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Assessment of Mycological Quality of Groundwater in Yenagoa Metropolis, Bayelsa State, Nigeria

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Abstract

This study examined the mycological quality of groundwater in Yenagoa metropolis, Bayelsa State, Nigeria. Triplicate water samples were obtained from 8 locations in the metropolis, and the fungi quality analyzed following standard microbiological procedures. Results showed that total fungi density ranged from 5.2±1.00 x102 to 8.50±0.56 x103 CFU/ml. Analysis of variance indicates statistical variation (p=0.001) across locations with total fungi density exceeding the limit of 102 CFU/ml specified by World Health Organization/Food and Agricultural Organization for potable water in 62.50% of samples. Eight fungi isolates (species) were identified in the study with frequency across the locations as follows: *Aspergillus flavus* (20.59%), *Aspergillus fumigatus* (20.59%), *Aspergillus niger* (20.59%), *Cladosporum* (5.88%), *Fusarium* (2.94%), *Mucor* (8.82%), *Penicilium* (14.71%) and *Rhizopus* (5.88%). Of these, *Aspergillus* species were predominant across the locations. Since groundwater meets diverse purposes, it is essential that it is suitable for the desired use, and this can be done using appropriate technology to make groundwater potable for human consumption.
Keywords: Contamination; Environmental health; Fungi; Ground water.

1. Introduction

The potability of water is often assessed based on appearance (colour, odor) and taste especially in rural areas. But these characteristics do not give a comprehensive feature of the water. This is because the potability of water is better assessed based on physicochemical and microbial qualities. The physicochemical characteristics are often assessed based on the pH, conductivity, salinity, total dissolved solid, total suspended solid, cations (magnesium, calcium, sodium and potassium), anions (phosphate, sulphate, nitrate, carbonate etc) [1-3], heavy metals (such as iron, mercury, chromium, cadmium, zinc, copper, nickel, cobalt, arsenic etc) [4, 5], while the microbial characteristics is assessed based on total heterotrophic bacteria, total fungi, Salmonella-Shigella, Vibrio, Staphylococci, total coliform and faecal coliform counts [6-10].

Microorganisms are diverse in nature with varying adaptive features that enable them survive. Many microbes thrive in different environmental conditions especially with respect to pH, temperature, salinity etc. Microorganisms play both essential and detrimental role in different environment [11]. The microbial content of potable water (zero tolerance for microbes of public health importance) is expected to be within the limits stipulated by Standard Organization of Nigeria, World Health Organization and United State Environmental Protection Agency. Most microbes that cause water borne diseases could lead to case morbidity and mortality especially in children [12].

A review study by Izah and Ineyougha [12] on water sources in Nigeria (surface, ground/ borehole/ well and rain) recorded a diversity of microbes viz: *Staphylococcus aureus*, *Escherichia* coli, *Alcaligenes faecalis*, *Proteus*, *Pseudomonas*, *Enterobacter*, *Salmonella*, *Klebsiella*, *Bacillus Aeromonas*, *Micrococcus*, *Citrobacter*, *Streptococcus*, *Vibrio*, *Shigella*, *Enterococcus*, *Flavobacterium*, *and Chromobacterium* species. The author's findings show that fungi species are not as commonly studied as bacteria. However a similar study in Ita-Nmo, Ilorin, Nigeria revealed the presence of *Curvularia*, *Penicillium*, *Rhizopus*, *Fusarium*, *Mucor*, *Cladosporium*, *Saccharomyces*, *Mortierella* and *Aspergillus* in surface water [13].

Researchers have conducted numerous studies on microbial quality of drinking water sources in different parts of Nigeria [12]. Specifically in Bayelsa State most studies on microorganisms in water sources often focused mainly on bacteriological quality viz: Taylor creek [10], Ikoli creek [7] and Epie creek [6, 14]. Also, ground water have been studied with respect to bacteriological quality in Yenagoa and its environs including Imiringi town [9], Otuoke [15], Okutukutu in Yenagoa metropolis [16] and well water in Amassoma [17]. But in Yenagoa metropolis, the capital of Bayelsa state, the mycological quality of potable water sources is scanty in literature. Therefore, this study focused on quality of fungi in groundwater sources in Yenagoa metropolis, Bayelsa State, Nigeria.

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2. Materials and Methods

2.1. Description of the Study Location

The study was conducted in Yenagoa metropolis, the Bayelsa State Capital. The state is blessed with several water sources including surface water (creek, creek-lets, rivers, stream, Lake Etc) and ground water. The groundwater in the area is harnessed as borehole and well water. In addition, the water table is quite high. The water table is less than 3-30 m and 15-60 m in some areas in wet and dry season, respectively. The untreated groundwater in the area is often characterized by yellowish brown or reddish brown, an indication of high iron content. However, most resident of the area that has borehole often treat it in a chamber containing sand and other materials.

2.2. Collection of Samples

A total of twenty four water samples were collected (three from each borehole) from five communities that constitutes Yenagoa metropolis as follows:

Location 1. Akenfa consisting stations A & B (6 samples)
Location 2. Edepie, consisting stations C and D (6 samples)
Location 3. Opolo consisting station E and F (6 samples)
Location 4. Biogbolo consisting station G (3 samples)
Location 5. Agudama-Epie consisting station H (3 samples)

The samples were collected with sterile container and preserved at 4ºC prior to analysis. The study was carried out in the month of November 2016.

2.3. Enumeration of Fungi Counts

The fungi population in the water was determined following serial dilution and subsequently followed by pour plate method described by Pepper and Gerba [18] and Benson [19]. Approximately 1.0ml of the diluent were aseptically plated Potato Dextrose Agar and incubated at 30°C for 5 days. The resultant colonies were counted and expressed as colony forming units (CFU)/ml of the water samples

2.4. Identification of the Fungi counts

The fungi isolates were identified based on their macroscopic/ colonial and microscopic characteristics. The microscopic characteristics was carried out using the wet mount preparation method, and staining was by Lactophenol cotton blue as described by Pepper and Gerba [18] and Benson [19].. The characteristics of the resultant fungi isolates from both microscopic and macroscopic examination were compared using the guide provided by Barnett and Hunter [20], Ellis, *et al.* [21], Benson [19].

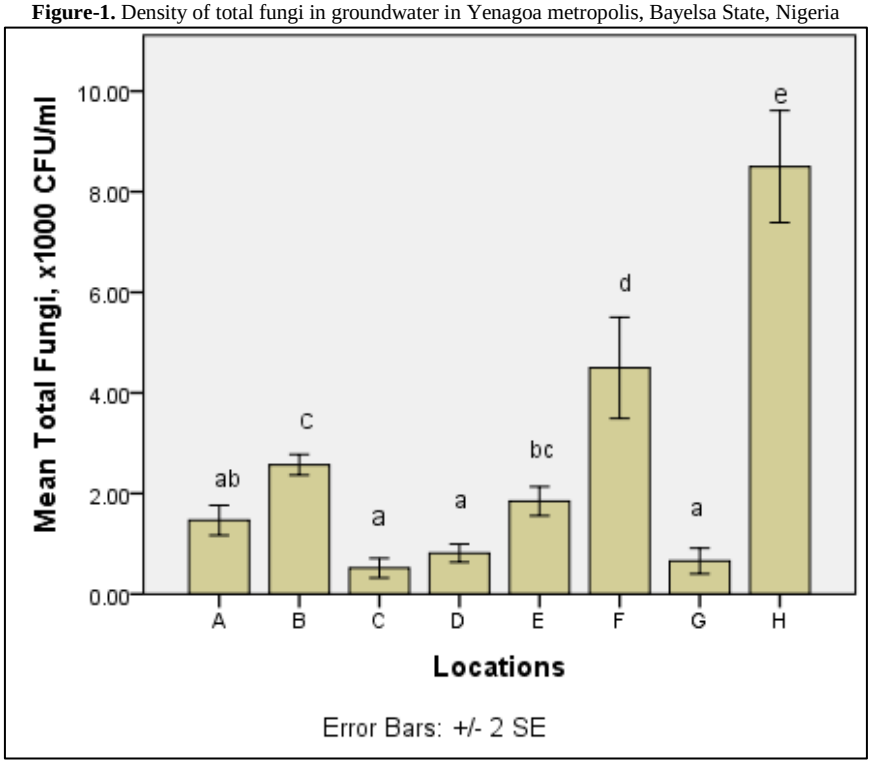
2.5. Statistical Analysis

SPSS version 20 was used in the statistical analysis. Descriptive statistics was carried out on the fungi density and data presented as mean ± standard error. One-way analysis of variance was carried out at P = 0.05 on the fungi population, and Waller-Duncan test statistics was used for mean separations. Also, the occurrence frequency of the isolates was presented in percentages and illustrated in bar charts.

3. Results and Discussion

The density of total fungi found in groundwater in Yenagoa metropolis, Bayelsa State is shown in Figure 1. The fungi density were 1.47±0.15 $x10^3$ CFU/ml, 2.57±0.10 $x10^3$ CFU/ml, 0.52±0.10 $x10^3$ CFU/ml, 0.81±0.09 $x10^3$ CFU/ml, 1.85±0.14 $x10^3$ CFU/ml, 4.50±0.50 $x10^3$ CFU/ml, 0.66±0.13 $x10^3$ CFU/ml and 8.50±0.56 $x10^3$ CFU/ml for Location A, B, C, D, E, F, G and H, respectively. Statistically, there was variation ($p<0.05$) across the locations. However, Waller-Duncan test statistics revealed no significant difference ($p>0.05$) between the mean values of Location A, C, D and G, between A and C, and between B, C and E. The significant variation observed may be due to impact of differences in maintenance and hygiene practices on sources of the groundwater. The values at location C, D and G were within 10^2 CFU/ml of the water samples as specified by World Health Organization/Food and Agricultural Organization for potable water [8, 12, 22-24]. While the others locations (A, B, E, F and H) had concentrations exceeding allowable limits. The values recorded are slightly higher than the density recorded in Otamiri River, Imo state [25, 26]. The values are also in consonance with values of 0.70 - 8.0 x 10^3 CFU/ml from groundwater and packaged water supply in Federal University of Technology, Owerri, Nigeria [27] and with the range of 0 – 4.53 Log_{10} recorded in tap and sachet water in Elele Rivers State [28]. This suggests that fungi especially molds are common contaminants of drinking water sources which is an indication of poor water handling, treatment and maintenance processes.

Figure-1. Density of total fungi in groundwater in Yenagoa metropolis, Bayelsa State, Nigeria



The percentage occurrence of isolates by location is shown in Figure 2. The percentage occurrence of *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger, Cladosporum, Fusarium, Mucor, Penicilium and Rhizopus* species were 15.38%, 30.77%, 46.15%, 0.00%, 0.00%, 0.00%, 7.69% and 0.00%, respectively (Location A), 35.71%, 14.29%, 28.57%, 7.14%, 0.00%, 0.00%, 14.29% and 0.00%, respectively (Location B), 30.77%, 38.46%, 23.08%, 0.00%, 0.00%, 7.69%, 0.00% and 0.00%, respectively (Location C), 0.00%, 0.00%, 57.14%, 0.00%, 0.00%, 0.00%, 28.57% and 14.29%, respectively (Location D), 41.67%, 25.00%, 8.33%, 0.00%, 0.00%, 25.00%, 0.00% and 0.00%, respectively (Location E), 10.00%, 20.00%, 30.00%, 0.00%, 10.00%, 0.00%, 10.00% and 20.00%, respectively (Location F), 33.33%, 44.44%, 0.00%, 0.00%,22.22%, 0.00%, 0.00% and 0.00%, respectively (Location G), and 23.08%, 38.46%, 7.69%, 15.38%, 0.00%, 7.69%, 7.69% and 0.00%, respectively (Location H). The fungi isolates identified in the study were 8 with different occurrence across the locations. *Aspergillus flavus, Aspergillus fumigatus* and *Aspergillus niger* occurred in 7 locations representing 20.59% each, others *Cladosporum, Fusarium, Mucor, Penicilium and Rhizopus* species occurred in 2, 1, 3, 5 and 2 locations representing 5.88%, 2.94%, 8.82%, 14.71% and 5.88%, respectively (Figure 3). From the study, *Aspergillus* species were the predominant species across the locations (Figure 4). Basically, *Aspergillus* has been observed to be predominant microbes in air environment of different setting, especially around dump sites [11]. The occurrence of this species in water suggests contamination due to human activities. Naturally, most fungi species occur in greater density in soil. Thus their presence in a water source may have stemmed from poorly kept materials (such as funnels, filters, tank covers) used in borehole activities. Again, water or moisture is necessary for the sporulation of fungi; hence it's crucial to treat the water properly prior to use to forestall possible health impacts associated with the use (drinking) of groundwater contaminated by molds.

The isolates recorded have been observed in other water sources used for drinking especially surface water. For instance, Braide, *et al.* [25] reported *Saccharomyces cerevisiae, Penicillium, Geotrichum, Aspergillus, Mucor* and *Rhizopus* species in Otamiri stream, Imo State. Some of the fungi isolated are known to produce toxins that may be detrimental to human health. The mould that produced mycotoxins includes *Penicillium, Fusarium* and *Aspergillus.* In additions most species of this isolate are known to cause diseases especially in immune-compromised patients. For instance diseases caused by this fungi include Aspergillosis (*Aspergillus* species), mucormycosis (*Mucor* species) and hyalohyphamycosis (*Penicillium* and *Fusarium* species) [11].

Figure-2. Percentage occurrence of fungi isolates found in different locations (A-H) in groundwater in Yenagoa metropolis, Bayelsa State, Nigeria

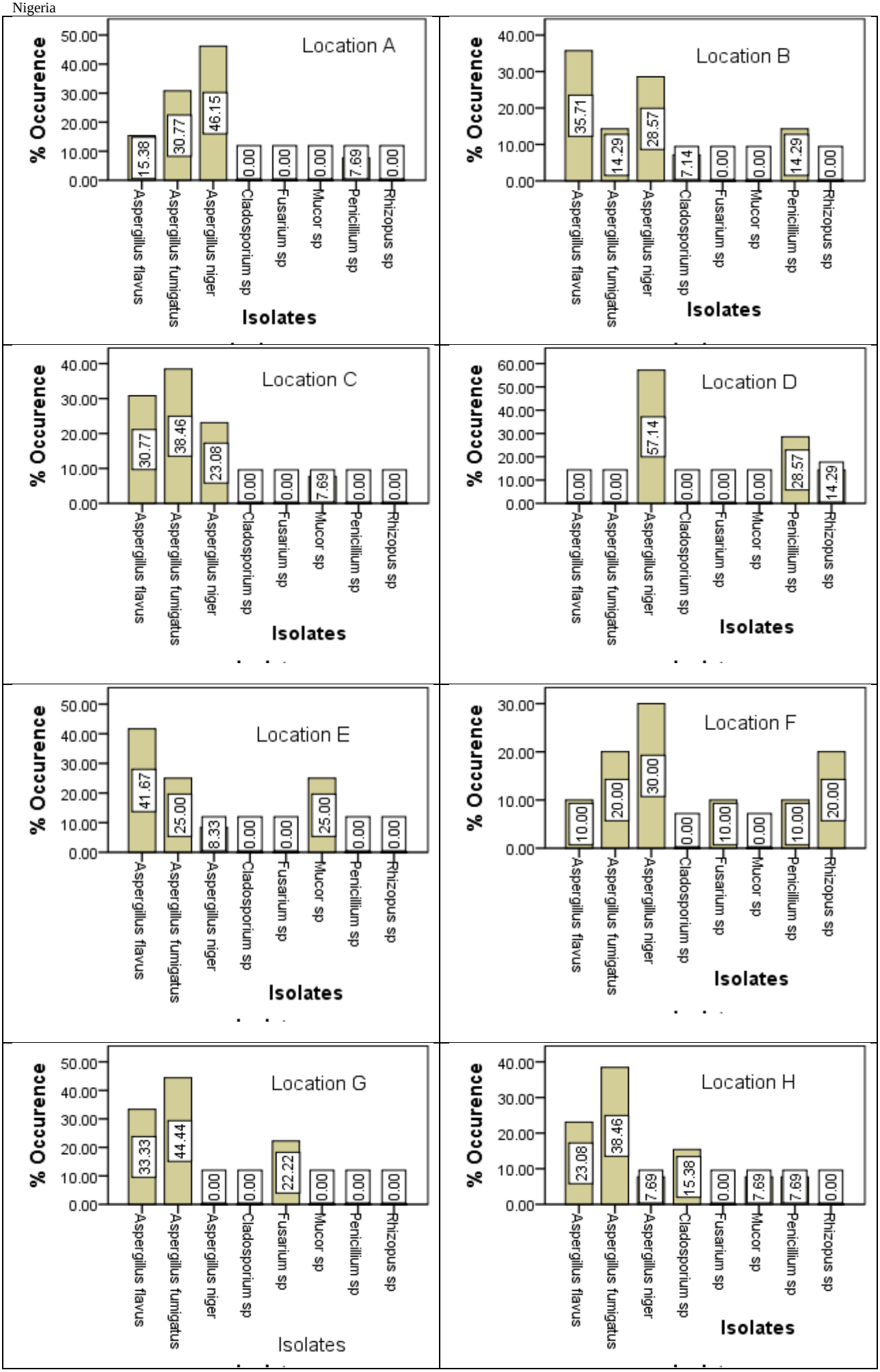


Figure-3. Percentage occurrence of total isolates of fungi across the locations in groundwater from Yenagoa metropolis, Bayelsa State, Nigeria

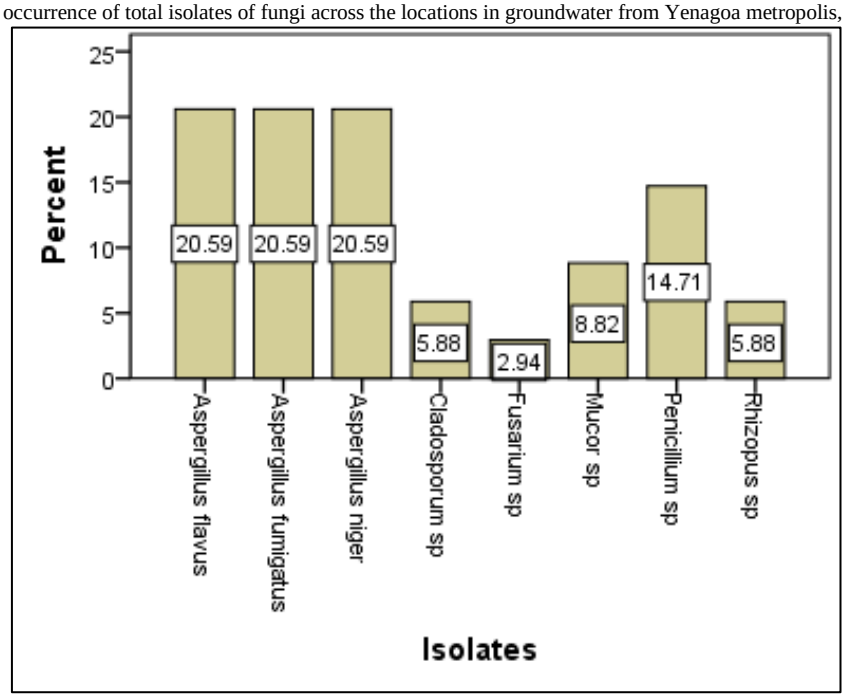
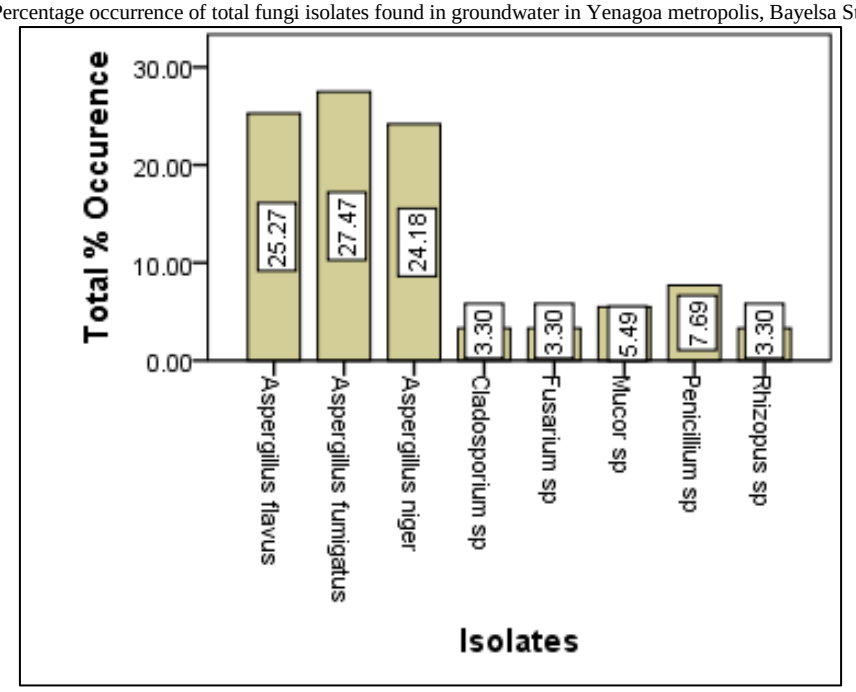


Figure-4. Percentage occurrence of total fungi isolates found in groundwater in Yenagoa metropolis, Bayelsa State, Nigeria



4. Conclusion

This study investigated the density and diversity of fungi in groundwater in Yenagoa metropolis, Bayelsa state, Nigeria and found that the density of fungi in the groundwater ranged from 10^2 to 10^3 CFU/ml. Also there was significant variations ($p<0.05$) across the locations, an indication of anthropogenic impact on ground water. A total of 8 fungi species was identified with 3 to 5 occurring in each of the locations. The results showed that *Aspergillus* species were the predominant isolates. Some isolates were identified as pathogenic especially on immune-compromised individuals. Hence, there is a need to frequently treat water and ensure that it meets WHO standard of potable water.

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