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MICROBIAL AND PHYSICOCHEMICAL ASSESSMENT OF FOMA RIVER, ITA-NMO, ILORIN, NIGERIA: AN IMPORTANT SOURCE OF DOMESTIC WATER IN ILORIN METROPOLIS.

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ABSTRACT: Water occupies about 70% of the earth's surface and yet it is one of the scarcest commodities especially in the developing countries of the world. It is one of the most demanded of all urban and rural amenities and it is indispensable for man's activities. The importance of Foma River, Ita-Nmo, Ilorin to the populace of some communities near the river in term of provision of domestic water and small scale farming around the river inspired the research into the microbial quality and the physicochemical parameters determination of the water and soil sediment of the river.

Forty-eight water samples from four sampling points along the course of Foma River, Ita-Nmo, Ilorin, Nigeria were analysed for their physicochemical and microbiological quality over a period of twelve months. The pH, turbidity, dissolved solids, dissolved oxygen, biological oxygen demand and temperature assessed had high values above permissible level for drinking and recreational activities. The total bacterial counts ranged from 2.7×10^3 - 1.23×10^4 cfu/ml while the fungal counts ranged from 7.0×10^2 - 8.0×10^3 cfu/ml. The bacterial isolates included genera *Enterobacter*, *Proteus*, *Escherichia* , *Staphylococcus*, *Pseudomonas*, *Sphaerotilus*, *Erwinia*, *Bacillus*, *Shigella*, *Klebsiella*, *Serratia*, *Salmonella* and *Yersinia* while isolated fungi genera included *Penicillium*, *Curvularia*, *Aspergillus niger*, *Mucor*, *Aspergillus*, *Saccharomyces*, *Mortierella*, *Cladosporium*, *Fusarium,* and *Rhizopus*. The high level of bacteria, physicochemical parameters and presence of coliforms in this river are causes for great concern health-wise.

Keywords: Microbial, Physicochemical, Health, Drinking, Recreational.

INTRODUCTION

Water occupies about 70% of the earth's surface and yet it is one of the scarcest commodities especially in the developing countries of the world. It is one of the most demanded of all urban and rural amenities and it is indispensable for man's activities. Water needs have had serious socio-economic and health influences on urban development in developing countries where populations' concentrations have put serious strains on available resources. Developing countries are steadily moving towards a situation where the carrying capacity of the urban areas is deteriorating due to growing populations that do not correspond with the rate at which resources are provided. Amongst the serious environmental problems are waste accumulation and lack of adequate and safe water supply (3). Some 40 percent of the world's population in over 80 countries are affected by serious water shortages. In other countries water is available but too expensive to use because more accessible resources have already been depleted and new sources cost much more to treat to an acceptable standard. Pollution must be seen as a gross misuse of an essential but scarce resource (10).

Rivers have been used as a sink for wastes from agriculture and industry due to its flow and ecological nature, rivers are able to regenerate themselves to admit staggering amount of tributaries. However, all rivers have limited absorptive capacity for sewage and fertilizer from cropland or farmland. If this limit is exceeded, the proliferation of bacteria, algae and plant life will consume all the oxygen dissolved in water (eutrophication) and drown insects and fish, which destroys the whole river ecosystem since they were broken off food chains.

Water pollution by chemicals that are usually not present in the system can have terrible consequences, because the rivers are very vulnerable to poisoning by the toxic products generated from mining, smelting and industry, such as heavy metals like lead, zinc, cadmium, acids, solvents and PVCs (polyvinyl chloride). These chemicals not only destroy life at the time pollution occurs but also slowly accumulate in sediments and souls of flood plain. Man is not free from the dangers arising from the consumption of water or foods that come from these rivers and contaminated soils (20).

Judging by the incidence of water-related illness in Africa, the continent is a very long way from providing 'safe water' for all its citizens. (21). Estimated that 80% of ill-health in less developed countries stems from lack of safe water and adequate sanitation. Microbiological contamination is the most common reason for water to be deemed unsafe and is usually detected by testing for indicator bacteria such as faecal coliforms. Freshwater is host to numerous microorganisms that affect human health directly.

Not only is freshwater essential to life but it is also a relatively scarce resource, and is likely to become more so with the impacts of global warming and population growth: the human population currently estimated at 6.24 billion, is predicted to rise to 10 billion by the year 2050. Some 80 percent of the global population live in developing countries (10).

Pollution of surface water occurs when too much of an undesirable or harmful substance flows into a body of water, exceeding the natural ability of that water body to remove the undesirable material, dilute it to a harmless concentration, or convert it to a harmless form. This can be from point or non-point sources (15).

The sampling points were along the course of the river flow labelled A, B, C and D. Along the bank of the river are farms with crops such as banana, rice, sugar cane and vegetables. Human activities found by the bank of the river are three cement block-making industries. The river also serves as recreational swimming pool for small children at nearby school.

Sampling point D is used for collection of drinking water for the populace near the river and neighbouring villages of Ogundele, Mahdi and Oke-Foma during the dry season when drinking- water availability is almost nil or non-existent.

Due to scarcity of safe and potable water during the dry season and unavailability of treated public water supply even during the rainy season, the populace within Ilorin metropolis, especially at Ita-Nmo, Oloje Estate area resort to this popular river for domestic water. The health implication of the use of such water source has negative economic importance to the community and her people. Water meant for preparation or formulations of consumables need to be potable and safe.

The aims and objectives for this research were to investigate the microbial quality of this river and the health implication of consumption of water from this river, as well as determine the possibility of this river being used as a small dam for treatment of water for public supply of the small communities near the river by assessing the physicochemical and microbiological qualities of this water source.

MATERIALS AND METHODS

Project Site

Foma River is located about seven kilometres from the Emir's Palace, Ilorin, Nigeria on latitude N 08.49574 and longitude E 004.5107. It is a freshwater and free-flowing during the rainy season while slow-moving during the dry season period.

Sample Collection

Water samples were collected from each of the four sampling points in sterile sampling bottles labelled A, B, C and D once a month for twelve months. The samples were immediately transferred to and analyzed in the laboratory (9).

Physicochemical parameters

The pH, temperature, turbidity, total hardness, magnesium hardness, calcium hardness, total solids, suspended solids, dissolved solids and alkalinity were all determined as described by A.P.H.A. (1).

The Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) were also determined using the Winklers titration method as described by A.P.H.A. (1) and (7).

Isolation and Estimation of Bacteria

Total aerobic heterotrophic bacterial populations, total coliforms and faecal coliforms were determined as described by A.P.H.A. (1). The pour plate method was used for isolation employing serial dilution (6). The colonies on each plate were counted after incubation for 24 to 48 hours at 35^0C. The most probable number (MPN) technique was used for isolation and enumeration of total coliforms and faecal coliforms (12).

Isolation and Estimation of Fungi

Potato dextrose agar was used for isolation of fungi using pour plate method and serial dilution of 10^{-2} (6) as described by A.P.H.A. (1). The plates were incubated at 25^0C for two-three days (9).

Purification and Identification of isolates

Bacterial isolates were sub-cultured until pure cultures were obtained before being characterized and identified. The fungi species were sub-cultured to obtain pure cultures. They were then characterized and identified (9) and (16).

RESULTS

pH

The lowest pH value obtained in the fifth month of sampling was 6.14 and highest value of 7.97 obtained in the eleventh month, all in sample A as shown in Table 1.

Turbidity

High turbidity levels were obtained in all the samples with the lowest turbidity value of 1.71 NTU in sample B in the tenth month of sampling as compared to the highest value of 70.40 NTU in sample A in the fourth month as shown in Figure 1.

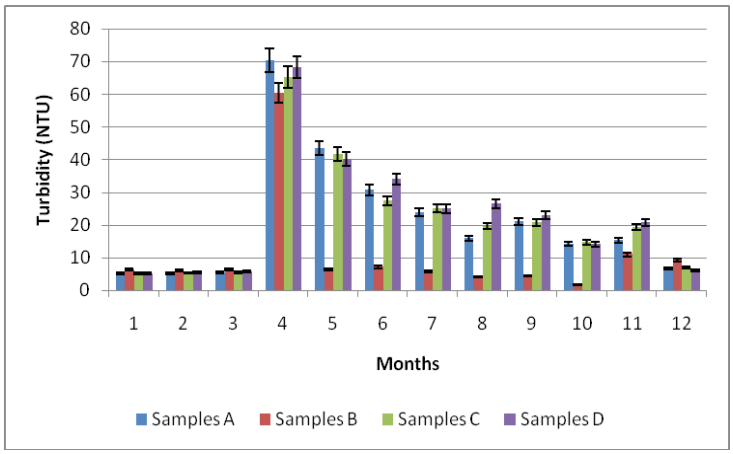

Figure 1: Turbidity values of Water of Foma River, Nigeria

Dissolved Solids

Dissolved solids values expressed in mg/l were generally high throughout the months with a range of 120 – 7800 mg/l in Figure 2 below.

Temperature

Temperature values expressed in ^{0}C ranged from 22 – 31 ^{0}C for the months shown in Table 2), the highest values were recorded for all the samples in the fourth month and lowest values occurred in the fist month of analysis for all the four samples.

Dissolved Oxygen

The lowest value of Dissolved Oxygen in this study is 0.40 mg/l in sample A in the twelveth month of sampling while the highest value is 18.40 mg/l also in sample A in the fourth month (Figure 3).

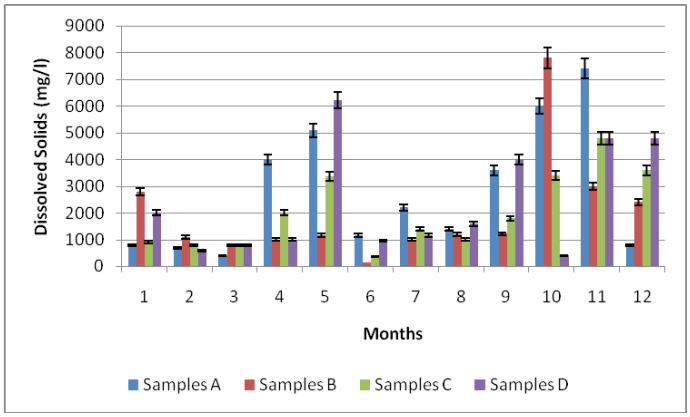

Figure 2: Dissolved Solids of Water of Foma River, Nigeria.

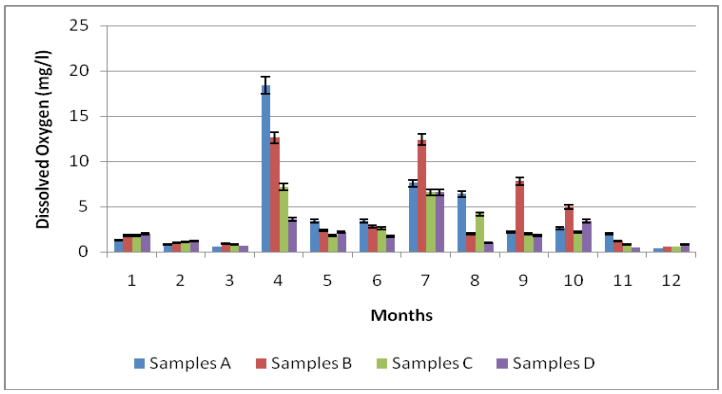

Figure 3: Dissolved Oxygen of water body of Foma River, Nigeria.

Biological Oxygen Demand (BOD_5)
The lowest BOD_5 value obtained occurred in the eight, eleventh and twelfth months in samples A, B, C and D while the highest value was got in sample B in the seventh month (Figure 4).
Bacteria and Fungi

The total bacterial count ranged from 2.7 x 10^3 - 1.23 x 10^4 cfu/ml as shown in Table 3 while total fungal count ranged from 7.0 x 10^2 - 8.0 x 10^3 cfu/ml (Table 4).

A total of fifteen bacteria were isolated and identified and their percentage frequency is shown in Table 5.

Seventeen fungi were isolated and identified with their percentage frequency shown in Table 6.

DISCUSSION

pH

pH values were generally in the optimal range of 6.14 - 7.97 indicating variation from acidity to alkalinity which is conducive for microbial activity similar to the one obtained by Eziuzor and Okpokwasili (8). The fifth and sixth months were acidic while the rest months were alkaline in nature (Table 1).

T able 1: pH of Water of Foma River, Ilorin, Nigeria

	Sampling Months											
Sampling Points	1	2	3	4	5	6	7	8	9	10	11	12
A	7.17a	7.03 a	7.20 a	7.02 a	6.14 a	6.89 c	7.67 c	7.49 c	7.21 b	6.89 b	7.97 d	7.13 a
B	7.20 b	7.32 b	7.34 c	7..34 c	6.34 b	6.85 a b	6.94 a	7.34 a	6.80 a	6.52 a	7.14 a	7.16 b
C	7.18 a	7.08 a	7.22 b	7.63 d	6.63 d	6.84 a	7.06 b	7.48 c	7.25 c	7.11 d	7.44 b	7.19 c
D	7.18 a	7.10 a	7.20 a	7.32 b	6.55 c	6.86 b	7.05 b	7.42 b	7.37 d	7.03 c	7.51 c	7.24 d

Values followed by the same alphabets along the same row are not significantly different but those followed by different alphabets are significantly different using Duncan's multiple range test at $p<0.05$

Turbidity

Only sample B in the tenth month had a value that fall within the permissible limit of (21), the rest samples for all the months showed pronounced deviations from WHO standard of 5.0 NTU (Figure 1). The values in all the samples in the fourth month were extremely high which mark the beginning of rainy season when run-off from land enters the river. Turbidity was generally lower from the third month to tenth months with exception of the fourth month which is similar to the results obtained by Akpata and Ekundayo (2) but was not determined by Orji and Anyaegbunam (17).

Dissolved Solids

Dissolved solids values expressed in mg/l were generally high throughout the months with a range of 120 – 7800 mg/l (Figure 2) which is similar to the one obtained by Ogbonna *et al*., 2010 on Orashi River. The values obtained in this study were higher than the permissible level (21).

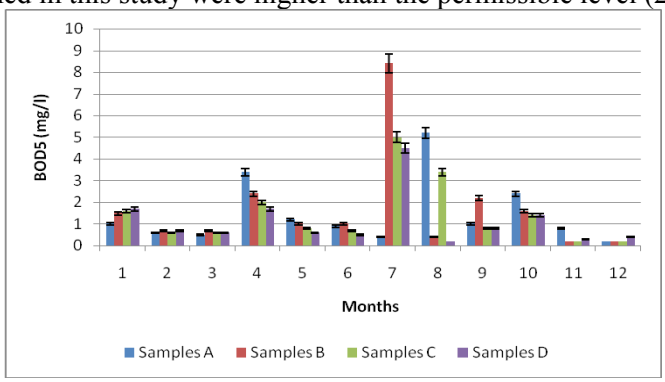

Figure 4: Biological Oxygen Demand of Water of Foma River, Nigeria.

Temperature

Temperature values expressed in ^{0}C ranged from 24.6 – 31 ^{0}C for the months (Table 2) , the highest values were recorded for all the samples in the fifth month when there was a break in rainfall which correspond with that obtained for temperature of freshwater fish propagation (11) and this temperature of the water body is believed to have been influenced by the intensity of of the sunlight as reported also by Okonko *et al*. (14).

Dissolved Oxygen

There is seasonal flunctuation in dissolved oxygen with rainy season having higher values beginning from the fourth month but the dry months of eleventh month to third month of the year have lower values (Figure 3) as observed by Olayemi (15) in a similar work on Asa River. The range of Dissolved Oxygen in this study is 0.40 – 18.40 mg/l. Dissolved oxygen is used as an indicator of the health of a water body, where higher dissolved oxygen concentrations are correlated with high productivity and little pollution (4).

Biological Oxygen Demand (BOD_5)

The BOD_5 values obtained in this study (Figure 4) were 0.20 -8.40 mg/l which were similar to that of (15) and there was gradual decrease in the values from the first month of the year to the twelfth month of the year in all the samples with the exception of seventh and eighth months when availability of organic materials were very high and biological activity of the microorganisms were high especially in sample B. This was also supported by result also obtained by Ogbonna *et al*.,(13) in a similar research.

Bacteria and Fungi

A total of fifteen bacteria consisting of *Enterobacter aerogenes*, *Proteus vulgaris*, *Escherichia coli*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Sphaerotilus natans*, *Erwinia amylovora*, *Bacillus licheniformis*, *Shigella dysenteriae*, *Klebsiella pneumoniae*, *Shigella sonnei*, *Serratia marcescens*, *Salmonella enteritiditis* and *Yersinia enterocolitica* were isolated and identified with bacteria load range of 2.7 x 10^3 - 1.23 x 10^4 cfu/ml (Table 3) and the frequency of occurrence is shown in Table 5. The bacterial isolates were similar to those obtained by Olayemi (15); (17) and (13) in researches similar to this work. In the study carried out by (15) on bacterial population of the surface and sediments of Asa River at two point sources upstream and one point source downstream; he reported that the majority of bacteria found in the river belong to the following groups; fluorescent bacteria (*Pseudomonas*), chromogenic rods (*Xanthomonas*), coliform group (*Escherichia*, *Enterobacter*, etc.), non-gas forming, non-chromogenic, non-spore forming rods, spore formers of the genus *Bacillus (*5).

Table 2: Temperature of Water of Foma River, Ilorin, Nigeria (^{0}C)

	Months											
Sampling Points	1	2	3	4	5	6	7	8	9	10	11	12
A	22.00a	27.00 a	30.00 a	28.00 a	30.00 a	26.00 a	25.00 a	24.80 b	27.00 a	27.60 b	26.70 d	28.20 b
B	22.60 a	28.00 a	32.00 b	29.00 ab	31.00 a	28.00 b	25.30 c	24.60 a	27.10 a	27.50 b	27.10 a	28.10 b
C	22.00 a	27.00 a	31.00 ab	30.00 b	30.00 a	26.00 a	25.60 d	25.10 c	27.00 a	27.30 a	27.30 b	28.10 a
D	22.00 a	27.00 a	30.00 a	28.00 a	30.00 a	27.00 ab	25.20 b	24.80 b	27.00 a	27.20 a	27.60 c	27.80 a

Values followed by the same alphabets in the same row are not significantly different but those followed by different alphabets are significantly different using Duncan's multiple range test at $p<0.05$

Table 3: Total Bacterial Counts of Water of Foma River, Ilorin, n x 10^2(cfu/ml)

	Months											
Sample	1	2	3	4	5	6	7	8	9	10	11	12
A	107	78	52	76	27	84	65	27	76	64	77	41
B	83	123	67	34	43	49	73	34	101	52	67	72
C	58	47	43	120	56	33	64	85	32	64	74	63
D	50	44	73	53	72	80	26	37	84	46	75	51

Seventeen fungi which include *Penicillium chrysogenum*, *Curvularia geniculata*, *Aspergillus niger*, *Penicillium frequentas*, *Mucor plumbeus*, *Aspergillus flavus*, *Saccharomyces cerevisiae*, *Mortierella ramanniana*, *Mucor racemosus*, *Cladosporium herbarum*, *Penicillium lapidosum, Penicillium piriformis, Penicillium digitatum, Mucor mucedo, Fusarium oxysporum, Rhizopus stolonifer and Rhizopus oryzae* were isolated and identified (16) with a load of 7.0 x 10^2 - 8.0 x 10^3 cfu/ml (Table 4) while the frequency of occurrence is shown in Table 6.

Table 4: Total Fungal Counts of Water of Foma River, Ilorin, n x 10^2(cfu/ml)

Sample						**Months**						
	Jan.	**Feb.**	**March**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
A	46	33	45	20	34	54	48	44	36	50	13	9
B	53	14	31	11	21	80	73	63	59	37	23	7
C	47	52	56	21	39	63	67	51	44	40	11	11
D	27	37	43	17	19	49	59	48	38	35	14	13

Table 5: Frequency of Occurrence of Bacteria in Water Samples of Foma River, Ilorin, Nigeria (%).

Isolates	% Frequency of Occurrence
Enterobacter aerogenes	17.4
Proteus vulgaris	5.8
Escherichia coli	17.4
Staphylococcus epidermidis	10.0
Staphylococcus aureus	7.2
Pseudomonas aeruginosa	4.4
Sphaerotilus natans	4.4
Erwinia amylovora	2.8
Bacillus licheniformis	2.8
Shigella dysenteriae	4.4
Klebsiella pneumonia	5.8
Shigella sonnei	4.4
Serratia marcescens	4.4
Salmonella enteritiditis	4.4
Yersinia enterocolitica	4.4

Table 6: Frequency of Occurrence of Fungi in Water Samples of Foma River, Ilorin, Nigeria (%).

Isolates	% Frequency OF Occurrence
Penicillium chrysogenum	6.1
Curvularia geniculata	3.0
Aspergillus niger	10.6
Penicillium frequentas	6.1
Mucor plumbeus	7.6
Aspergillus flavus	7.6
Saccharomyces cerevisiae	12.1
Mortierella ramanniana	4.5
Mucor racemosus	6.1
Cladosporium herbarum	6.1
Penicillium lapidosum	3.0
Mucor piriformis	4.5
Penicillium digitatum	4.5
Mucor mucedo	4.5
Fusarium oxysporum	3.0
Rhizopus stolonifer	6.1
Rhizopus oryzae	4.6

(2) Isolated a number of fungi from Lagos lagoon which included the genera *Aspergillus, Cladosporium*, *Fusarium*, *Geotrichum*, *Mucor*, *Penicillium* and *Trichoderma* which is similar to the fungi isolated from Foma River.

Fungi also constitute a group of living organisms found in water. They are devoid of chlorophyll, have cell walls and are heterotrophic in nutrition, and in most cases, they are saprophytic. Many of the primitive fungi are aquatic and they are collectively known as water moulds or aquatic Phycomycetes. They occur on the surface of decaying plant or animal materials in ponds, rivers and streams (18, 19).

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