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Public Health Implications of Fungi-Aerosol Contamination around a Major Dumpsite in Bayelsa State, Nigeria

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Abstract

Atmospheric pollution is a major global environmental issue. Improper waste management is among the leading cause of environment contamination in many cities in developing nations. Improper waste management leads to the release of bio-aerosol into the atmosphere. Some microbial air contaminants are known to cause diseases in human especially on immune-compromised individuals. This study evaluates the fungi-aerosol around waste dumpsite in Bayelsa State, Nigeria. Triplicate Potatoes dextrose agar was exposed for 10 minutes around a major dumpsite in Bayelsa State at a height of 1meter. The fungi density and diversity were determined following standard microbiological procedures. Results showed that the total fungi-aerosol counts ranged from 0.0004 – 0.0094 CFU/min-m^2 in dry season and 0.0001 – 0.0036 CFU/min-m^2 in wet season. There were statistical variations ($p<0.05$) across months, distances, and interaction between months and distances. Of the 16 fungi diversity isolated, *Aspergillus fumigatus*, *Aspergillus flavus*, *Aspergillus niger*, *Penicillium* and *Rhizopus* species had the highest occurring frequency in both seasons of study. Again, the isolates showed that the diversity decreased with distance (200 ->1000 ft) away from the main dumpsite. Similarity interaction between each of the distances ranged from 42.86 – 88.89% and 36.36 – 82.35% for dry and wet seasons, respectively with index above critical level of significance (50%) in most cases. Some fungi species are known to produce toxins that cause diseases in humans. Hence, personal safety measures including effective treatment of waste by appropriate agencies before disposal to reduce exposure to bioaerosols to scavengers and others are needed.

Keywords: Air pollution, Bioaerosols, Dumpsite, Environmental Health, Fungi, Waste

1 Introduction

Waste generation and its management are among the major problems affecting environmental sustainability [1]. Indiscriminate wastes disposal impacts on the major environmental components such as soil, water and air. Wastes are mainly dumped on soil, but in coastal regions like Bayelsa state, Nigeria, wastes are also discharged directly into surface water bodies. These wastes include solid wastes (resulting from household and municipal activities), as well as sewage from pier toilet systems. For instance, Ben-Eledo et al. [2] reported the discharge of toilet and bathroom waste water directly into a creek in Bayelsa state. Seiyaboh and Izah [3] reported that a tidal creek in Bayelsa State also receives effluents from slaughter house. Both researchers reported on the adverse impact of such practices to the environment.

According to Odonkor and Mahami [4], air pollution is now a major global issue especially in developing nations. Pollutants arising mainly from human activities have been reported to alter the composition of particulates, elemental metals and microbial air contaminants depending duration of exposure and physical composition [5]. In different part of Nigeria particularly in Bayelsa State, wastes have been reported to cause a variation in the ambient composition of particulate matter (PM2.5, 4.0, 7.0, 10, and total) [6], noxious gases (such as ammonia, hydrogen sulphide, carbon monoxide, sulphur dioxide and nitrogen dioxide) [7] and volatile organic compounds [8].

Heavy metals do not contaminate only the air, but also cause pollution in the water [9, 10], food materials [11, 12], sediment and soil. Heavy metals which have known biological functions at certain concentrations are often referred to as essential metals. They include iron, manganese, copper, zinc, chromium, cobalt, nickel. On the other hand, those without any known biological function are often referred to as non-essential metals. Consequently, even at very low concentrations they may portend adverse environmental and health implications [11]. Examples of these non-essential metals include lead, cadmium, mercury, etc.

Microbes by their nature are everywhere. They play diverse roles in any ecosystem, some of which are essential while others are detrimental. For instance, the roles played by microbes in biogeochemical cycles are beneficial to the environment. Some others are useful for the recovery of precious metals from their ores. Other microbes have the potential to cause human, plant and animal diseases (opportunistic microbes) with abundance around dump sites.

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Humans especially the scavengers that depend on materials from dumpsite for survival may unknowingly breathe in bioaerosol from dumpsite.

Hence the need to continually assess them to forestall the potential health implication associated with pathogenic microbes that are profuse around the ambient environment of dumpsites. Several studies have been carried out with respect to microbial air contaminants in Nigeria including Port Harcourt [13, 14] and Keffi metropolis [15]. But information about microbial air contaminants from waste dumpsite and its environs in Bayelsa State are scares in literature. Again, vectors (such as insects and rodents) that transmit the causative agents of some diseases such as amoebic and bacillary dysentery, typhoid fever, salmonellosis, cholera, plague etc are found in dumpsite [13]. Hence, this study focused on the public health implications of fungi-aerosols contamination around waste dumpsite in Bayelsa State, Nigeria. The findings of this study will be useful to stakeholders, policy makers and individuals that survive based on the activities of dumpsite (especially the scavengers).

2 Materials and Methods

2.1. Description of the Study Location

The study was conducted in the Central waste dumpsite off Yenagoa-Amassoma road in Yenagoa Local Government Area of Bayelsa State. The dumpsite is among the largest in the State. Most household wastes from Yenagoa metropolis and its environs end up is this dump. Many scavengers looking for useful materials such as empty cans of bottle water, irons, etc, are found in the area. Like every other region in the Niger Delta, the atmospheric conditions of the area is similar to that previously reported by Agedah et al. [16], Izah et al. [17].

2.2 Collection of Samples

The samples were collected following the methods previously described by Nrior and Dumbor [13] with slight modification. The algal plates containing prepared sterile Potatoes dextrose agar was exposed to the air environment at 1m height for 10 minutes for each sample collected. Samples were collected at the 10 ft (AF1), 25ft (AF2), 50ft (AF3), 100ft (AF4), 200ft (AF5), respectively at the dumpsite. A control station was established over 1000 ft (AF6) away from the dumpsite with little human activities. Triplicate samples were collected at each distance. The study was carried out between November 2016 and September 2017.

2.3 Examination of the fungi counts

The exposed agar plates were incubated in an inverted position at 30ºC for 5 days. The resultant colonies were counted and expressed as colony forming units (CFU)/min-m^2 as described by Nrior and Dumbor [13].

2.4 Identification of the fungi counts

The resultant isolates were identified based on their macroscopic/ colonial and microscopic characteristics. The microscopic morphology was determined following the wet mount preparation of the isolate using Lactophenol cotton blue stain as previously described by Pepper and Gerba [18], Benson [19]. The resultant microscopic and macroscopic characteristics were compared using the scheme of Bartnett and Hunter [20], Ellis et al. [21], Benson [19].

2.5 Statistical Analysis

The statistical analysis was carried out using SPSS version 20. Descriptive statistics on (mean, deviation at 95confidence interval and simple percentages) was carried out. Two-way analysis of variance was carried out at P = 0.05 on the microbial density, and Waller-Duncan test statistics was used to discern the source of the observed differences. Sorenson qualitative index by Ogbeibu [22] was used to show similarity in the fungi diversity between each of the distances.

3 Results and Discussion

The density of the total fungi counts across the various months and distances of study is presented in Figure 1 and 2, respectively. The mean population at November, January, March, May, July and September were 0.0039 CFU/min-m^2, 0.0050 CFU/min-m^2, 0.0043 CFU/min-m^2, 0.0017 CFU/min-m^2, 0.0013 CFU/min-m^2 and 0.0010 CFU/min-m^2, respectively. There was significant difference (p=0.000) across the months. However, Waller-Duncan multiple tests showed that there is no significant variation between the month of November and March, and between May and July, and July and September (Figure 1).

The mean population at 10, 25, 50, 100, 200 and >1000 ft (control) were 0.005 CFU/min-m^2, 0.004 CFU/min-m^2, 0.003, CFU/min-m^2, 0.003 CFU/min-m^2, 0.002 CFU/min-m^2 and 0.0006 CFU/min-m^2, respectively. There was significant difference ($p<0.05$) across the distances. However, Waller-Duncan multiple tests showed that there is no significant difference between 50 ft (AF3) and 100 ft (AF4) distance (Figure 2).

There was significant interaction ($p<0.05$) between the months and the various distances. The density of the total fungi decreases away from the dumpsite. Again the density were in the order; January > November > March > May > July > September (Figure 3). The density ranged from 0.0004 – 0.0094 CFU/min-m^2 in dry season months (November, January and March) were clearly higher compared to 0.0001 – 0.0036 CFU/min-m^2 in wet season months (May, July and September) of study. However, there was occasional overlap in the density between January and March for dry season, and July and September for wet season.

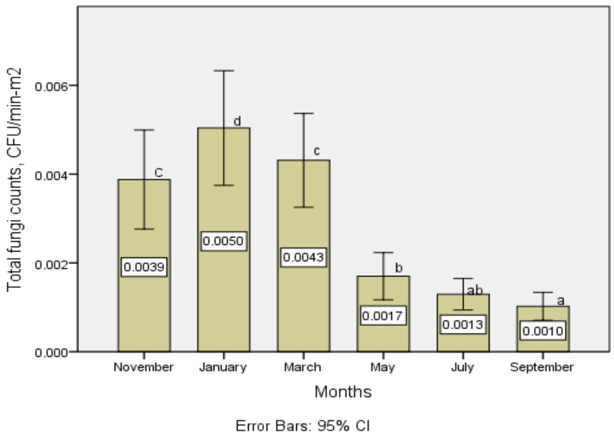

Figure 1: Total fungi counts across the months of study

The significant variations suggest differences in density of fungi-aerosols in a major dumpsite and its environs. The statistical interactions that occur also indicate the effects of months and distances in the fungi density in the area. The density is higher in the dry season months especially in January compared to the wet season. This is due to the effect of season. This is because during the dry season, the relative humidity decreases and temperature increases. Also intermittently the wind speed also increases slightly in dry season above the wet season. This may have increased the air movement. According to Odonkor and Mahami [4], fungi count in the air is supposed to be higher in wet season due to the presence of moisture and water that enhance their growth, but due to the fact that fungi-aerosols exist as spores that are released under high temperature. The authors further reported that fungal spores are multiplied during the rainy season and are better released into the atmosphere during the dry season, and this account for the higher fungi density recorded in dry season.

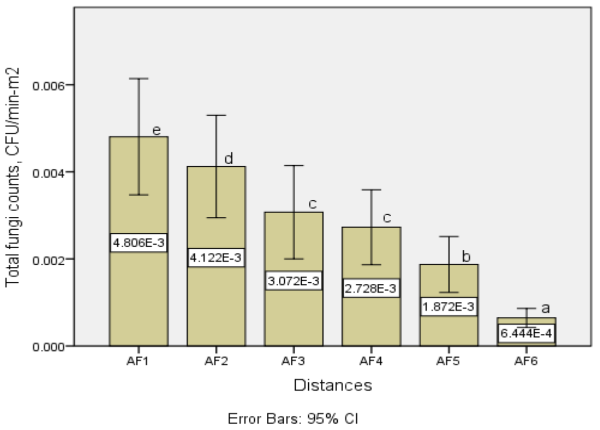

Figure 2: Total fungi counts across the various distance of study

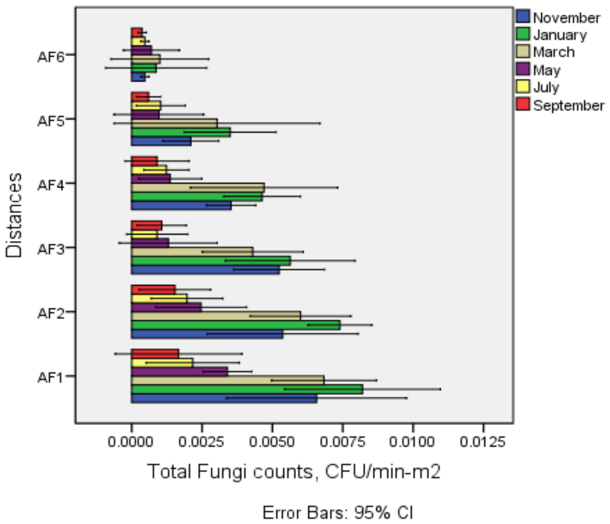

Figure 3: Density of total fungi across the various distances for each of the months

The trend of this study, that fungi population is higher in dry season compared to wet season is in accordance with previous report by Odonkor and Mahami [4]. Also microbial density decreases with distances away from dumpsite have been reported by Nrior and Dumbor [13]. Basically this trend have also been recorded in other air pollutants from dumpsites including noxious gases [7], particulates [6] and volatile organic compounds [8].

The percentage occurrence of the fungi isolates across the seasons is shown in Figure 4. *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Penicillium* species, *Microsporium canis, Trichoderma, Cladosporium, Alternaria, Pullularia, Fusarium, Trichothecium, Mucor, Rhizopus, Trychophyton, Helminthosporium* and *Candida* species had occurrence rate of 13.07%, 15.69%, 15.69%, 7.84%, 1.96%, 1.31%, 2.61%, 3.92%, 0.00%, 13.07%, 1.31%, 5.88%, 15.03%, 2.61%, 0.00% and 0.00%, respectively for dry season, and 16.00%, 15.00%, 19.00%, 8.00%, 0.00%, 3.00%, 1.00%, 6.00%, 2.00%, 7.00%, 2.00%, 8.00%, 10.00%, 0.00%, 2.00% and 1.00%, respectively for the wet season. The number of fungi isolates at AF1, AF2, AF3, AF4, AF5 and AF6 were 10.00, 9.00, 11.00, 8.00, 5.00 and 3.00, respectively for dry season, and 9.00, 10.00, 7.00, 7.00, 5.00 and 4.00, respectively for wet season (Figure 5). The similarity of the fungi diversity between the various distances based on Sorenson qualitative index is shown in Figure 6. The similarity interaction between each of the distances ranged from 42.86 – 88.89% and 36.36 – 82.35% for dry and wet seasons, with the similarity index above critical level of significance (50%) in most of the interactions. However, for dry and wet seasons, two (AF1 – AF6 and AF3 – AF6) and three (AF1- AF6, AF2 – AF6 and AF5 – AF6) interactions had a value below the critical level of significance. The trend observed suggest that most of the insolates found in the different distances are similar.

This finding suggests that there is seasonal influence in the distribution of fungi-aerosols in the dumpsite. The number of isolates decreases as we move away from the emission source. The study also showed that the number of fungi aerosol in the control area is far lesser compared to AF1 – AF4 from the dumpsite. Thus, the effect of unfavorable conditions might have hindered the growth of fungi in the air control station. This indicates the effects of waste dump in the distribution of fungi aersol. Among the genus identified, *Aspergillus* has the highest occurrence frequency. This trend is in consonance with previous report by Nrior and Dumbor [13], Nrior and Adiele [14], Odonkor and Mahami [4]. This indicates that *Aspergillus* is among the major air contaminants in different settings.

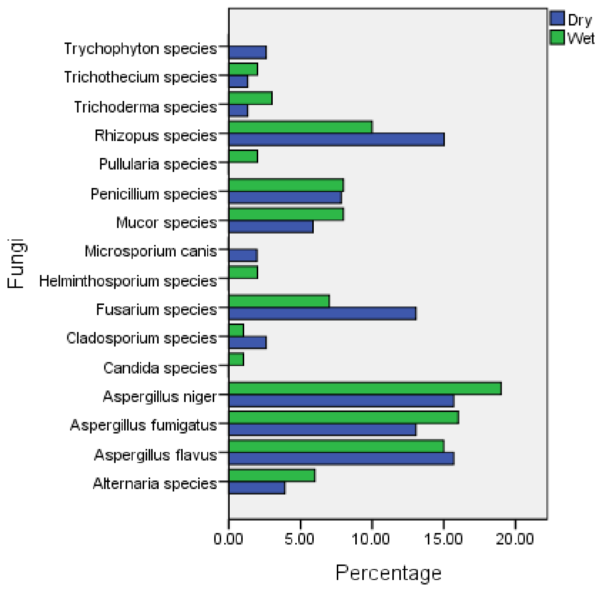

Figure 4: Percentage occurrence of the fungi isolates across the season

The diversity of fungi found in this study had some similarity with previous works. Nrior and Dumbor [13] reported occurrence rate of fungi in air from a dumpsite in Port Harcourt, Nigeria as *Aspergillus fumigatus* (16.62%), *Microsporium canis* (15.40%), *Aspergillus flavus* (14.75%), *Aspergillus niger* (10.99%), *Conidiobolus coronatus* (10.19%), *Pheaocremonium parasiticum* (6.97%), *Fusarium chlamydosporium* (6.70%), *Trychophyton etriotrephon* (5.63%), *Trychophyton quinckeanum* (4.02%), *Lichtheeimia* *corymbifera* (3.57%), *Cladosporium cladosporioides* (2.95%), *Saccharomyces* species (2.68%). Nrior and Adiele [14] reported *Aspergillus flavus, Aspergillus niger, Aspergillus nidulans, Aspergillus terreus, Penicillum* and *Fusarium* species as fungi-aerosol contaminants in a campus community in Rivers State, Nigeria.

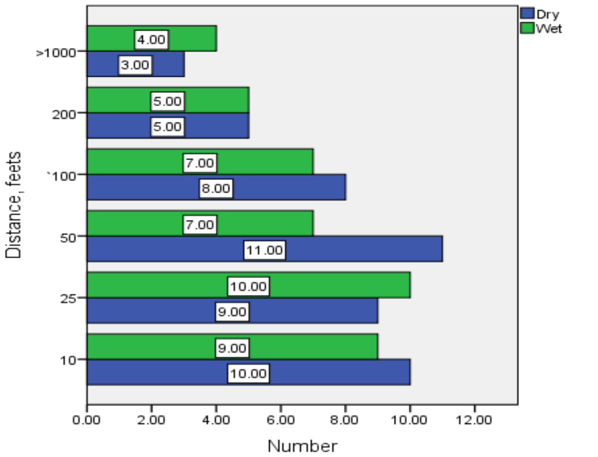

Figure 5: Number of fungi isolates identified in each of the location across both seasons

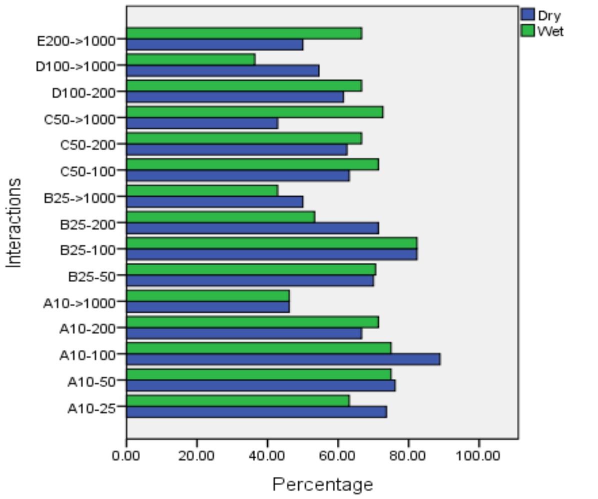

Figure 6: Similarity index of fungi diversity found in waste dumpsite in Bayelsa State, Nigeria

Ndimele et al. [23] reported *Trichophyton rubrum, Microsporium distortum, Aspergillus flavus, Candida utilis, Aspergillus fumigatus, Aspergillus niger, Rhodotorula glutinis, Rhizopus* and *Penicillium* species as fungi isolates found in the ambient environment within some teaching hospitals in Nigeria. Obiekezie et al. [15] reported *Aspergillus niger, Rhizopus stolonifer, Alternaria, Penicillum, Mucor, Fusarium* and *Candida* species as fungi isolates found in air environment around waste dumpsites in Keffi metropolis, Nigeria. Odonkor and Mahami [4] reported *Aspergillus niger, Aspergillus brevipes, Aspergillus flavus, Aspergillus parasiticus Speare, Cladosporium* species, *Penicillium halicum, Phanerochaete chrysosporium, Rhizopus stolonifer* and *Ulocladium chartarum* as fungi-aerosols found around landfill sites in selected districts in the Greater Accra Region of Ghana.

Some species within the fungi genera isolated are known to cause diseases. For instance, some species of *Aspergillus* produces aflatoxins and ochratoxins which could lead to liver cancer and renal tumour, respectively; *Penicillium* toxins such as Citrinin and Cyclopiazonic acid which could lead to kidney disorder and Kodua poisoning, respectively; and *Fusarium* toxins such as Moniliformin and Fumornisins could lead to Onlyai disease and Leukoencephalomalacia, respectively [24 – 26]. According to Akpeimeh et al. [27], 76% and 63% of *Aspergillus fumigatus* and total fungi respectively has a repirable size and could penetrate into the respiratory system, where it could cause adverse health effect. The authors further suggested bioaerosols from open dumpsite could lead to high prevalence of the chronic respiratory discomfort especially among workers in the vicinity. The presence of some pathogenic mould in the study area is an indication of health risk to humans especially scavengers that work in the dumpsite. As such there is need to adopt proper precautionary measures to advert adverse impact associated with waste in the open environment [13] and the health of those residing close to such locale.

4 Conclusion

This study evaluated the public health implications of fungi found in the ambient environment around a major dumpsite in Bayelsa State, Nigeria. The study showed that the fungi density is higher in dry season compared to wet season, suggesting seasonal influence in the release of fungi spores. Also the density and diversities decreases as the distance away from dumpsite increases especially from 200 ft to >1000 ft of the dumpsite. Some species of the fungi genera isolated produce toxins that could be injurious to human health. The high fungi density indicates that waste dump environment have adverse influence on the aero microbiology of the area. As such, there is need to create awareness and sensitize individuals, especially scavengers working in the dumpsite. Also there is the need to monitor species diversities of microorganisms found in dumpsite vicinity. Thus proper waste management strategies are crucial to human health and environmental safety.

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