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Research Article

Soil-borne Fungi Community of a Major Dumpsite in Bayelsa State, Nigeria

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A B S T R A C T

Fungi play essential role in the soil especially in biodegradation of toxicants. This study investigated the soil-borne fungi diversity of a major waste dumpsite in Bayelsa State, Nigeria. Triplicate samples of soil were collected from 6 locations at 50 ft distance apart. The samples were analyzed following standard mycological processes. Results of the fungi population ranged from 6.70 x 10^3 to 7.27 x 10^4 CFU/g. Analysis of variance showed significant variations (p=0.017) in the density of the soil-borne fungi across the study locations There was, no statistical difference (p>0.05) in mean values across some locations. A total of 13 fungi genera were identified with *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger* and *Saccharomyces* species constituting the predominant isolates with frequencies of 17.40%, 14.64%, 16.85% and 12.15%, respectively. Other isolates include *Penicillium, Fusarium, Mucor, Rhizopus, Cryptococcus, Cladosporium, Pullularia, Alternaria, Microsporium, Candida* and *Trichoderma* species. The interaction between species across study locations ranged from 55.56 to 90.00 with a similarity index above critical level of significance (50%). This indicates that isolates of the dumpsite are similar. Again, most of the isolates are opportunistic pathogens with disease causing propensity especially in immune-compromised individuals. Therefore, there is need for appropriate personal protective gear and appropriate measures when working on dumpsites.

Keywords: Environmental Health, Fungi, Microorganisms, Waste Dumpsite

Introduction

The increase in industrialization, urbanization and population growth has intensified environmental degradation,[1] which in turn affects its sustainability. There are evidence of degradation in the atmospheric, soil and water environment which has impacted on life forms including plants (such as seed and seedless plants), animals (mammals, avian fauna, reptiles, amphibians, Pisces and even coelomate invertebrates).[2] The prevailing environmental degradation has become a front burner issue for both environmentalist and policy makers alike.

Most environmental contaminants emanates from industrial and traffic emissions as well as poor waste management. Wastes are generated in different area of human activities. These wastes exist in 3 major forms including solid, liquid and gaseous effluents. In many developing nations including

Nigeria waste management is a problem. Wastes are dump in different areas including uncompleted buildings, undeveloped plots of land, along major express ways and streets, water canals, surface water and burrow pits among others. Also in many coastal communities sewage is deposited in surface water via the use of pier toilet system.[3-6]

Among the components of the environment (soil, water and air), soil is where most human activities are carried out with devastating consequences on the physical, chemical and biological as well as the microbial characteristics of the soil. The fauna and flora of a given soil play an essential role in mineralization and biogeochemical cycles.[7] Anthropogenic activities affect the population and diversities of microorganism in an environment. For instance, Douglas[8] reported that the activities of artisanal crude oil refining reduce the density of fungal populations and diversity in contaminated soil. Similarly, Izah and Aigberua[9] also reported that cassava waste water cause a decline in the diversity and population of soil microorganisms. As such human activities such as indiscriminate dumping of wastes in the soil, may cause a distortion on the ecological balance.[8]

Soil-borne fungi play crucial role in the maintenance and balance of soil environment.[1] Several studies have been carried out with respect to microbial diversity of a dumpsite. Some species of fungi and bacteria possess biodegradation and bioremediation potentials. Also most soil-borne fungi can be used as biological markers on polluted soil because of their bioremediation properties.[1] The authors similarly stated that fungi have the tendency to degrade natural materials, such as lignin, chitin, and cellulose. Again, fungi population can be influenced by climatic conditions such as temperature, relative humidity, nutrient composition, pH and the chemical composition of the soil.

Yenagoa metropolis is a fast growing State capital with significant expansion on population, land use and urbanization within the last decade. Several studies have been carried out with respect to microbial content of dumpsite in different environment in Nigeria.[10-12] But information on soil-borne fungi content of a major dumpsite for municipal wastes of Yenagoa metropolis is scanty in literature. Hence, this study investigated the population and diversity of soil-borne fungi in a major dumpsite in Yenagoa metropolis, Bayelsa state, Nigeria.

Materials and Methods

Study Area

The study was conducted in the largest municipal waste dump site in Yenagoa Local Government area of Bayelsa state. The dumpsite is located off Yenagoa- Amassoma road. Most wastes generated by different households in Yenagoa metropolis is dumped in receptacles were they are moved to the major dumpsite. Different type of wastes emanating from households is found at the dump. Scavengers often search for useful materials from the dumpsite. There is homogeneity in climatic (environmental) condition as reported by Izah et al.[13] for other part of the Niger Delta.

Sample Collection

Soil sample was collected in March 2017 from a major dumpsite off Amassoma-Yenagoa road, Bayelsa State. The samples were collected from 6 locations (A, B, C D, E and F). The distance between each location is about 50 ft. At each location, the soil samples were collected in triplicates at a depth of 0 – 20cm. The sample was packaged in a sterile Ziploc bag and analysis was carried out <6 hours after collection.

Enumeration of the Total Fungi

The soil samples were serially diluted and then plated using the pour plate method previously described by Benson,[14] Pepper and Gerba.[15] Approximately 1.0 of the serially diluted soil sample was plated potato dextrose agar, and the inverted plates were incubated at 30°C for 4-5 days. After incubation, the colonies that grew on the medium were counted and expressed as colony forming units (CFU)/g of the samples.

Soil-borne Fungi Identification

Macroscopic/ colonial and microscopic characteristics were considered in the identification of the fungi. The mould was determined microscopically following wet mount preparation of the isolate using Lactophenol cotton blue stain as identification dye. This method was carried out following the guide provided by Pepper and Gerba,[15] Benson.[14] The yeast was identified using carbon fermentation and assimilation techniques of glucose-peptone-yeast extract broth as described by Kurtzman and Fell,[16] and have been applied by Iwuagwu and Ugwuanyi,[17] Okoduwa et al.,[18] Izah et al.[19] The resultant microscopic and macroscopic characteristics of the fungi were compared with the scheme provided by Ellis et al.[20] and Benson.[14]

Statistical Analysis

The statistical analysis was carried out using SPSS version 20. One-way analysis of variance was carried out at P = 0.05 on the population of soil-borne fungi, and Duncan multiple range test statistics was used to compare the means. The percentage occurrence of the isolates and fungi populations across the various locations was also calculated. The results of the study were presented with bar charts. The Sorenson qualitative index was used to show similarity in the fungi diversity in the various locations as previously described by by Ogbeibu.[21]

Result and Discussion

Figure 1, shows the density of total fungi in a major waste

dump site in Bayelsa State, Nigeria. The values were 6.83 x 10^4 CFU/g, 1.65 x 10^4 CFU/g, 7.27 x 10^4 CFU/g, 2.40 x 10^4 CFU/g, 6.70 x 10^3 CFU/g and 4.45 x 10^4 CFU/g for Locations A, B, C, D, E and F, respectively. There was statistical variations (p=0.017) across the various locations. However, Duncan multiple range test statistics showed that the variation was not significant (p>0.05) between samples from Location B, D, E and F, and between A, C and F. The mean fungi density were higher in the locations in the following order; C > A> F> D > B> E (Figure 2). Observed variation depicts differences in fungi activities across study locations of the dumpsite. The values observed in this study are in accordance with previous studies in the Niger Delta. For instance, Obire et al.[22] reported total fungi in the range of 1.9 to 7.1 x 10^4 CFU/g in a dumpsite in Eagle Island, Port Harcourt. Osazee et al.[23] recorded total fungal counts in the range of 7.0 × 10^2 to 3.3 × 10^3 CFU/g in municipal waste dump in Benin City. Douglas[8] reported total fungi counts in the range of 1.6 x10 to 3.4 x 10^3 cfu/g for soil of an artisanal crude oil refining location in Boodo community, Rivers State. The similarity in fungi population across dumpsites may be due to similarity in the meteorological and climatic conditions of the area, which are known to influence fungi population.

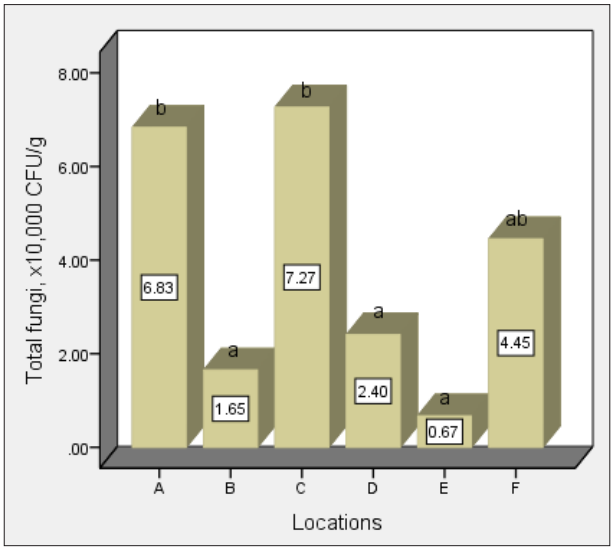

Figure 1.Density of total fungi in a major waste dump site in Bayelsa State, Nigeria

Percentage occurrence of soil-borne fungi according to the locations in a major waste dump site in Bayelsa State, Nigeria is shown in Figure 3. In location A, *Mucor, Rhizopus, Cladosporium, Pullularia, Alternaria* and *Candida* species was not detected, while *Fusarium, Microsporium, Trichoderma, Cryptococcus, Penicillium* species, *Saccharomyces* species, *Aspergillus fumigatus*, *Aspergillus flavus* and *Aspergillus niger* had occurrence frequency of 4.26%, 4.26%, 4.26%, 6.38 %, 10.64 %, 17.02%, 14.89 %, 19.15 % and 19.15 %, respectively. In location B, *Mucor, Cladosporium, Pullularia, Trichoderma, Saccharomyces* and *Microsporium* species was not detected, while *Alternaria, Fusarium, Rhizopus, Cryptococcus, Candida, Penicillium, Aspergillus flavus, Aspergillus fumigatus* and *Aspergillus niger* had occurrence frequency of 3.13%, 6.25%, 6.25%, 7.81%, 7.81%, 12.50%, 17.19%, 18.75% and 20.31%, respectively.

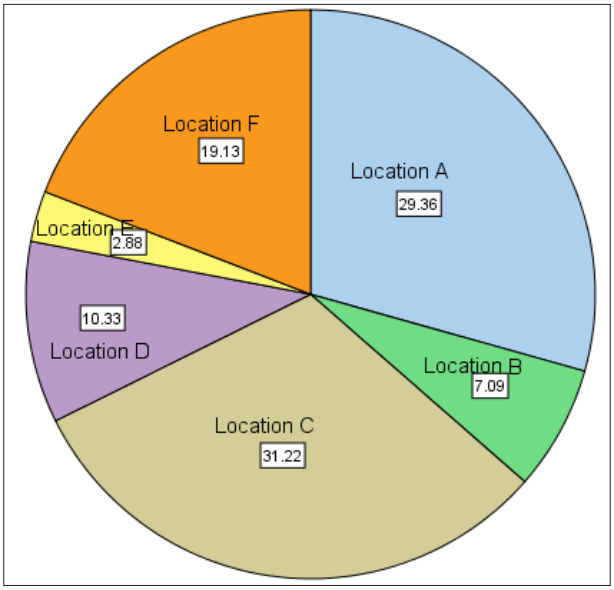

Figure 2.Distribution of the fungi population across the various locations

In location C, the occurrence frequency of *Rhizopus, Mucor, Fusarium, Microsporium, Trichoderma, Saccharomyces* species *Aspergillus fumigatus, Aspergillus niger* and *Aspergillus flavus* were 1.52%, 4.55%, 7.58%, 10.61%, 12.12%, 10.61%, 13.64%, 16.67% and 22.73%, respectively, *while Penicillium, Cryptococcus, Cladosporium, Pullularia, Alternaria* and *Candida* species were not detected. In location D, *Fusarium, Rhizopus, Pullularia, Microsporium* and *Saccharomyces* were not detected, while the occurrence frequency of *Alternaria, Cladosporium, Trichoderma, Mucor, Cryptococcus, Penicillium, Candida* species, *Aspergillus flavus, Aspergillus niger* and *Aspergillus fumigatus* were 2.27%, 4.55%, 4.55%, 6.82%, 9.09%, 13.64%, 13.64%, 6.82%, 18.18% and 20.45%, respectively.

In location E, *Cryptococcus, Microsporium, Candida and Trichoderma* were not detected, while the occurrence frequency of *Rhizopus, Fusarium, Cladosporium, Alternaria, Penicillium, Mucor, Pullularia, Aspergillus flavus, Saccharomyces* species, *Aspergillus niger* and *Aspergillus fumigatus* were 2.90%, 4.35%, 4.35%, 4.35%, 5.80%, 5.80%, 7.25%, 14.49%, 14.49%, 15.94% and 20.29%, respectively. In Location F, the occurrence frequency of *Pullularia, Fusarium, Microsporium, Penicillium, Trichoderma, Mucor, Rhizopus, Saccharomyces* species, *Aspergillus flavus, Aspergillus niger* and *Aspergillus fumigatus* were 2.78%, 4.17%, 4.17%, 5.56%, 5.56%, 6.94%, 8.33%, 15.28%, 12.50%, 15.28% and 19.44%, respectively.

The overall percentage occurrence of total soil-borne fungi in a major waste dump site in Bayelsa State, Nigeria is shown in Figure 4. The occurrence frequency of *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Penicillium, Fusarium, Mucor, Rhizopus, Cryptococcus, Cladosporium, Pullularia, Alternaria, Microsporium, Candida, Trichoderma* and *Saccharomyces* species were 17.40%, 14.64%, 16.85%, 7.46%, 4.70%, 4.14%, 3.59%, 3.31%, 1.38%, 1.93 %,1.66%, 3.31%, 3.04%, 4.42 %, 12.15, respectively.

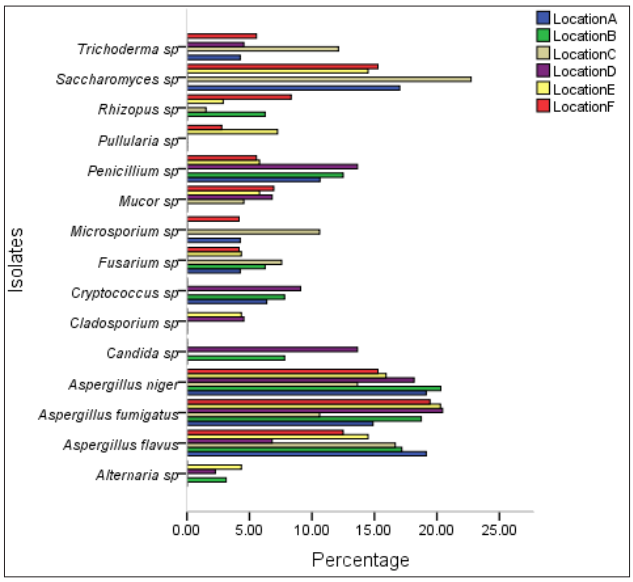

Figure 3.Percentage occurrence of soil-borne fungi according to locations in a major waste dump site in Bayelsa State, Nigeria

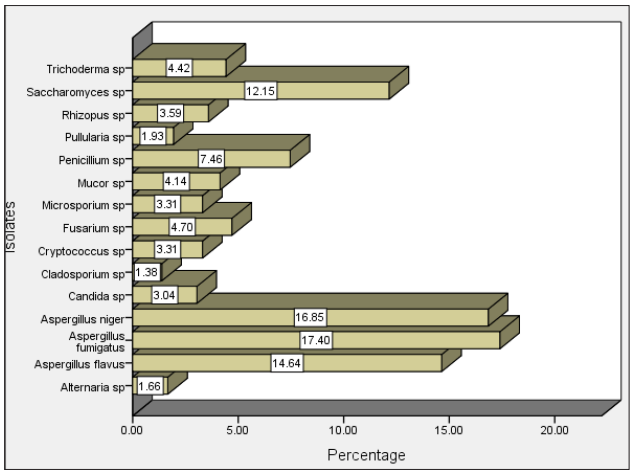

Figure 4.Percentage occurrence of total soil-borne fungi in a major waste dump site in Bayelsa State, Nigeria

The isolates recorded across the various locations had some similarity with records from other locations in the Niger Delta region of Nigeria and other parts of the world. For instance, Osazee et al.[23] recorded *Aspergillus*, *Mucor*, *Fusarium* and *Saccharomyces* species as fungi genera found in dumpsite in Benin City. The report also showed that *Aspergillus niger* and *Aspergillus tamarii* were the predominant species with occurrence frequency of 37% and 21.6%, respectively. Obire et al.[22] reported occurrence frequency of fungi isolates 25.3% (*Aspergillus*), 5.4% (*Fusarium*), 11.50% (*Mucor*), 12.60% (*Penicillium*), 2.50% (*Rhizopus*) and 42.80% (*Saccharomyces*) from dumpsite in Eagle Island, Port Harcourt. Findings from this study is similar to report on surface water of open drains in Port Harcourt by Ogbonna,[24] (*Aspergillus niger, Penicillium chrysogenum Aspergillus tamarii, Cryptococcus neoformans, Aspergillus versicolor, Torulopsis glabrata, Rhizopus, Mucor* species) and (*Aspergillus*, *Penicillium*, *Trichoderma*, *Absidia*, and *Fusarium* species) recorded as influenced by Marine Environment of Jansen Lagoon State Park in São Lu´ıs, Maranhão, Brazil reported by Rodrigues et al.[1] Also, Douglas[8] recorded *Aspergillus niger, Aspergillus flavus, Fusarium solani, Penicillium*, *Rhizopus*, *Mucor, Candida*, *Cladosporium* and *Saccharomyce* species from soil of an artisanal crude oil refining location in Boodo community, Rivers State.

The similarity index of soil-borne fungi diversity across the various locations is shown in Figure 5. The similarity interaction between each of the locations ranged from 55.56 to 90.00 with a similarity index above critical level of significance (50%). This suggests that the fungi isolate that dominated soil across dumpsite of the study area highly similar.

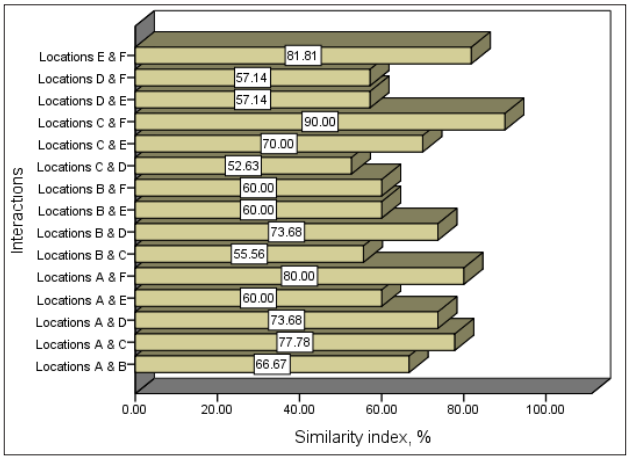

Figure 5.Similarity index of soil-borne fungi diversity found in isolated from a major waste dumpsite in Bayelsa State, Nigeria

From the study, *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger* and *Saccharomyces* species had the highest occurrence frequency in the study. This is in accordance with previous study by Obire et al.[22] that reported *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger* as the dominant *Aspergillus,* and 2 species of *Saccharomyces.* The authors further recorded the occurrence frequency of the fungi in the order; *Saccharomyces > Aspergillus > Pencillium > Mucor > fusarium > Rhizopus.* Basically most of the fungi

isolates have been reported in different environmental components such as air, water and soil. *Aspergillus* has been reported as the predominant fungi species in different settings.[10,15] Among the species, *Aspergillus fumigatus* has been recorded to have the highest occurrence frequency in dumpsite. Some species of *Aspergillus* has clinical importance because they can cause different type of diseases in animals and human especially in immune-compromised individuals. Many of the fungi species isolated are potential pathogens that could cause diseases. Some of the species could be due to source and characteristics of different type of wastes that are found in the dumpsite.

Conclusion

This study evaluated the fungi characteristics found in a major waste dump in Bayelsa State, Nigeria. The study found a significant variation in the fungi population around the dumpsite. Also, some of the fungi pathogens isolated have clinical importance. Hence there is fungi hazard associated with the waste in the dumpsite. Hence there is for caution to be exercise when working the vicinity especially by the scavengers.

Conflict of interest: None

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