ANTHROPOGENIC EFFECTS ON MICROBIAL COMMUNITY OF RIVER IBI IN TARABA STATE, NIGERIA

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Abstract: Rivers are the most important freshwater resource for man. Apart from its function as a source of freshwater for drinking, domestic and industrial uses; freshwater resources serve multiple functions most of them being critical to human settlement and survival. Safe water is a fundamental right of humans and if contaminated with opportunistic pathogens, may be unsafe for human use and consumption and can also serve as vehicle for spread of diseases, hence there is need for investigating the anthropogenic effects on the microbial community of river Ibi in Taraba state, Nigeria. Water microbial analysis were conducted for three weeks in the morning and evening; at two sections: A (along the river banks) and B (inside the river) using standard microbiological methods. Physicochemical analysis of water samples at two sections was conducted. The result shows Parameters such as colour, pH, DO, BOD, turbidity and TSS exceeded the WHO standard, while temperature, alkalinity, total hardness, TDS, and conductivity complied with the WHO standard for drinking water. The highest bacterial count ranged from $6.0x10^4$ CFU m^{-3} to $5.0x10^4$. The result shows the isolation of the following bacteria including: *Staphylococcus aureus*, *Salmonella typhi*, *Shigella dysenteriae*, *Streptococcus pyogenes*, *Escherichia coli*, *Pseudomonas aeruginosa*, *enterobacter species*. *Staphylococcus aureus* (99%) was the most frequently isolated bacteria. The molecular analysis of some organism shows *Staphylococcus aureus* with 100% ID and 100% query. This study shows that anthropogenic activities such as farming, waste disposal, buying and selling among others encourage the growth and replication of microorganism in water sample and these has to be reduced to minimize its health effect on human.

Keywords: Anthropogenic, Effect, Pathogens, River and Ibi.

Introduction

The most valuable supply of freshwater for humans is rivers. Potable water and other domestic uses are primarily derived from surface water (Izal *et al*., 2016; Ogamba *et al*., 2017). Freshwater resources have several purposes besides providing drinking, household, and industrial uses of water; the majority of these uses are essential to human settlement and existence (Ugbogu, *et al* 2013). Human have a basic right to clean water, which, if contaminated with opportunistic pathogens, may make it unsuitable for use and consumption, as well as act as a vector for the transmission of disease (Agwaranze, 2021). A sufficient amount of clean, treated freshwater is a necessity for both economic and human growth. It is important to have enough access to clean, fresh water for both economic and health development. According to a Food and Agriculture Organization (FAO, 2007) report, water-related diseases have been impeding basic human development in African nations, particularly Nigeria. Since there are fewer acceptable water sources available due to urbanization, industry, and population growth, there is a growing need for water (Eyankware, 2014). Microbes connected to humans are thought to spread through water. Water-borne illnesses are frequent in the majority of Nigeria's northern states, and their scarcity and pollution are somewhat related to their occurrence (Agwaranze, 2021; Agwaranze *et al.*, 2017).

Untreated surface water from rivers can be used for drinking and other domestic needs directly in rural communities. Numerous anthropogenic variables, among which pollution is the most significant issue, are rapidly having an impact on the common water sources that are available to local populations in Nigeria (WHO, 2017). The most significant and frequent supply of freshwater for humans is rivers. One of the main sources of drinking water is river water. Drinking water dependence on rivers is fast growing as a result of declining rainfall and falling ground water levels. The presence of harmful microorganisms in drinking water is one of the biggest worries for water consumers regarding its quality (Ugbogu, *et al* 2013). Numerous microorganisms, including different bacteria, viruses, fungi, and parasites, are known water pollutants, and some of them have been linked to epidemics and diseases that are transmitted through the consumption of water (WHO, 2017). In terms of the quality of drinking water, bacteria are likely the microorganism category that is investigated the most.

Rivers and other water bodies can become contaminated in a number of ways, whether it's due to human domestic activity or industrial waste. These open water sources are susceptible to contamination from bacteria brought on by agricultural inputs, sewage overflow, and animal, human, and industrial waste, making the water unfit for human use (Nganje *et al*.,2010). Diseases are spread largely through contaminated water. Water quality and quantity can deteriorate due to water abstraction for residential use, agricultural production, mining, industrial production, power generation, and forestry practices, which affects both the aquatic ecosystem and the water supply for human consumption. River water is typically impacted by environmental activities, including both human and industrial ones. Water contamination in Nigeria is primarily caused by anthropogenic environmental change, according to several research (Ogidiaka *et al.*, 2012; Ugbogu, *et al.*, 2013; Agwaranze *et al.*, 2017).

The purpose of this study is to ascertain the impact of human activity on the Microbial Community of River Ibi in Taraba State, Nigeria. The following are some of the study's precise goals:

To ascertain the physicochemical parameters of the river at various locations and time, to enumerate the bacteria viable count and to characterize some of the isolated organisms at the molecular level.

Materials and methods

Study Area

The Ibi River is situated in Ibi Town, a local government area and administrative district in Taraba State, Nigeria. In terms of latitude and longitude, Taraba State is positioned about between 630 and 936 north and 910 and 50 east. Gombe State borders it on the northeast and Bauchi State borders it on the north. Additionally, it has borders with Plateau State to the north-west and Adamawa State to the east. The states of Nasarawa and Benue also border Taraba state to the west, and to the south and southeast, the state and the Republic of Cameroon share an international border. The town is located on the South bank of the Benue river opposite the influx of the much smaller Shemanker River. Within the LGA, the Donga and Taraba rivers both run into the Benue River.

Sampling Site

Water and air samples were taken from different sites. Water samples were taken at two distinct riverbank locations that is; at the river bank and inside the body of the river with the most anthropogenic activities. Assessment of water quality was conducted weekly for a period of three to four weeks, and samples were collected in batch that is: morning and evening from two stations along the river bank (Agwaranze, 2017).

Collection of water samples

Following the methods of Ugwuorah *et al*, (2012) and Agwaranze (2021). Samples were collected at different sampling point's using 500ml sterile plastic containers and was brought to the laboratory in plastic boxes containing icepacks to minimize continuous microbial activities.

Determination of physiological Properties of the Water Samples

pH, Color, Temperature, Alkalinity, Turbidity, Conductivity, Total Hardness, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), and Biochemical Oxygen Demand (BOD) were determined. Various digital hand-held electronic instruments of HANNA and HACH water and waste water monitoring equipment were used in the process. The metallic ion analysis was based on atomic adsorption spectrometric method as described by UNEP (2006).

Microbiological quality analysis

A. Preparation of media

Media were used for the isolation of microorganisms include Nutrient Agar (NA), MacConkey Agar (MA), Eosin Methylene (EMB) agar, and SS agar.

According to the manufacturer's instructions, the various media that were utilized in isolation were prepared. Weights were assigned to the dehydrated powdered medium: 28g for nutritional agar (Biomark), 52g for MacConkey agar, and 65g for Saboroud Dextrose Agar. Each weighted medium was put into Conical flask containing 900ml of distilled water and heated in an electric water bath (GFL, Germany) until properly dissolved. It was made up to 1 litre and its pH was measured with pH metre (Hanna, Romania) to ensure compliance with the standard (7.3 ± 0.2 for nutrient agar, 7.2 ± 0.2, 7.4 ± 0.2 for MacConkey agar, 5.6 ± 0.2 for SabauraudDextrose Agar). The media was then sterilized in an autoclave at 121^0C, 15 p.s.i. for 15 minutes. The sterilized media was allowed to cool to about 45^0c before they were separately dispensed aseptically into pre-sterilized Petri dishes in 20ml aliquots. The poured plates were allowed to cool and gel before they were used for microbial culture.

Isolation of Microorganisms

Bacterial counts; this aspect was done using two methods; 1. Most Probable Number (MPN) and 2. Membrane filtration Technique (MFT) (Agwaranze, 2020).

Most Probable Number Test

This test involves three steps, which includes**;**

Step 1 Presumptive test this test was done using the three tube method. The presumptive coliform test was carried out according to the method described by Ngwa and Chrysanthus (2013).

Step 2 Confirmation test; Positive tubes of the above test was sub-cultured on EMB agar for observation of *E. coli*

Step 3 Completed test. The *E. coli* observed in 2 above was cultured on Nutrient and Gram stained to observe gram reaction, morphology and cell arrangement to confirm the organism as *E. coli*. The pure cultures obtained were characterized using, colonial, microscopy, biochemical and sugar fermentation tests as described by Agwaranze, 2021

Molecular methods for the identification of organism.

Isolation of DNA

It took 72 hours to extract the genomic DNA from the culture. A sterile 1.5-micron centrifuge tube was used to hold the 100 microgram of mycelium for the isolation of DNA for three of the most frequently isolated bacteria According to Hunt *et al.* (2014).

Results

The result of the physicochemical parameters conducted on the water samples at various sections (A & B) is shown in table 1 below. The result is shown to have some variation. The physicochemical parameters that were analyzed include: colour, temperature, pH, turbidity, total hardness, DO, BOD, TSS, alkalinity, conductivity and TDS.

Table 1: Results of Physicochemical Analysis compared with WHO standard

S/N0	PARAMETERS	RESULT (A)	RESULT(B)	WHO Standards 2011
1	pH	7.14	6.41	6.5-9.0
2	Temperature (^{O}C)	31.6	30.5^{0}C	24-30^{0}C
3	DO(mg/L)	4.94	3.9	>5.0mg/L
4	BOD(mg/L)	3.21	3.11	3.0mg/L
5	Colour(PCU)	420	418	Cleared
6	Alkalinity (mg/L)	3.0	2.4	100mg/L
7	Total Hardness(mg/L)	15	14	NS
8	TDS(mg/L)	24.05	22.20	0-500mg/L
9	TSS(mg/L)	2.3	2.1	50mg/L
10	Conductivity(µs/cm)	48.73	46.12	1200µs/cm
11	Turbidity (NTU)	850	820	NS

The total viable count in water samples for bacteria ranged from 0.8x10^{4}CFUm^{-3} to 6.0x10^{4}CFUm^{-3} in week one as shown in table 2.

The total viable count in water samples for bacteria ranged from 0.9x10^{4}CFUm^{-3} to 6.1x10^{4}CFUm^{-3} for week two as shown in Table 3. During this week, water samples were collected immediately after a heavy rain fall and a high colony count was observed in the plates.

The total viable count for week three ranged from 1.0x10^{4}CFUm^{-3} to 6.0x10^{4}CFUm^{-3} as shown in 4. The total coliform count ranged 0.2x10^{2} CFU/ml to 2.6x10^{2} CFU/ml for week three as shown in Table 4.

Table 2: Enumeration of Bacteria of Water sample in Week One

	WA		WB	
Sampling time	Morning	Evening	Morning	Evening
Bacteria viable count (CFUm^{-3})				
	1.1x10^{4}	1.1x10^{4}	1.1x10^{4}	1.4x10^{4}
	2.0x0^{4}	2.4x10^{4}	1.8x10^{4}	6.0x10^{4}
	0.8x10^{4}	3.6x10^{4}	2.0x10^{4}	1.0x10^{4}
	1.1x10^{4}	0.9x10^{4}	0.9x10^{4}	1.6x10^{4}

KEYS: WA: Water sample station A, WB: Water sample station B.

Table 3: **Enumeration of Bacteria of Water sample in Week Two**

	WA		WB	
Sampling time	Morning	evening	morning	Evening
Bacteria viable count (CFUm^{-3})				
	3.1x10^{4}	1.1x10^{4}	6.1x10^{4}	1.4x10^{4}
	1.0x10^{4}	1.4x10^{4}	2.8x10^{4}	2.0x10^{4}
	4.8x10^{4}	1.6x10^{4}	2.0x10^{4}	1.0x10^{4}
	2.1x10^{4}	0.9x10^{4}	3.9x10^{4}	1.6x10^{4}

KEYS: WA: Water sample station A, WB: Water sample station B.

Table 4: **Enumeration of Bacteria of Water sample in Week Three**

	WA		WB	
Sampling time	Morning	Evening	Morning	Evening
Bacteria viable count (CFUm^{-3})				
	1.1x10^{4}	6.0x10^{4}	1.1x10^{4}	2.4x10^{4}
	2.0x10^{4}	2.4x10^{4}	2.8x10^{4}	6.0x10^{4}
	1.8x10^{4}	3.6x10^{4}	1.0x10^{4}	4.0x10^{4}
	2.1x10^{4}	2.9x10^{4}	1.0x10^{4}	4.6x10^{4}
Total coliform count(CFU/ml				
	2.4x10^{2}	1.6x10^{2}	0.8x10^{2}	0.3x10^{2}

KEYS: WA: Water sample station A, WB: Water sample station B

Table 5 presents all the microorganism isolated during the study. *Staphylococcus aureus, Salmonella typhi, Shigella dysenteriae, Streptococcus pyogenes*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterobacter species*. *Staphylococcus aureus* was isolated from almost all the media showing its prevalence than other organism this.*Staphylococcus aureus* (99%) was the most frequently isolated bacteria as presented in figure 1.

TABLE 5: List of Bacteria Isolates within three Weeks for Water Sample.

Sampling Time		Isolates
Section A: Water	Morning	*Staphylococcus aureus, Streptococcus pyogenes,, Pseudomonas aeroginosa.*
	Evening	*Shigella dysenteriae, E. coli, Salmonella typhi.*
Section B: Water	Morning	*Staphylococcus aureus, Enterobacter species, Streptococcuspyogenes*
	Evening	*Salmonella typhi, Staphylococcus aureus, Streptococcus pyogenes.*

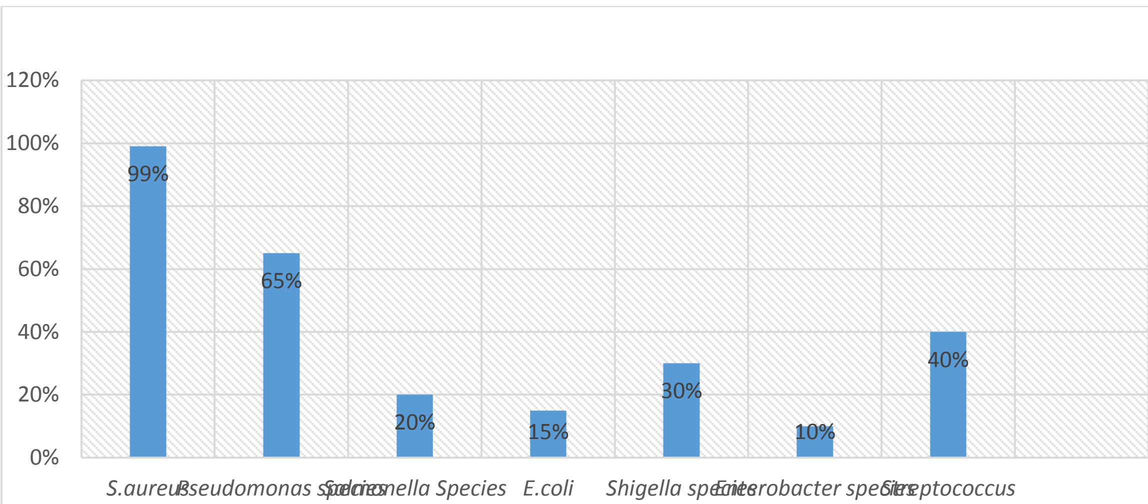

Fig. 1: Percentage of Occurrence of Bacteria Isolate for Water sample

Table 6: molecular characterization of some organisms isolated

Some of the prevalently isolated organism were characterized molecularly to ascertain and identify DNA strands. The organisms that were characterized include *Staphylococcus aureus,* and *Salmonella typhi.*

Organism	Percentage ID	E.Value	Query	Quary ID	Molecular Type	Query Lenght	Accession No
Staphylococcus aureus	100%	0.00	100%	60201	DNA	1520	NZCP065712.1
Pseudomonas monteillii	100%	0.00	100%	108221	DNA	1120	NZCP022562.1

Discussion

The anthropogenic effects on microbial community of river Ibi were analyzed in this study. The analyses were done in sections. The residents of Ibi use the water for so many purposes such as bathing, Cooking, drinking, washing, farming and even direct consumption. The isolation and identification of pathogenic organism is of public health importance, of which the presence of these pathogenic coliform organism have been shown to change the quality of water (Agwaranze *et al* 2017; Ugbogu *et al* 2013).

This study evaluated the anthropogenic effect of river Ibi , Taraba state.

Physicochemical parameters
The result of the physicochemical parameters conducted on the water samples at various sections (A & B) is shown to have some variation. The physicochemical parameters that were analyzed includes colour, temperature, pH, turbidity, total hardness, DO, BOD, TSS, alkalinity, conductivity and TDS.

Colour
Water samples from all the sections under study showed observable colours and odour at the time of sampling. The values ranged from 418 for section B to 420 for section A against WHO standard which states that any healthy water must be cleared from colour. Colour in water may be due to the construction and human activities. Safe water for human consumption should be colourless; changes in the colour of water and the appearance of new colours serves as indicators that further investigation is needed. It is standard requirement that good quality water should be free of colour and odour (WHO, 2013). Odour in water is caused mainly by the presence of organic substances. The observable water colouration and odour observed in the water sample is indicative of increased biological activities or water pollution caused by continuous anthropogenic and construction activities

Temperature
The water temperature recorded values of 31.6^{o}C for section A and 30.5^{o}C for section B in this study. This high temperature is similar to that of Okorafor *et al*, (2013) for Calabar River and Duru, *et al*, (2018) in a study of the impact of organic waste on water quality of Woji creek in Port Harcourt Nigeria. Heat from the sun which increased the surface water temperature maybe the major cause of the high temperature of the surface water. The high temperature obtained is within the permissible limit of WHO.

pH
The pH values are 7.14 for section A and 6.51 for section B for the water sample collected from Ibi river. This may be due to the influx of acidic forming substances into the water body through surface runoff. This result is similar to that of George and Atakpa (2015) for cross River Estuary. This value fall within the permissible standard of 6.5-8.5 set by WHO (2010).

Turbidity
Water turbidity reflect transparency and it an important criteria for assessing water quality. The Turbidity value for this study falls between 820 for section B and 850 for section A and this is higher than the standard recommendation by WHO (2018) and this may indicate that the entire river contain pollutant and may pose problem to aquatic life. This might be due to surface runoff and waste water from different anthropogenic activities. Similar higher turbidity value where also recorded by some researcher as compare to the limit set by WHO. This value falls within the range of 2NTU to 47NTU reported by Asonye, *et al*, (2017) in a study of some physicochemical characteristics and heavy metal profiles of Nigerian rivers, stream and water ways. The turbidity results of this study agree with those of Onojake *et al* (2015) in the New Calabar River and Amah-Jerry *et al* (2017) in the Aba River. Turbidity is an indication of water pollution; it is caused by the presence of suspended matters like clay, silt and microorganism which makes water cloudy Edokpayi, *et al*, (2018).

Total Hardness
The values fall between 15 for section A and 14 for section B in this study. The amount of calcium and magnesium ions in a water sample expressed as mg/l value is considered to be within the regulatory recommendation.

DO
Dissolved oxygen is an important parameter used in determining the quality of water. In this study, the value gotten which where 4.94 mg/L for section A and 3.9 mg/L for section B could be attributed to anthropogenic activities from surrounding environment into the water during the period. This report is similar to the findings of George and Abowei (2018) in the upper New Calabar River.

BOD
Increase in anthropogenic activities causes adverse increase in the biological oxygen demand. The result gotten from this study ranged from 3.21 mg/L for section A and 3.11 mg/L for section B. The DO and BOD were above the limits by WHO (2010).This trend is similar to the report of George and Abowei (2018) in the upper New Calabar River. Afolabi *et al* (2012) posited that any water with BOD value within 2-3 mg/L was termed contaminated and was unwholesome for human consumption.

TSS
High total suspended solids can also be attributed to the proximity of the sampling station to residential area, runoff water from the rain during sampling period and also industrial activities from the construction site. This may also be as a result of the market which uses the river as waste disposal site. TSS decrease water transparency, inhibits photosynthesis, increase of bottom sediments, and smothers aquatic organism breeding bed (Ogbeibu & Anagboso, 2013). The result shows the value of 2.3 for section A and 2.1 mg/L for section B.

Alkalinity
A water body's alkalinity is an indicator of its ability to neutralize acids to a specified pH (Edokpayi, 2015). The low value gotten from this study 3.0 for section A and 2.4 mg/L for section B is linked to the high rainfall which could result in the dilution of this parameter. The value obtained is similar to that of Ibok *et al*, (2010) and Deekae *et al* (2010). This result is permissible limits of WHO (2018).

Conductivity
An indicator of the total ion concentration in a water sample is conductivity. Typically, dissolved inorganic salts have an impact on this. The high value of conductivity 48.73 for section A and 46.12 for section B agrees with the work of Ekpo *et al*, (2012) for Ikpa River and this may be due to the positive effect of rainfall which leads to subsequent runoff of salt-rich substances from land into the river. This result is within the permissible limits of WHO (2018).

TDS
Influx of allochthonous inputs into the river through surface runoff can cause high value of the total dissolved solids. The result from this study which is 850 for section A and 820 for section B is similar to that of George and Atakpa (2015) in Cross River Estuary. The result is within the permissible limits of WHO (2018).

Water analysis
The result showed the presence of pathogenic and opportunistic organism which is of public health concern. The total bacterial count which ranged from 0.1×10^{4} -

6.0×10^4 CFU m^{-3} was high and exceeded the recommended limit of <500 cfu/ml this report is similar to that of Agwaranze *et al*, (2017). This high value can be attributed to the runoff water that enter into the river body during rain and other substances like faecal matter from human activities that enters the river from time to time. During week 2 of the study (morning section), numerous colonies of bacteria were observed because water samples were collected immediately after rainfall. Any water used for drinking or cleaning purposes should not contain any pathogenic organism (Agwaranze *et al.*, 2017). The organism of pathogenic group isolated during this study include *Staphylococcus aureus*, *Salmonella typhi, Shigella dysenteriae, Streptococcus pyogenes, Escherichia coli, Pseudomonas aeruginosa*, *Enterobacter species,* for water samples and this is similar to report of Agwaranze *et al,* (2017), Ugbogu *et al*, (2013) and Ologbosere *et al,* (2015) were both work reported the isolation of pathogenic organism such as *Staphylococcus aureus*, *Salmonella typhi*, *Streptococcus pyogenes*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterobacter species.* The occurrence of coliforms or faecal coliform in water sample in this study which range from 0.2×10^2-2.6×10^2CFU/ml indicates the presence of faecal contamination and this is similar to the report of Suma *et al* (2014) These organism can harbor potential pathogens and the presence of pathogenic organisms can pose severe health risks to consumers in general and immunocompromised individual (Suma *et al.*,2014). This trend is similar to the report of Bello-Osagie and Omoruyi (2012) who reported a high number of E. coli from water samples of Ikpoba River. The microbial quality of drinking water has become an increasing cause of concern world wide as the practice of disposing waste which usually find its way into the body of the streams and river. Some of these resident understands duly the negative health issues consuming this water can pose to them but due to other better alternative the practice is continued. In Nigeria, most surface water especially in rural area, are used for domestic purposes. The microbiological quality of water samples is very poor when compared to Federal Ministry of Environment limits for potable water, hence, the direct consumption of Ibi river should be discouraged as these organisms are causative agents of human diseases and their presence poses a potential threat to human populace (Ologbosere *et al.*, 2015).

Molecular characterization of some organism

Some of the prevalently isolated organism were characterized molecularly to ascertain and identify DNA strands. The organisms that were characterized include *Staphylococcus aureus* and *Salmonella typhi.* This organism were sent based on no particular other, it was simply based on the prevalence of occurrence and interest on the isolates. From the result, *Staphylococcus aureus had* 100% ID and 100% Query, while *Salmonella typhi* from the result turned out to be Pseudomonas monteillii with 100% ID and 100& Query number showing a different isolate from the expected one. This result therefore shows the confirmation of some this species and their presence in the river which is of public health importance.

Conclusion

The anthropogenic effects on microbial community of river Ibi were analysed in this study. This study discovers that pathogenic bacteria associated with water could contribute to health issues and pandemic. This study presents the usefulness of microbiological experiments and physicochemical analysis in the assessment of water quality. As a rural community, their major occupation is fishing and farming, the result of the analysis reflected anthropogenic activities responsible for water pollution in ibi river were mainly the construction activities which causes water pollution, dumping and defecating of waste into the water, inflow of animal dumps from farm lands during and after rainfall into the river, washing of clothes, cars and bikes around the river banks and also, the economic activities going on within or around the river bank. The result gotten also shows that the river is unsafe for human use and consumption as it has a larger number of microbial load.

More studies are needed in order to check for emergency fecal pollution outbreaks.

Recommendation

Infectious diseases caused by organism are the most leading cause of deaths in the world and most of these causative agents have been isolated from Ibi River showing that the water is unsafe for human consumption. The study therefore recommends that further research needs to be conducted to estimate, to what extend the impact of this activity affects the health of humans.

Extensive public health enlightenment schemes aimed at educating the general public and the residents living close to the river of the dangers of deliberate human fecal pollution and animal waste dumps in the river and direct consumption of water collected from Ibi River should be conducted by both relevant Government and Non-Governmental agencies and overall provision of potable water supply should be made available to all. There is need for improved sanitation that takes care of proper management of human and animal waste.

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