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# Physicochemical and Microbiological Assessment of Source and Stored Domestic Water from Three Local Governments in Ile-Ife, Nigeria

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***Abstract*—**Some of the main problems man contends with are the quantity (source and amount) and quality of water in Nigeria. Scarcity leads to water being obtained from various sources and microbiological contamination of the water may thus occur between the collection point and the point of usage. This study thus aims to assess the general and microbiological quality of domestic water sources and household stored water used within selected areas in Ile-Ife, South-Western part of Nigeria for microbial contaminants.

Physicochemical and microbiological examination were carried out on 45 source and stored water samples collected from well and spring in three different local government areas i.e. Ife east, Ife-south and Ife-north. Physicochemical analysis included pH value, temperature, total dissolved solid, dissolved oxygen and biochemical oxygen demand. Microbiology involved most probable number analysis, total coliform, heterotrophic plate, faecal coliform and streptococcus count.

The result of the physicochemical analysis of samples showed anomalies compared to acceptable standards with the pH value of 7.20-8.60 for stored and 6.50-7.80 for source samples. The total dissolved solids (TDS of stored 20-70mg/L, source 352-691mg/L), dissolved oxygen (DO of stored 1.60-9.60mg/L, source 1.60-4.80mg/L), biochemical oxygen demand (BOD stored 0.80-3.60mg/L, source 0.60-5.40mg/L). General microbiological quality indicated that both stored and source samples with the exception of a sample were not within acceptable range as indicated by analysis of the MPN/100ml which ranges between (stored 290-1100mg/L, source 9-1100mg/L). Apart from high counts, most samples did not meet the World Health Organization standard for drinking water with the presence of some pathogenic bacteria and fungi such as Salmonella and Aspergillus spp. To annul these constraints, standard treatment methods should be adopted to make water free from contaminants. This will help identify common and likely water related infection origin within the communities and thus help guide in terms of interventions required to prevent the general populace from such infections.

***Keywords*—**Domestic, microbiology, physicochemical, quality, water.

## I. Introduction

WATER of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability [1], [2]. In developing countries, many people are living in rural communities and have to collect their water some distance away from the household and transport it back in various types of containers [3]. Microbiological contamination of the water may occur between the collection point and the point of usage which makes it unhygienic [1], [2]. To improve the microbiological quality and to reduce the potential health risk of water to individuals in households, intervention strategies are needed that is easy to use effectively, affordable, functional and sustainable [3], [4]. This study hence aimed to assess the general quality and evaluate domestic water sources and household stored water used within some areas in Ife (Osun state) South-Western part of Nigeria for microbial contaminants. This will help identify common and likely water related infection origin within the communities and thus help guide in terms of interventions required to prevent the general populace from such infections. This work is expected to give information about burden of water related infections and to help correct the basic problems associated with the domestic water in the selected environment.

The lack of safe household water and adequate sanitation measures lead to a number of diseases such as cholera, salmonellosis, typhoid and cutaneous infections. Every year, lives are claimed due to above listed diseases which are symptoms of infection or the result of a combination of pathogens. To tackle these problems, the following will be taken to consideration.

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## II. Materials and Methods

### A. Study Area and Sampling

Forty-four source and stored water samples from three different areas with varying socioeconomic and demographic status in Osun state were randomly collected for physicochemical and bacteriological analysis. The areas are Ife-east (Location W), Ife north (Location X), Ife south (Location Y).

Well water constitutes the major source of drinking water in these areas. Most of the wells under study were privately owned and are usually open to general public. Half of the numbers of the studied wells were covered while the others were not. Drawing of water from these wells was done by the use of 5-7L containers, which is tied directly to the well cover. In certain cases where this is not possible, individual fetcher usually comes with small bucket to draw water. The wells are not less than 10years old.

The samples were collected aseptically using the sampling and storage procedures according to [5]. All samples were collected in sterile autoclavable plastics, labeled with different

codes and immediately stored at 4°C. Samples was transported back to the laboratory from sample collecting sites and analysed within 24h.

*B. Physicochemical Analysis*

The Physiochemical and Bacteriological of water samples were analyzed with methods of FAO [2]. Identified source water (well, spring, and river) as well as stored household water were collected at different locations within the selected areas. Onsite physicochemical parameters of water like temperature, pH, metallic compositions, Total dissolved solids (TDS), turbidity etc was recorded. Water samples was then taken to the laboratory and analyzed within 8hrs (maximum transit and process time). Turbidity was carried out by measuring the absorbance of the sample at 540nm wavelength using calorimeter. The turbidity absorbance reading at 540nm wavelength was taken after the collection of raw water samples.

*C. Microbiological Analysis*

The general microbiological quality of water was determined using most probable number (MPN) methods. The test will be performed between 24h of sample collection. A serial dilution method was used for total viable counts. The sterility of each batch of test medium was confirmed by incubating one or two un-inoculated tubes or plates along with inoculated tests. The uninoculated tubes or plates were always examined to show no evidence of bacterial growth. Pure cultures of bacteria and fungi isolates were subjected to various morphological and biochemical characterization tests to determine and identity bacteria isolates with reference to Bergey's Manual of Determinative Bacteriology [6].

*D. Identification of Bacteria*

Colonies from different plate counts were streaked out for proper colony isolation, while positive tubes from the presumptive tests were also sub-cultured on MacConkey agar for the enumeration of Escherichia coli and other enteric coliforms. *Salmonella typhi* and *Shigella* spp. were enumerated using Salmonella-Shigella agar and Triple Sugar Iron agar (TSI). All the inoculated media were incubated aerobically at 37$^0$C for 24-hours after which the isolates were further characterized by a combination of colonial and morphological characteristic on solid media as well as standard biochemical tests as described by [7].

*E. Identification of Isolated Fungi*

The technique of James and Natalie [8] was adopted for identification of the unknown isolated fungi using cotton blue in lactophenol stain. Isolate was identified by placing a drop of the stain on clean slide with the aid of a mounting needle, where a small portion of the mycelium from the fungal cultures was removed and placed in a drop of lactophenol. The mycelium was spread very well on the slide with the aid of the needle. A cover slip was gently applied with little pressure to eliminate air bubbles. The slide was then mounted and observed with x10 and x40 objective lenses respectively. The species encountered will be identified in accordance with [9] and Pictorial identification of soil fungi [10].

## III. Results and Discussion

Physicochemical analysis of freshly collected source and stored water samples from Ife south-western part of Nigeria were represented on Table I. Samples collected from Ife south local government i.e. spring water were found to be between pH 5.10-7.80 while almost half of samples (from alum spring) were found to be acidic and below standard limit for drinking water and waste discharges. Samples from Ife central and Ife north (well water) were between 4.00-8.60, some of which are highly acidic and others falling within the range (6-9) set as standard limit for drinking and household water [11]. According to Medera et al. [12], the pH of most natural water ranges from 6.5-8.5, while deviation from the natural 7.0 is as a result of $CO_2$/ bicarbonate/ carbonate equilibrium. However, the decrease in the spring water sample may be due to the alum concentration which tends to reduce the pH of the water samples between X7s-X10s (called alum water).

Total dissolved solids (mg/L) of well water samples collected in Ife east (W1-W10) ranges between 20-704mg/L, those collected from Ife north had values ranging between 108-400mg/L whereas spring water from Ife south local government (X1-X10) ranges between 108-613mg/L. Most spring and well water values have wide range difference compare to 500mg/L standard accepted by World Health Organization for household water. Some treatment such as addition of coagulants may be required to make this water suitable for domestic uses. Dissolved oxygen (DO) and biochemical oxygen demand (BOD) of samples were within 6mg/L standard recommended for BOD in drinking water with exception of sample W2w collected in Ife east local government area of Osun state having 9.60mg/L and 7.40mg/L for both stored and source samples respectively which insinuates that samples lower than the prescribed limit of 60% are less polluted by organic matter and could support aquatic life, while those above prescribed limit are said to be contaminated by organic matter and detrimental to life [13].

TABLE I
PHYSICOCHEMICAL PROPERTIES OF WATER SAMPLES COLLECTED AT IFE SOUTH-WESTERN PART OF NIGERIA

| LOCAL GOVTS. | pH | | TEMP | | TDS(ppm) | | D. O. (mg/L) | | B. O. D. (mg/L) | |
|---|---|---|---|---|---|---|---|---|---|---|
| IFE-EAST | A | B | A | B | A | B | A | B | A | B |
| $W1^{w}$ | 7.60 | 6.50 | 27 | 28 | 20.00 | 352.00 | 4.00 | 4.40 | 2.00 | 2.00 |
| $W2^{w}$ | 8.60 | 7.30 | 20 | 27 | 704.00 | 691.00 | 9.60 | 7.40 | 0.80 | 5.40 |
| $W3^{w}$ | 7.50 | 7.00 | 27 | 29 | 113.00 | 483.00 | 5.20 | 4.80 | 3.60 | 0.80 |
| $W4^{w}$ | 7.30 | 7.30 | 28 | 29 | 465.00 | 471.00 | 4.20 | 4.40 | 1.00 | 1.60 |
| $W5^{w}$ | 7.50 | 7.50 | 28 | 28 | 424.00 | 424.00 | 4.80 | 5.00 | 1.20 | 0.60 |
| $W6^{w}$ | 7.50 | 7.80 | 27 | 29 | 507.00 | 455.00 | 1.60 | 2.60 | 1.20 | 1.40 |
| $W7^{w}$ | 7.20 | 7.40 | 24 | 29 | 502.00 | 450.00 | 2.70 | 1.60 | 0.80 | 0.80 |
| $W8^{w}$ | 7.40 | 7.60 | 26 | 30 | 510.00 | 472.00 | 2.00 | 2.00 | 1.60 | 1.60 |
| $W9^{w}$ | 7.30 | 7.70 | 28 | 29 | 465.00 | 422.00 | 4.20 | 1.60 | 1.00 | 1.00 |
| $W10^{w}$ | 7.70 | 7.50 | 31 | 30 | 487.00 | 517.00 | 2.00 | 2.20 | 1.60 | 1.40 |
| IFE-SOUTH | | | | | | | | | | |
| $X1^{s}$ | 7.70 | 7.70 | 30 | 29 | 409.00 | 404.00 | 1.00 | 1.20 | 0.60 | 0.80 |
| $X2^{s}$ | 7.60 | 6.50 | 25 | 28 | 369.00 | 345.00 | 4.00 | 1.60 | 1.20 | 1.20 |
| $X3^{s}$ | 7.00 | 6.80 | 24 | 29 | 399.00 | 385.00 | 2.50 | 2.40 | 1.70 | 1.60 |
| $X4^{s}$ | 7.80 | 7.30 | 25 | 27 | 486.00 | 486.00 | 1.00 | 1.20 | 0.60 | 0.60 |
| $X5^{s}$ | 7.60 | 7.30 | 28 | 28 | 613.00 | 613.00 | 3.40 | 3.40 | 0.60 | 1.40 |
| $X6^{s}$ | 7.30 | 6.80 | 27 | 25 | 513.00 | 513.00 | 3.80 | 2.40 | 1.00 | 1.00 |
| $X7^{s}$ | 5.40 | 5.10 | 29 | 28 | 130.00 | 130.00 | 3.20 | 2.40 | 2.40 | 0.80 |
| $X8^{s}$ | 5.10 | 5.10 | 26 | 28 | 124.00 | 130.00 | 2.80 | 2.40 | 1.20 | 0.80 |
| $X9^{s}$ | 5.10 | 5.10 | 27 | 28 | 120.00 | 130.00 | 3.60 | 2.40 | 1.60 | 0.80 |
| $X10^{s}$ | 5.20 | 5.10 | 26 | 28 | 108.00 | 130.00 | 4.60 | 2.40 | 1.80 | 0.80 |
| IFE-NORTH | | | | | | | | | | |
| $Y1^{w}$ | 5.20 | 5.10 | 26 | 28 | 108.00 | 130.00 | 2.30 | 2.40 | 0.70 | 0.80 |
| $Y2^{w}$ | 4.10 | 4.00 | 26 | 27 | 140.00 | 139.00 | 4.40 | 1.20 | 2.40 | 0.80 |
| $Y3^{w}$ | 4.00 | 4.00 | 28 | 27 | 146.00 | 139.00 | 2.20 | 1.20 | 1.00 | 0.80 |
| $Y4^{w}$ | 4.00 | 4.00 | 28 | 27 | 144.00 | 139.00 | 3.60 | 1.20 | 1.20 | 0.80 |
| $Y5^{w}$ | 4.00 | 4.00 | 28 | 27 | 145.00 | 139.00 | 2.00 | 1.20 | 1.00 | 0.80 |
| $Y6^{w}$ | 4.00 | 4.00 | 28 | 27 | 145.00 | 139.00 | 1.80 | 1.20 | 0.70 | 0.80 |
| $Y7^{w}$ | 7.10 | 7.00 | 28 | 29 | 328.00 | 325.00 | 1.80 | 2.40 | 1.40 | 0.80 |
| $Y8^{w}$ | 7.10 | 7.00 | 30 | 29 | 330.00 | 325.00 | 2.00 | 2.40 | 1.40 | 0.80 |
| $Y9^{w}$ | 7.30 | 7.00 | 31 | 28 | 396.00 | 398.00 | 2.00 | 2.00 | 0.80 | 0.80 |
| $Y10^{w}$ | 7.50 | 7.00 | 30 | 28 | 400.00 | 398.00 | 1.40 | 2.00 | 0.60 | 0.80 |

KEY:A - Stored water; B - Source water; $W_1^{w}$- 1st Ife south well sample; $X_1^{s}$- 1st Olode spring sample; $Y_1^{w}$- 1st Ipetumodu well sample, TDS- total dissolved solids; TEMP- Temperature.

The presumptive coliform assessment of samples with the most probable number value of stored and source samples are as shown in Table II. All samples except X6 from Ife south local government area were greatly polluted and not portable for consumption. Recommended standard for portable water is less than 2MPN/100ml [14]. Table III represents standard counts for microbial load in samples with mean Cfu/ml of analysis on each sample greater than the standard for portable water. Meanwhile, large difference was noticed in stored and source samples collected from each area. Total coliform and fecal coliform counts of samples were also above standard for household water with wide range difference observed in stored samples and sources i.e. most stored samples elicit greater contamination than their sources. The study observed that high coliform contamination of stored samples indicates that samples were contaminated by coliforms due to negligence and access of children to stored water. Meanwhile, coliform are also found in different source water due to closeness to septic tank and other anthropogenic activities.

TABLE II
MOST PROBABLE NUMBER VALUES OF SAMPLES SHOWING PRESUMPTIVE RESULTS

| | 10ml | | 1ml | | 0.1ml | | MPN VALUE | | COMMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| LOCAL GOVTS. | ST | SO | ST | SO | ST | SO | ST | SO | ST | SO |
| IFE-EAST | | | | | | | | | | |
| W1 | 3 | 3 | 3 | 3 | 2 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| W2 | 3 | 3 | 3 | 3 | 3 | 2 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| W3 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| W4 | 3 | 3 | 2 | - | 3 | 3 | 290 | 95 | Greatly polluted | Greatly polluted |
| W5 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| W6 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| W7 | 3 | 3 | 2 | 3 | 3 | 3 | 290 | 1100 | Greatly polluted | Greatly polluted |
| W8 | 3 | 3 | 3 | 3 | 2 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| W9 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| W10 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| IFE-SOUTH | | | | | | | | | | |
| X1 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| X2 | 3 | 3 | 3 | 3 | 2 | 2 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| X3 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| X4 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| X5 | 3 | 3 | 3 | 3 | 2 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| X6 | 3 | 2 | 3 | - | 3 | - | 1100 | 9 | Greatly polluted | Acceptable |
| X7 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| X8 | 3 | 3 | 3 | 3 | 1 | 3 | 460 | 1100 | Greatly polluted | Greatly polluted |
| X9 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| X10 | 3 | 3 | 3 | 3 | 1 | 3 | 460 | 1100 | Greatly polluted | Greatly polluted |
| IFE-NORTH | | | | | | | | | | |
| Y1 | 3 | 3 | 3 | 3 | 1 | 3 | 460 | 1100 | Greatly polluted | Greatly polluted |
| Y2 | 3 | 3 | 3 | 2 | 1 | 3 | 460 | 290 | Greatly polluted | Greatly polluted |
| Y3 | 3 | 3 | 3 | 2 | 1 | 3 | 460 | 290 | Greatly polluted | Greatly polluted |
| Y4 | 3 | 3 | 3 | 2 | - | 3 | 240 | 290 | Greatly polluted | Greatly polluted |
| Y5 | 3 | 3 | 3 | 2 | 1 | 3 | 460 | 290 | Greatly polluted | Greatly polluted |
| Y6 | 3 | 3 | 3 | 2 | 1 | 3 | 460 | 290 | Greatly polluted | Greatly polluted |
| Y7 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| Y8 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| Y9 | 3 | 3 | 3 | 3 | 3 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |
| Y10 | 3 | 3 | 3 | 3 | 2 | 3 | 1100 | 1100 | Greatly polluted | Greatly polluted |

Morphological characteristics of isolates obtained from analyzed samples revealed presence of *Escherichia coli*, *Staphylococcus aureus*, *Proteus* spp., *Enterobacter aerogenes*, *Pseudomonas aeruginosa*, *Bacillus* spp. and host of others as shown in Fig. 1. Comprehensive detail about bacteria isolated from collected samples according to Fig. 1, showed *E. coli* having the highest percentage of about 26.40%, *Enterobacter aerogenes* has 25.60%, *Pseudomonas* spp. have 16.30%, *Klebsiella* spp. with 15.40% and others. Enteric organisms dominated the whole analytical step affirming results gotten from presumptive and confirmed tests. Higher microbial isolates where obtained from most stored samples indicating that organisms are mostly introduced into water at the household point due to non-hygienic way of handling them. To buttress this point, during the course of questioning residents of each household and general survey, septic tanks were observed built very close to source of water and by so doing enteric organisms can easily contaminate the proclaimed portable household water [15].

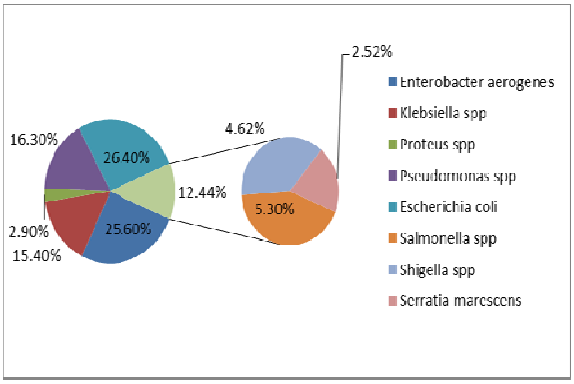


Fig. 1 Percentage occurrence of bacteria isolated from samples

TABLE III
MICROBIAL COUNT OF SAMPLES COMPARING STORED AND SOURCE SAMPLES COLLECTED FROM EACH LOCAL GOVERNMENT AREAS OF IFE

| LOCAL GOVTS. | H-P COUNT (105) | | F-C COUNT (105) | | T-C COUNT (105) | | FUNGI COUNT (105) | | ENTEROCOCCUS COUNT (105) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ST | SO | ST | SO | ST | SO | ST | SO | ST | SO |
| IFE-EAST | | | | | | | | | | |
| W1 | TNTC | 21.00 | TNTC | 10.00 | TNTC | 06.00 | 02.00 | NG | TNTC | TNTC |
| W2 | 04.00 | 20.00 | 07.00 | 02.00 | NG | 08.00 | 02.00 | 15.00 | TNTC | 86.67 |
| W3 | 15.00 | 41.00 | 04.00 | 17.00 | 33.00 | 04.00 | 01.00 | 10.00 | 160.00 | 42.33 |
| W4 | 11.00 | 1.00 | 01.00 | 05.00 | 59.00 | 01.00 | TNTC | 08.00 | 13.67 | 10.00 |
| W5 | 08.00 | TNTC | NG | NG | 30.00 | NG | 01.00 | TNTC | 12.33 | 12.00 |
| W6 | 09.00 | 02.00 | 06.67 | NG | 12.33 | 05.00 | TNTC | TNTC | 63.67 | 20.00 |
| W7 | 12.00 | NG | NG | 02.67 | 09.33 | 12.67 | NG | 02.00 | NG | 26.67 |
| W8 | 21.00 | 09.00 | 11.00 | 11.67 | 12.67 | 01.00 | 43.00 | 26.00 | 22.67 | 15.67 |
| W9 | 34.00 | 40.00 | 15.00 | 00.67 | 09.33 | 25.00 | 04.00 | 05.00 | 00.33 | 01.67 |
| W10 | 91.70 | 40.00 | 04.67 | 00.33 | 26.00 | 14.33 | 14.00 | 05.00 | 16.67 | 42.67 |
| IFE-SOUTH | | | | | | | | | | |
| X1 | 34.30 | 40.00 | 02.67 | 06.67 | 25.00 | 00.33 | 01.00 | 05.00 | NG | 02.00 |
| X2 | 101.00 | 40.00 | NG | NG | 52.00 | 00.33 | 09.00 | 05.00 | 01.67 | 03.33 |
| X3 | 49.00 | 46.00 | 02.67 | 03.00 | 54.00 | 00.33 | 15.00 | 01.00 | 01.00 | 01.00 |
| X4 | 11.30 | 46.00 | 30.67 | 10.67 | 42.00 | 00.33 | 09.00 | 01.00 | 02.00 | NG |
| X5 | 00.67 | 46.00 | 42.00 | 10.67 | 42.00 | 00.33 | 01.00 | 01.00 | 137.00 | 19.33 |
| X6 | 25.67 | 46.00 | TNTC | 10.67 | 57.67 | 14.67 | 21.00 | 01.00 | 57.00 | 19.33 |
| X7 | 25.67 | 46.00 | 108.00 | 10.67 | 01.00 | 14.67 | 03.00 | 08.00 | 53.33 | 19.33 |
| X8 | NG | 01.33 | 118.70 | 10.67 | 00.33 | 14.67 | 51.00 | 08.00 | 104.00 | 19.33 |
| X9 | NG | 01.33 | 06.67 | 62.00 | 04.33 | 14.67 | 22.00 | NG | 104.00 | 19.33 |
| X10 | 15.00 | 10.00 | NG | 62.00 | 01.00 | 14.67 | 02.00 | NG | 93.33 | 44.67 |
| IFE-NORTH | | | | | | | | | | |
| Y1 | 00.33 | 10.00 | NG | 08.67 | 06.67 | 34.00 | 01.00 | 12.00 | 29.00 | 44.67 |
| Y2 | 00.33 | 10.00 | 00.33 | 08.67 | 18.00 | 06.00 | 03.00 | 02.00 | 07.33 | 44.67 |
| Y3 | 07.00 | 10.00 | 02.67 | NG | 06.33 | 06.00 | 02.67 | 02.00 | 13.33 | 44.67 |
| Y4 | 00.33 | 00.33 | 00.33 | NG | 11.33 | 06.00 | 03.67 | 02.00 | 13.33 | 44.67 |
| Y5 | 11.00 | 00.33 | NG | NG | 11.00 | 06.00 | 04.67 | 02.00 | 01.00 | 36.67 |
| Y6 | 02.67 | 02.67 | 02.00 | NG | 00.67 | 06.00 | NG | 02.00 | 06.67 | 36.67 |
| Y7 | 14.33 | 12.00 | 03.00 | NG | 07.00 | 06.00 | NG | 02.00 | 18.67 | 01.33 |
| Y8 | 51.00 | 02.00 | 00.67 | NG | 02.00 | 01.67 | NG | NG | 03.67 | 01.33 |
| Y9 | 13.67 | NG | 04.67 | NG | NG | NG | NG | NG | 00.33 | 01.33 |
| Y10 | 20.07 | 09.33 | 03.67 | 00.33 | 98.00 | 31.67 | 03.67 | 02.00 | 93.33 | 01.33 |

KEY: TNTC- Too numerous to count; NG- no growth; T-C Count- Total coliform count; H-P Count- Heterotrophic plate count; F-Count- Fecal count; F-C-Fungi count; E-C- Enterococcus count.; ST= Stored sample; SO=Source sample

Five genera of fungi were isolated from analyzed water viz: *Aspergillus*, *Sclerotia*, *Mucor*, *Candida* and *Pythium* spp. (Table IV). This indicates these household water samples are not portable enough for human consumption and also chlorination method for dogmatic treatment of domestic water was observed ineffective on fungi in domestic water. Studies have reported that chlorination as a method of purification cannot eliminate fungi spores [16]-[18]. Invariably, other means of countering this constraint should be researched on to make water a friend rather than threat. All collected water samples showed high level of fungi contamination which probably indicates poor treatment techniques and non-hygienic handling methods giving room to contamination which were observed in stored in stored samples having more fungi isolates than their sources. Previous studies reported that the presence of fungi in domestic water samples may be as a result of compromised water during distribution [18]-[21] and also the difference in raw water sources, treatment protocol and system maintenance could certainly account for the unique fungal assemblage [22].

TABLE IV
COMPARISON OF FUNGI LOAD OF SAMPLES

| LOCAL GOVTS. | *A. niger* | | *A. fumigatus* | | *A. parasiticus* | | *S. pellicularia* | | *Mucor janssenii* | | *Candida albicans* | | *Pythium debaryanum* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLES | ST | SO | ST | SO | ST | SO | ST | SO | ST | SO | ST | SO | ST | SO |
| IFE-EAST | | | | | | | | | | | | | | |
| W1 | ++ | + | +++ | + | + | + | ++ | + | ++ | + | + | + | + | + |
| W2 | ++ | + | +++ | ++ | + | + | ++ | + | + | + | + | + | + | + |
| W3 | + | + | ++ | + | - | - | + | - | - | - | - | - | - | - |
| W4 | +++ | ++ | +++ | +++ | + | + | + | + | + | + | + | + | - | - |
| W5 | ++ | + | +++ | ++ | + | + | + | + | ++ | ++ | + | + | - | - |
| W6 | ++ | ++ | +++ | ++ | - | - | + | + | + | + | + | + | + | + |
| W7 | - | - | ++ | ++ | - | - | - | - | - | - | - | - | - | - |
| W8 | ++ | ++ | +++ | +++ | - | - | ++ | ++ | + | + | + | + | - | + |
| W9 | + | + | + | + | + | + | - | - | + | + | - | - | - | - |
| W10 | + | + | ++ | ++ | + | - | + | + | + | - | + | + | - | - |
| IFE-SOUTH | | | | | | | | | | | | | | |
| X1 | + | + | ++ | ++ | + | - | - | - | - | - | - | - | - | - |
| X2 | +++ | ++ | ++ | +++ | - | - | - | - | - | - | + | + | - | - |
| X3 | + | + | +++ | ++ | + | + | - | - | - | - | - | - | - | - |
| X4 | ++ | ++ | ++ | ++ | - | - | + | + | - | - | - | - | - | - |
| X5 | - | + | +++ | - | - | - | - | - | - | - | - | - | - | - |
| X6 | ++ | - | + | - | + | + | + | + | + | + | + | + | + | - |
| X7 | + | + | +++ | +++ | + | + | - | - | - | - | - | - | - | - |
| X8 | ++ | + | +++ | ++ | ++ | + | + | + | + | + | + | + | - | + |
| X9 | - | - | ++ | ++ | - | - | + | + | - | - | - | - | - | + |
| X10 | - | - | + | + | - | - | - | - | - | - | - | - | + | + |
| IFE-NORTH | | | | | | | | | | | | | | |
| Y1 | ++ | +++ | + | ++ | - | - | - | - | + | - | - | - | - | - |
| Y2 | ++ | ++ | +++ | ++ | + | - | + | - | - | - | - | - | - | - |
| Y3 | +++ | - | + | - | - | - | - | - | - | -- | - | - | - | - |
| Y4 | - | +++ | - | +++ | - | + | - | - | - | - | - | - | - | + |
| Y5 | ++ | +++ | ++ | +++ | + | - | - | - | - | - | - | - | - | - |
| Y6 | - | + | +++ | ++ | - | - | - | - | - | - | - | - | - | - |
| Y7 | ++ | - | + | - | - | - | - | - | - | - | - | + | + | - |
| Y8 | +++ | - | ++ | - | - | - | - | - | - | - | - | - | - | - |
| Y9 | +++ | - | + | - | - | - | - | - | - | - | - | - | - | - |
| Y10 | ++ | - | ++ | - | + | + | - | - | - | - | + | - | - | - |

KEY:ST=Stored sample;
SO=Source sample

Genus *Aspergillus* was the most frequently isolated in our investigation. Our results are consistent with the findings of [23], [24] that *Aspergillus* is the most common isolated genera in water. *Aspergillus* spp. are known to cause a wide range of diseases in human ranging from hypersensitivity reactions to invasive infections associated with angio-invasions. *Aspergillus fumigatus* had the highest frequency in our investigation especially samples from well. *A. niger* penultimates *A. fumigatus* in our investigation and is known to be causes of opportunistic invasive infections in hospitalized immunized patients [25].

*Rhizopus* spp. and other Zygomycetes were also isolated in water samples which are known to be causal agent of disease in immunocompromised patients, *Mucor* spp. are known to cause thrombiosis, infarction nasal or paranasal sinus infection [18], [26]-[28].

## IV. CONCLUSION

Conclusively, portability of domestic water highly depends on the way they have been handled and serving as a means of rendering them unfit for human consumption. Meanwhile, water is expected to meet acceptable standard depending on the use, and the quality should be controlled in other to minimize acute problem of water related diseases. A lot need be done to provide quality water in adequate amount to the citizenry. Also it is a necessity to educate the populace on proper handling of water to have a healthy and productive citizenry.

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