids, turbidity, nitrate phosphate, iron, lead, manganese, cadbium, sulphate, and nitrite contents. These were carried out using standard protocols [12]. The temperature was determined *in situ* by using the mercury in glass thermometer in centigrade scale .the temperatures were taken by dipping the thermometer into 50ml of the water samples.

The pH was determined by using pH test strips in situ while suntex pH meter was used to check the pH ex situ. Electrical conductivity was determined using Wissen Schaffich Techiske conductivity meter. Turbidity of the samples was determined by using logging spectrophotometer at a wavelength of 860 nm and product number of 450.

3. Results

Table 1. *Physiochemical parameters of Oguta Lake.*

Parameters	Samples A	Sample B	Sample C	Mean sample
Temperature	30.6	30.9	31.0	30.8
pH	5.49	5.87	5.76	5.71
Conductivity	234	58	49	113.7
TDS	152	37.7	31.9	73.87
TSS	0 .0	12	9.0	7.0
Colour	123	47	102	90.67
Turbidity	26	14	11	17
Nitrate	0.9	0.9	0.8	0.9
Phosphate	0.50	0.04	0.02	0.19
Sulphate	2.0	1.0	2.0	2.0
Iron	0.46	0.45	0.50	0.47
Lead	0.15	0.15	0.25	0.18
Manganese	0.0	0.2	0.1	0.1
Cadmium	0.06	0.07	0.10	0.08
Appearance	clear	clear	clear	clear
Odour		unpleasant	unpleasant	unpleasant

Table 2. *Total heterotrophic bacterial counts.*

Samples used	No. of colonies 10^{-5}	No. of colonies 10^{-6}	Total counts obtained Cfu/ml	Total counts obtained Cfu/ml	Mean average counts
Sample A	7	4	7×10^6	4×10^7	2.35×10^7
Sample B	10	6	1×10^7	6×10^7	3.5×10^7
Sample C	13	8	1.3×10^7	8×10^7	4.65×10^7

Table 3. *Total coliform bacterial counts (Cfu/ml).*

Samples	Total counts		Mean average counts
	Plate 1	Plate 2	
Sample A	3×10^6	1×10^7	6.5×10^6
Sample B	5×10^6	2×10^7	1.25×10^7
Sample C	8×10^6	1.1×10^8	5.75×10^7

Table 4. *Total feacal coliform counts per 100ml.*

Samples	*Escherichia coli*
Sample A	5
Sample B	18
Sample C	11

Sample A– Up stream; Sample B – Mid stream; Sample C – Down stream

Table 5. *Salmonella, Shigella and Vibrio cholera count.*

Medium	Sample	Dilution Factor	Mean count (CFU)
Salmonella Shigella agar	A	10^{-4} 10^{-5}	NG
	B	10^{-4} 10^{-5}	NG
	C	10^{-4} 10^{-5}	NG
Thiosulphate Citrate bile salt sucrose agar	A	10^{-4} 10^{-5}	NG
	B	10^{-4} 10^{-5}	NG
	C	10^{-4} 10^{-5}	NG

Legend: NG = No Growth

Table 6. *Isolates from specific sample points.*

Isolates	Samples		
	A	B	C
Staphylococcus sp.	+	+	+
Escherichia coli	+	+	+
Klebstella sp.	+	-	-
Pseudomonas sp.	+	+	+
Bacillus sp.	-	+	+
Proteous sp.	+	+	-
Enterobacter sp.	-	+	+

Table 7. *Percentage of average bacteria count of the samples.*

Sample Points	THBC	TCBC	FCBC
A	22.9	16.7	14.7
B	33.3	29.1	52.9
C	43.8	54.2	32.4

Table 8. *Morphological and Microscopic characteristics of fungi isolated from the samples.*

Medium	Samples	Cultured characteristics	Microscopic characterization	Suspected Organism
SSA	A 10^{-4}	Fluffy brown pigmentation	Hyphae small and irregular	*Microsporum* sp.
	10^{-6}	Purple brown to black	Hyphae relatively small and regular with district cross septa	*Aspergillus* sp.
	B 10^{-4}	Greyish green colony that is dense	Septate hyphae, brush like spore bearing structure	*Penicillium* sp.
	10^{-6}	Purple brown to black	Hyphae relatively small and irregular with distinc septa	*Aspergillus* sp.
	C 10^{-4}	Greyish green colour	Septate hyphae, brush like spore bearing structure with chain conidia	*Penicillium* sp.
	10^{-6}	Purple brown to purpose black	Hyphae relatively small and regular with district septa	*Aspergillus* sp.

Table 1 shows the physiochemical parameters of the water samples. The total heterotrophic counts are shown in Table 2 while Table 3 shows the result of total coliform count obtained from sample. Table 4 shows values of the feacal coliform isolated with mid-stream having the highest number of count while upstream has the lowest number of counts. There was no observable growth of *Samonella, Shigella* and *Vibro cholerae* in their respective media as shown in Table 5. Identified bacterial isolates from specific sample collection points are as shown in Table 6. Table 7 shows the percentage of the average bacteria counts of samples. The morphological characteristics of the fungi isolated from samples are shown in Table 8.

4. Discussion

The results obtained in this study agree with similar studies by other researchers who reported that heterotrophic bacteria are found in water and could be from human/animal wastes, runoffs, pasture, natural soil or plant bacteria, sewage and other unsanitary, practices [14, 15 16]. Runoffs, sewage and agricultural waste are usually high inorganic matter and nutrients and could cause increase in the microbial flora of the water bodies, thereby resulting in high heterotrophic bacteria counts [17]. The high number of bacteria recorded could be as a result of the increased surface area which exposes the water to contaminant as well as human activities like swimming, washing, dipping of dirty legs, hands and cans inside the stream while fetching water as also reported by [18, 19, 20].

The water samples did not comply with the World Health Organization (WHO) [21] standards for total heterotrophic count of 1.0 x 10^{-2} in 100 ml of water. The total coliform counts for all samples were higher than WHO standard of zero MPN in 100 ml for drinking and recreational water. According to [21], drinking water can be graded into four (4) categories depending on their most probable number (MPN) value. Water with MPN of zero (0) 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 [21].

The high coliform values obtained maybe an indication that the water samples were feacally contaminated as also reported in a similar study by [22]. The presence of *E.coli, Kebslella*, *Enterobacter* sp and other bacteria not only make water unsuitable for human consumption and usage but also pose serious health concerns [23]. Similar studies reported the presence of those bacteria in drinking water sources [24, 25] and attributed it to indiscriminate human and animal defecation and general poor sanitation.

Other bacteria isolated: *Staphylococcus* sp*., Pseudomonas aeruginosa, Proteus* sp. are also of public health importance. *Enterobacter aerogenes* isolated from the water samples are examples of non-feacal coliforms and can be found in vegetation and soil [26] which could have served as sources by which the pathogens entered the water. Counts greater than 10^4 are considered unsatisfactory for *Enterobacter* sp. The fungal growth was also higher than WHO [21] and EPA [27] standards with fungi that are of possible public health concern isolated from all three samples. These imply that

water from Oguta lake is microbiologically unfit for both drinking and recreational purposes.

The physiochemical parameters; sulphate, manganese, pH, TDS, TSS, turbidity and appearance conform to WHO standards. However, conductivity, color, iron, lead, cadmium, odor and nitrite had values above the standard. The iron content is above the WHO standard of 0.05 mg/l [21]. Iron has corrosive property. It gives water a corrosive taste, and according to [28] can cause harm to humans if it exceeds the WHO permissive limit of 0.05mg/l. Lead content is higher than WHO standard of 0.05 mg/l and accumulation of lead at higher concentration has some severe consequences on physical and mental development, along with deficit in learning ability in infant as well as increase in blood pressure and kidney problem in adults [28]. Cadmium permissible limit as set by WHO [21] is 0.05 mg/l which is lower than the results from this study. This is also worrisome as high concentration of cadmium in water when consumed, has been reported to cause nausea, vomiting, diarrhoea, muscle cramps, salivation, and at high accumulation; senses disturbances, liver injury, convulsion, stuck and renal failure [29]. Accumulation of high concentration of nitrite also has adverse effect on man especially infants. High level of nitrite has also been reported to cause algal bloom, which is unhealthy for aquatic life. Nitrite is the main constituent of inorganic fertilizer, and must have seeped into the lake through agricultural runoff. The presence of these harmful elements at concentrations above internationally acknowledged permissive limits make the water body unfit for drinking and recreation.

5. Conclusion

It has been revealed that currently, the microbiological and physiochemical quality of water from the Oguta lake makes it unfit for drinking and recreational activities. Yet many unassuming people are found using the water body for both activities. The contaminants seem to have seeped into the water body via human activities and agricultural runoff. There is therefore serious need to control activities around the Lake to prevent microbial as well as harmful chemical contaminats which have public health implications.

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