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Survey and Identification of Fungi Associated with Selected Dumpsite Soils in Lagos State, Nigeria

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ABSTRACT

Background and Objective: Soil is a species-rich habitat containing major groups of microorganisms including fungi, bacteria, protists and algae. The study aimed at surveying and identifying fungi associated with the soil of some dumpsites in Alimosho Local Government Area of Lagos State, Nigeria. **Materials and Methods:** Soil samples were taken from four dumpsites within the test area. A mercury-in-glass soil thermometer was used to measure the soil's temperature at the collecting site. The pH of the soil samples was also recorded. Fungi isolation was done by direct plating and serial dilution while identification of fungi was done using macroscopic and microscopic characters. **Results:** Soil samples from Lanre, Akesan, Oko filling and Unity dumpsites had average temperatures from 26.3 to 27.3°C and pH values of 6.0 to 7.8. Akesan samples contained *Penicillium chrysogenum*, *Aspergillus flavus*, *A. niger* and *A. fumigatus*. Lanre samples had *A. fumigatus*, *A. terreus*, *Penicillium digitatum*, *Mucor* sp. and *Rhizopus stolonifer*. Oko-filling samples contained *A. flavus*, *A. fumigatus*, *A. niger*, *R. stolonifer*, *Mucor* sp., *Penicillium antarcticum* and *Cladosporium* sp., *A. niger*, *A. flavus*, *Mucor* sp., *A. fumigatus* and *P. digitatum* were recorded from Unity samples. **Conclusion:** To reduce the health risks associated with careless waste dumping, waste materials should be properly managed before disposal.

KEYWORDS

Alimosho Local Government, dumpsite soils, fungi, survey, wastes

INTRODUCTION

Waste is any material that is disposed of following major usage. Wastes are useless materials, defective, worthless and of no use. It could be community solid waste such as domestic garbage, harmful waste and wastewater such as sewage, which contains bodily wastes like faeces and urine and other wastes[1]. Wastes are generated during the working of raw materials into intermediary and end products, the consumption of these products and other anthropogenic undertakings. As a result of urban industrialization, social change and population growth, solid waste production is increasingly growing, making garbage contamination a grave issue[2,3].

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Waste could be dangerous if it is infective, that is, having viable microorganisms or toxins that may be harmful to both humans and animals[4]. Waste disposal constitutes a menace to humans, animals and the soil. Chemical hazards and disease-causing agents may be spread through wind and water in the environment. The waste site might potentially be home to poisonous plants, insects, animals and indigenous pathogens[2]. When the trash is thrown on the ground, soil microorganisms, such as fungi and bacteria, quickly colonize the trash, causing the degradable organic elements in the trash to degrade and begin to convert. The microorganisms multiply and use the waste materials' components as a source of nutrients for their growth while also breaking down the organic waste materials. As the digestive processes of these organisms break down complex organic molecules into simpler or less harmful ones, the fungi and bacteria in the soil utilize the waste constituents as nutrients, detoxifying the materials[5].

Fungi are essential parts of soil micro-biota normally accounting for more biomass than bacteria, based on depth of soil and nutrition status[6]. Based on their habits in the soil, fungi could be pathogens, mutualists, or decomposers[7,8]. A good number of fungi complete at least parts of their life cycles in soil[9]. Saprobic fungi make up the majority of fungal organisms in the soil and they play an important part in the breakdown of plant morphological polymers like cellulose, hemicellulose and lignin, leading to the global carbon cycle's maintenance[10,11].

Wastes are aesthetically displeasing, constitute an eyesore and emit offensive odour especially when their organic components are acted upon by putrefying fungi and bacteria. Thus, refuse dumps serve as a habitat for organisms that can spread or cause diseases including typhoid, infantile diarrhea and cholera in humans and animals[12].

Waste generation and its control have assumed a significant role in our ecosystem with the population doubling and residents' changing lifestyles, the rate at which municipal waste is being produced is alarming. Most of this waste is dumped in a designated disposal yard. The most difficult problem facing environmentalists is how to handle waste in an environmentally responsible way and using microorganisms in this situation offers an advantage over other technologies that are now available. Microorganisms digest organic waste, preventing it from producing odours, sludge, pollution or ugly mess.

The Lagos State Waste Management Agency (LAWMA) is an agency in charge of handling waste produced in Lagos State via a waste collection, conveyance and disposal framework. The mission of LAWMA is to enhance the environment in order to bring about positive and significant changes in people's living conditions, particularly with regard to wellness and cleanliness. The Lagos State Refuse Disposal Board (LSRDB) was established under Edit No. 9 of 1977, making it the first organization of its sort in West Africa. The Board was given authority over domestic waste collection and disposal as well as environmental sanitation in Lagos state. The Board evolved over time into the organization that is now known as the Lagos Waste Management Authority (LAWMA) Law 2017, gaining additional responsibilities such as managing commercial, industrial and medical waste streams, maintaining highway cleanliness, clearing out drainage systems and other water bodies and managing construction and demolition waste and so on. There are sixteen landfills in Lagos State out of which eleven are not currently active[13].

Soil microbes are becoming an increasingly significant source in the quest for compounds with industrial significance. Soil microorganisms such as fungi, play a major role in soil fertility and promoting the health of crops. There may be more beneficial compounds to be discovered from soil microorganisms since the extent of microbial diversity in nature is still mostly unknown. In soil, about 80 to 90% of microbes are yet unknown, these biological communities are well known to have a significant part in preserving a biosphere that is sustainable[14]. Therefore, this research aimed at surveying and identifying fungi associated with soil from dumpsites from selected locations in Lagos State.

MATERIALS AND METHODS

Study area: This study was carried out at the Department of Botany, Lagos State University, Ojo, Lagos State, Nigeria from February to May, 2022.

Sample locations: Twelve samples were taken from four dumpsites located along the LASU-Isheri Expressway in the Alimosho Local Government Area of Lagos State, Nigeria and a composite sample was obtained for each site. The sites were, Akesan located on Longitude 3°17'46"E and Latitude 6°36'39"N, Lanre, 4°9'48"E and 8°38'41"N, Oko-filling, 3°16'46"E and 6°34'38"N and Unity, 3°15'42"E and 6°32'36"N.

Akesan dumpsite is situated around houses and shops. Lanre dumpsite is an industry-based dumpsite while Oko-filling is located around houses, markets and filling stations. The unity dumpsite is near homes and a market area. The components of the waste were: ashes, papers, water sachets, food wastes, cans, sacks, clothes, glass bottles, foams, human faeces, plastics, bottles, cotton wool, hair, medicine bottles, fruits, cardboard, dry leaves, straws, shoes, sunglasses, toothbrushes, spoons, cloths, bags and so on.

Collection of samples: The surface debris was cleared away and the topsoil was dug up to a depth of about 15 cm with a hand shovel. Twenty grams of soil samples were obtained at three distinct points in every dumpsite. Within the confines of each waste collection location, soil samples were taken from a depth of 0 to 15 cm and placed in sterile polythene bags following the procedure adopted by Williams and Hakam[15]. Samples were later taken to the laboratory and stored in a refrigerator until required. The soil samples were sieved using a sterilized 0.2 mm wire mesh to get fine soil particles.

Determination of soil temperature: The temperature of the soil samples taken from the dumpsite was measured at the site after collection using a mercury-in-glass soil thermometer (Sunlite, Zhejiang, China).

pH determination: Soil pH was determined using a Hanna pH meter (Phep) (Hanna Instruments, USA, Smithfield, Rhode Island) and pH 4 and 7 buffer solutions were used to standardize it. Ten grams of the soil samples were weighed and then put into a 100 mL beaker (Benemed Industry Co. Limited, China, Henan, Hong Kong). Then, 50 mL of sterile distilled water was added and thoroughly stirred using a glass rod. It was left for about 20 min in the beaker with occasional stirring. The pH meter (Hanna Instrument, USA, Smithfield, Rhode Island) was immersed and its automated display provided the pH value.

Media preparation: Potato dextrose agar (PDA) was used for culturing isolated fungi. The media was prepared following the manufacturer's instructions.

Isolation of fungi

Direct plating method: One gram each from the already sieved soil samples was on a solidified PDA. The plates were gently rotated to disperse the soil particles on the medium. The plates were then incubated. Repeated sub-culturing was done until pure isolates were obtained.

Serial dilution: Ten gram of soil samples from each site was thoroughly shaken to homogenize in 10 mL of sterile distilled water in a test tube. Aliquot (1.0 mL) from the stock solution was dropped into the next test tubes and diluted serially in one-tenth serially to 10^{-6} according to Obire *et al.*[16]. One mililitre of the aliquot was introduced into already prepared PDA and spread with a bent sterile glass rod. The Petri dishes were incubated at a room temperature of 28°C±3°C. Pure cultures of fungi from the media were obtained by recurrent sub-culturing.

Identification of isolates: The growth of the pure isolates allowed for detailed descriptions of each fungus on the medium, which were then frequently checked for colonial or cultural characteristics. Lactophenol cotton blue stain was used to study microscopic morphology by staining. A tiny portion of the mycelial growth from a 7 days old culture was picked up with a sterile inoculating needle and gently teased off onto a clean, grease-free glass slide. Then, a cover slip was carefully placed over the preparation to prevent the formation of air bubbles. The slides were then examined under a microscope (Zeiss Model SHD-32A Zoom 1600x Digital Photo Camera Microscope, Oberkochen, Baden-Wurttemberg, Germany). Isolated fungi were carefully checked by contrasting their cultural and morphological features to previously known fungi[17,18].

RESULTS AND DISCUSSION

From the survey, the average temperature of the soil samples from Lanre, Akesan, Oko filling and Unity dumpsites was 27.3, 26.3, 26.7 and 26.7°C respectively. The mean pH values were 6.8, 7.8, 6.0 and 6.3 in the same order. A total of 10 fungal species were isolated and identified from the four sampled areas. From Akesan samples, *Aspergillus niger*, *A. fumigatus*, *A. flavus* and *Penicillium chrysogenum* were isolated, while *Aspergillus fumigatus*, *Penicillium digitatum*, *A. terreus*, *Mucor* sp. and *Rhizopus stolonifer* were recorded in samples from Lanre dumpsite. From Oko-filling, *Aspergillus niger*, *A. fumigatus*, *A. flavus, Cladosporium* sp, *Mucor* sp., *Penicillium antarcticum* and *Rhizopus stolonifer*. Whereas samples from unity, *A. niger*, *A. fumigatus*, *A. flavus*, *Mucor* sp. and *P. digitatum* were recorded. In all, there were four species of *Aspergillus*, three species of *Penicillium* and one species each of *Mucor*, *Rhizopus* and *Cladosporium* (Table 1). More fungal diversity was found in Oko-filling than in all other dumpsites.

The survey clearly showed that there exists enough diversity of fungal flora in the sampling sites. The genera: *Aspergillus*, *Penicillium*, *Mucor*, *Rhizopus* and *Cladosporium* were isolated. *Aspergillus* contributed the maximum by recording the highest frequency of isolation followed by *Penicillium*. All four sites had one species of *Aspergillus* or the other. The majority of fungi in the Oko-filling region is possible because of rotting and decaying food products as it is situated close to a market area. These garbage dumps provide a safe haven for a variety of fungi to reproduce. As a result, these fungal spores are dispersed into the atmosphere. *Cladosporium* recorded the lowest frequency of isolation in the dumpsites as it was only recorded in the Oko-filling site. The market area and its surroundings are the main sources of fungal spores because residents discard food scraps, vegetable remains and other trash into these areas. This research has revealed the presence of various fungi known to be associated with dumpsite soil. In certain environments, fungi are more prevalent due to favourable environmental conditions, vegetation types and nutritional variation. The richest location in terms of species was Oko-filling and this may be due to the presence of different food, hospital materials and other forms of waste that have accumulated in the soil over time. The result of this present work also agrees with various studies done by other researchers as all of these species have been reported as commonly isolated fungi from different land use types[15,16,19]. Among all the fungi, *Aspergillus* spp., was the most isolated in the four dumpsites (Table 1). The widespread distribution of *Aspergillus* species in all four dumpsites may be due to its extreme ubiquitary quality. It typically grows as a saprobe on stored grains, compost heaps, leaf debris and other types of decaying vegetation[20]. It was found that land-adapted microorganisms were more prevalent since land provides the optimal environment and nutrition for growth and reproduction. Additionally, it was discovered that some fungi were equally widespread on land and in water, indicating that some fungi species do utilize water for dispersion and dispersal.

Table 1: Fungi isolated from four selected dumpsite soils

	Direct plating				Serial dilution			
	Lanre	Akesan	Oko-filling	Unity	Lanre	Akesan	Oko-filling	Unity
Aspergillus flavus	-	+	+	+	-	+	+	+
Aspergillus fumigatus	+	+	+	-	+	+	+	+
Aspergillus niger	-	+	+	+	+	+	+	-
Aspergillus terreus	+	-	-	-	-	+	-	-
Cladosporium sp.	-	-	+	-	-	-	+	-
Mucor sp.	+	-	+	-	+	+	+	-
Penicillium antarcticum	-	-	+	-	-	-	+	-
Penicillium chrysogenum	-	+	-	-	-	+	-	-
Penicillium digitatum	+	-	+	+	+	-	+	+
Rhizopus stolonifer	+	+	+	-	-	+	+	-

+: Present and -: Absent

The isolation of *Mucor*, *Aspergillus* and *Rhizopus* is similar to a study by Obire *et al.*[16] which highlighted the presence of these microbes in soils collected from a waste dumpsite located at Eagle Island, Rivers State, Southern Nigeria. *Rhizopus, Aspergillus, Mucor* and a variety of yeasts have also been linked to reports of garbage biodegradation[21]. Generally, *Rhizopus* and *Mucor* were the least abundant species while *Aspergillus* and *Penicillium* were the most abundant species in the selected locations (Table 1). Similar studies by Ewekeye *et al.*[19] also recorded *Penicillium* and *Aspergillus* to be both common in waste sites. The temperature range for the Akesan dumpsite was between 26-27°C while for the dumpsite at Lanre was between 27-28°C.

This research has assisted in identifying the existence of several fungi in dumpsites. These dumpsites can be sources of various pollutants, including heavy metals and toxic compounds, which can have implications for human health. The presence of fungi in these soils can help determine any threats to human health, particularly if they can release toxins or cause infections. Also, this study has implications for waste management, bioremediation, biodiversity protection and scientific understanding.

The study can serve as a baseline for further investigations into the effects of dumpsites on fungal communities. It becomes possible to track changes in fungal diversity and abundance over time by frequently conducting surveys and identifying the fungi present in dumpsite soils. Furthermore, the study's findings can aid in making well-informed decisions on how to manage land. By understanding the fungal communities in dumpsite soils, it becomes possible to identify regions where soil remediation and restoration efforts are necessary before repurposing the land for different uses. This knowledge can aid in reducing potential health risks to people, preventing future contamination and ensuring the long-term sustainability of land use techniques.

From the findings of this study, it is recommended that: There should be an implementation of efficient waste management techniques such as proper waste segregation and recycling to lessen the accumulation of pollutants in dumpsites and prevent additional contamination of the soil and nearby ecosystems, market areas, homes and shops should not be situated close to dumpsite areas to protect human health and prevent exposure to disease-causing agents in the environment, there should be more research on fungal ecology in dumpsite soils to learn more about the variety of fungi, the dynamics of their communities, more collaborations should exist between researchers, environmental agencies, waste management authorities and other stakeholders to collectively address the environmental issues associated with dumpsites.

The findings in this study were specific to selected dumpsites, limiting the applicability of the findings to other dumpsites with various environmental factors, waste compositions, or management techniques. Since this study was carried out during a specific season, the changes in fungal populations throughout the year might not be fully captured. This is because of temporal variations exhibited by fungal communities, influenced by seasonal changes in environmental conditions. The limitations of this study can impact the scope, reliability and generalizability of the study results.

CONCLUSION

This study demonstrated that the soils collected from dumpsites contain different varieties of fungi. When the spores of these fungi are dispersed to the surroundings, some of them could cause allergic reactions and pose health hazards. Hence, dumping of wastes around residential locations should be strongly discouraged and wastes should be appropriately treated before disposal so as to reduce the health risks these fungi might cause to humans.

SIGNIFICANCE STATEMENT

The indiscriminate dumping of waste materials in dumpsites located within residential areas is becoming more prevalent and thus exposing inhabitants of such areas to health risks. Due to improper waste management, harmful insects and microorganisms can thrive in these dumpsites. This study was conducted to enlighten and caution the general public and the government on the need for good waste management to enhance good living conditions and environmental sanitation. Goal 3 (good health and well-being) and Goal 6 (clean water and sanitation) of the Sustainable Development Goals (SDGs) are the two goals that this study tends to promote. Thus, the healthy lifestyle of the citizens is key to contributing significantly to the prosperity and progress of a nation.

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