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Seasonal Variation in Mycological Quality of Air Environment Around a Major Market Along East-West Road in Bayelsa State, Nigeria

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Abstract

The distribution of bio-aerosols in diverse environments is a major concern to aero-microbiologists and environmentalist in general. The study evaluated the mycological quality of air environment around a market along East-West road in Bayelsa State, Nigeria. Petri dish containing sterile Potatoes dextrose agar was exposed for 10 minutes around a market along East-West road in Bayelsa state at a height of 1 meter. The density and diversity of the isolates were determined following standard mycological procedures. The density of the fungi–aerosols ranged from 0.0073 - 0.0268 CFU/min-m^2 and was statistical higher in dry (November, January and March) compared to wet (May, July and September) seasons, an indication of seasonal influence. A total of 11 fungi species were recorded with 5 predominant species viz *Aspergillus fumigatus*, *Aspergillus flavus*, *Aspergillus niger*, *Fusarium chlamydosporum* and *Penicillium* species (occurring in ≥66.67% of the study months), while 6 species, *Aspergillus lentulus*, *Aspergillus nidulans*, *Aspergillus terreus*, *Cladosporium cladosporioides*, *Microsporum canis* and *Mucor* species are opportunistic occurring in ≤50% of the study months). Most fungi species are found in the soil, and are known to produce toxins and cause diseases. There is need for a concerted effort by local government authorities via its agencies to sensitize people on proper hygiene practices around markets.

Keywords: Air pollution; Bayelsa state; Environmental health; Fungi; Market.

1. Introduction

The rate and intensity of atmospheric degradation have been on the increase possibly as a result of population growth, urbanization and industrialization. Like soil and water pollution, the effect of air pollution is a threat to the aero-environment and the associated biota. Thus, atmospheric pollution could lead to changes in composition and distribution of species especially in microbes found in such environment.

The distribution and presence of a particular microbe in a given environment depends on its adaptive strategies that enable it to thrive in such habitats. Microbes play detrimental as well as beneficial roles to both the environment and humans. However, the adverse roles play by microbes with respect to public health are of a serious concern because many infectious diseases that have devastated the world are caused by microorganisms (bacteria, viruses and fungi) [1].

Disease is easily transmitted in public places via droplets (saliva and mucus produced by coughing, sneezing, talking, laughing; and also through dust and air) dispersion containing microbes [2]. According to Nrior and Adiele [2], 10,000 and 100,000 microbes are released into the environment in a single sneeze. Many disease that affect humans (diphtheria, meningitis, pneumonia, tuberculosis and whooping cough) [2], plants and other animals are transported via the air.

The viability of the aero-microorganisms depends on the prevailing climatic condition such as temperature, sunlight, relative humidity and rainfall. These factors affect disease burden and distribution in the vicinity and may also account for a greater prevalence of certain disease in a particular season.

Several microbes including fungi and bacteria have been reported in air environment [3]. The most commonly isolated fungi species is *Aspergillus* species which has been reported in waste dump [4]. *Aspergillus* species has health implication because of its capacity to produce aflatoxin [5]. *Aspergillus* species are known to cause Aspergillosis in human and animals [5]. In humans the effect is common in immune compromised individuals. The clinical manifestation of Aspergillosis in human which mostly affects the lungs differs, from the non-invasive form with symptom such as sinusitis, otomycosis, keratitis and onychomycosis. Of the species of *Aspergillus*, the most commonly identified are Aspergillus *niger*, *Aspergillus fumigatus*, *Aspergillus flavus* because they can thrive under harsh or stressful environmental conditions. Due to the diverse nature of these fungi in the environment, people inhale their spores on daily basis without serious symptom probably due to efficient immune response.

The health of a community is crucial to its survival. Microbes being ubiquitous tend to occur in higher density in crowded areas and dumpsites. In many developing countries like Nigeria, the number of persons in a given market is tightly packed with little or no physical distancing. More-so, there are no standards for hygiene. Hence there is every tendency that cross contamination of pathogens may occur between vendors, their buyers and the goods itself. Studies have been widely carried out showing microbial air contaminants in diverse environments including smallholder gari processing facility [3], waste dump [4, 6-10], around a University campus in Nigeria [2], but information of microbial air contaminants in public places like market and highway is scanty in literature. Therefore, this study focused on seasonality in fungi-aerosol around a major market along East-West road in Bayelsa State, Nigeria

2. Materials and Methods

2.1. Description of the Study Location

The study was conducted in Zarama market along East-West road in Yenagoa Local Government Area of Bayelsa State. Several perishable goods are sold in the market. The market is transacted once in a week. Taylor creek passes beside the Market. Some goods sold in the market are displayed on bare ground (e.g. yam, plantain etc), either exposed or slightly covered (gari etc). Two predominant season occurs in the area just as in other Niger Delta States as previously reported [11, 12].

2.2. Collection of Samples

The sedimentation method previously described by Nrior and Dumbor [7], was adopted for this study. Triplicate samples of petri dish containing sterile Potatoes dextrose agar was exposed to the air environment at 1m height for 10 minutes. The samples was obtained bimonthly from November 2016 to September 2017 being 3 months of dry season (November, January and March) and wet seasons (May, July and September).

2.3. Examination of the Fungi Counts

The agar plates exposed to the market environment for 10 minutes were incubated at 30ºC for 5 days [4]. The colonies were counted and expressed as colony forming units (CFU)/min-m^2 as described by Nrior and Dumbor [7], and the fungi was sub-cultured into pure culture.

2.4. Identification of the Fungi Counts

The pure culture of each of the isolates was identified based on their macroscopic/ colonial and microscopic characteristics. The wet mount preparation of the isolate using Lactophenol cotton blue stain as previously described by Pepper and Gerba [13], Benson [14], was adopted in this study. Both the microscopic and macroscopic characteristics of each of the isolates were compared using the scheme of Barnett and Hunter [15], Ellis, *et al.* [16], Benson [14].

2.5. Statistical Analysis

SPSS version 20 was used to carry out the statistical analysis. The data obtained was analyzed using one way analysis of variance at p=0.05, and Waller-Duncan statistics was used to discern the source of the observed variation. The occurrence rate of the isolates were computed and expressed in percentages. The results were presented in charts (pie and bar charts). The bar chart is expressed as mean ± standard error. From the occurrence rate, isolates having ≤50% (or ≤3 out of 6 months of study) and ≥50% (or ≥3 out of 6 months of study) are considered as opportunistic and predominant isolates, respectively.

3. Results

Figure 1 shows the density of total fungi in the ambient environment around a market in East-West road, Bayelsa State, Nigeria. In November, January, March, May, July and September, the density ranged from 0.0170 – 0.0328 (mean ± standard error, 0.0237±0.0047 CFU/min-m^2), 0.0207 – 0.304 (mean ± standard error, 0.0268±0.0031 CFU/min-m^2), 0.0201 – 0.0255 (mean ± standard error, 0.0229 ± 0.0016 CFU/min-m^2), 0.0067 – 0.0128 (mean ± standard error, 0.0089±0.0019 CFU/min-m^2), 0.0067 – 0.0085 (mean ± standard error, 0.0075±0.0005 CFU/min-m^2) and 0.0061 – 0.0085 (mean ± standard error, 0.0073±0.0007 CFU/min-m^2), respectively. Statistically, there was variation (p<0.05). However, Waller-Duncan comparison showed that there is no significant difference between the dry season (November, January and March) and wet season (May, July and September) months. Furthermore, 75.56% and 24.44% of the total fungi occurred in dry and wet season, respectively (Figure 2).

Figure-1. Density of total fungi in air environment around a market in East-West road, Bayelsa State, Nigeria

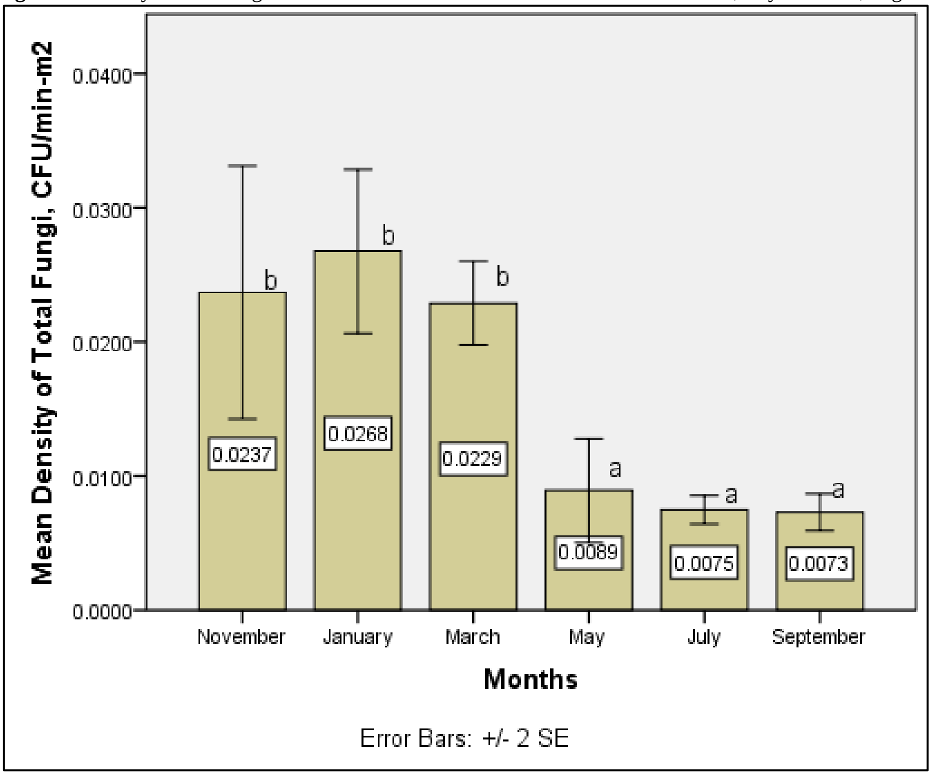


Figure-2. Seasonal Distribution of the total fungi density in air environment around a market in East-West road, Bayelsa State, Nigeria

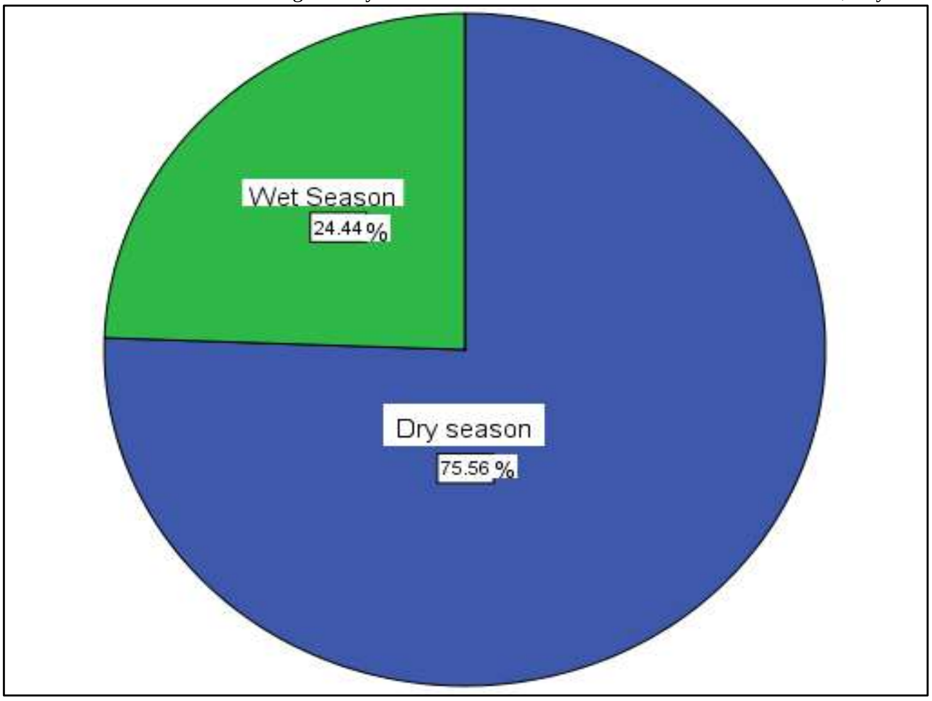


Figure 3 shows the occurrence of the fungi isolates in each of the months of the study. *Aspergillus lentulus*, *Aspergillus fumigatus*, *Aspergillus flavus*, *Aspergillus nidulans*, *Aspergillus niger*, *Aspergillus terreus*, *Cladosporium cladosporioides*, *Fusarium chlamydosporum*, *Microsporum canis*, *Penicillium* and *Mucor* species were 2.63%, 34.21%, 31.58%, 0.00%, 18.42%, 0.00 %, 0.00 %, 0.00%, 5.26%, 7.89% and 0.00%, respectively (November), 0.00%, 31.25%, 27.08%, 0.00%, 18.75%, 0.00%, 2.08%, 8.33%, 0.00%, 10.42% and 2.08 %, respectively (January), 0.00%, 28.95%, 21.05%, 2.63%, 10.53%, 7.89%, 0.00%, 5.26 %, 7.89 %, 15.79% and 0.00%, respectively (March), 0.00%, 33.33%, 14.29%, 0.00%, 23.81%, 0.00 %, 9.52%, 4.76%, 4.76%, 9.52% and 0.00%, respectively (May), 0.00%, 42.86%, 21.43%, 0.00%, 14.29%, 0.00%, 14.29%, 7.14%, 0.00%, 0.00 % and 0.00%, respectively (July), and 0.00%, 40.00%, 35.00%, 10.00%, 15.00%, 0.00%, 0.00%, 0.00%, 0.00%, 0.00% and 0.00%, respectively (September). Based on the months of study, the percentage distribution of the isolates in November, January, March, May, July and September were 21.23%, 28.82%, 21.23%, 11.73%, 7.82% and 11.17%, respectively (Figure 4). This is in line with findings of this study showing greater isolates occurring in the dry season months.

Figure-3. Occurrence of the fungi isolates in each of the months of the study

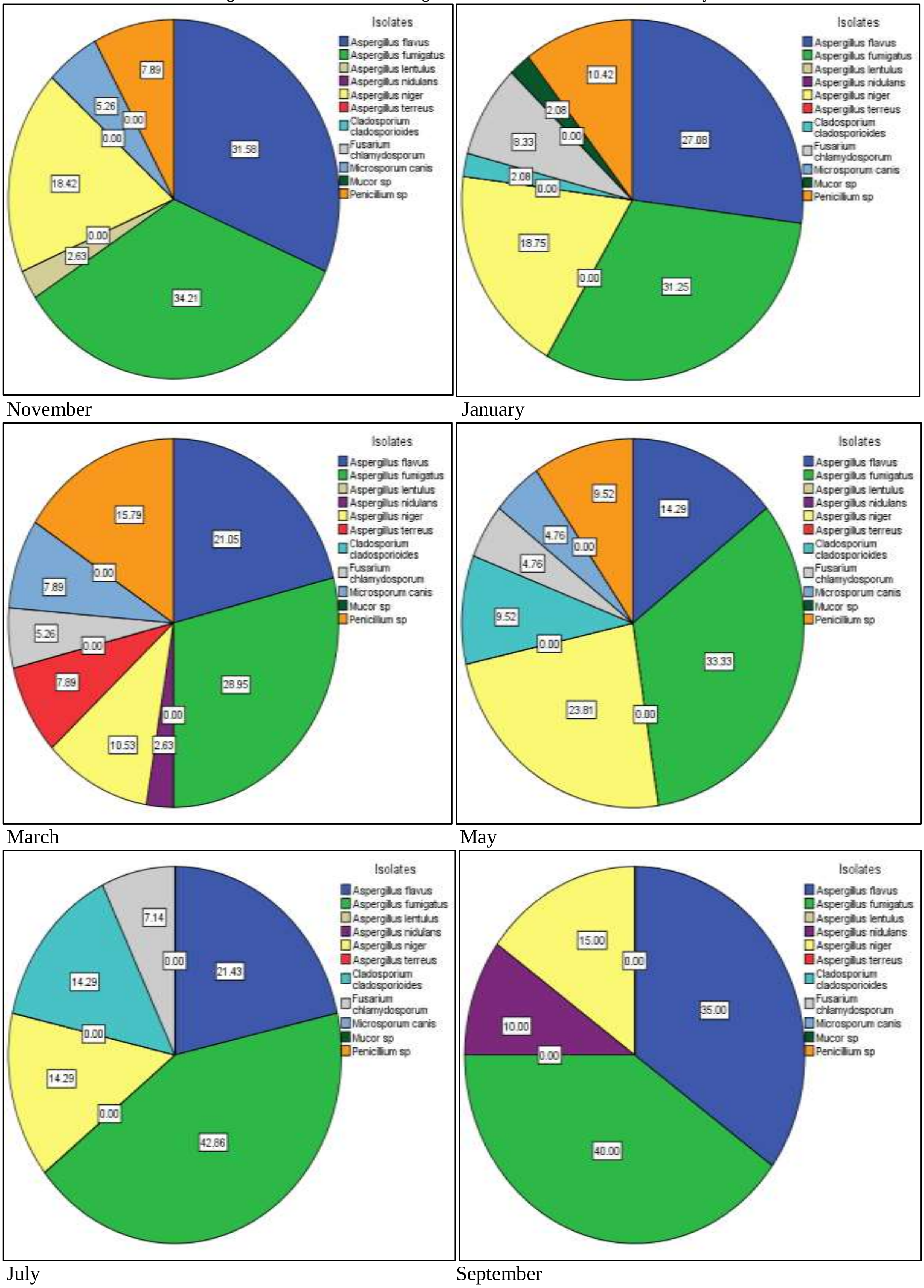
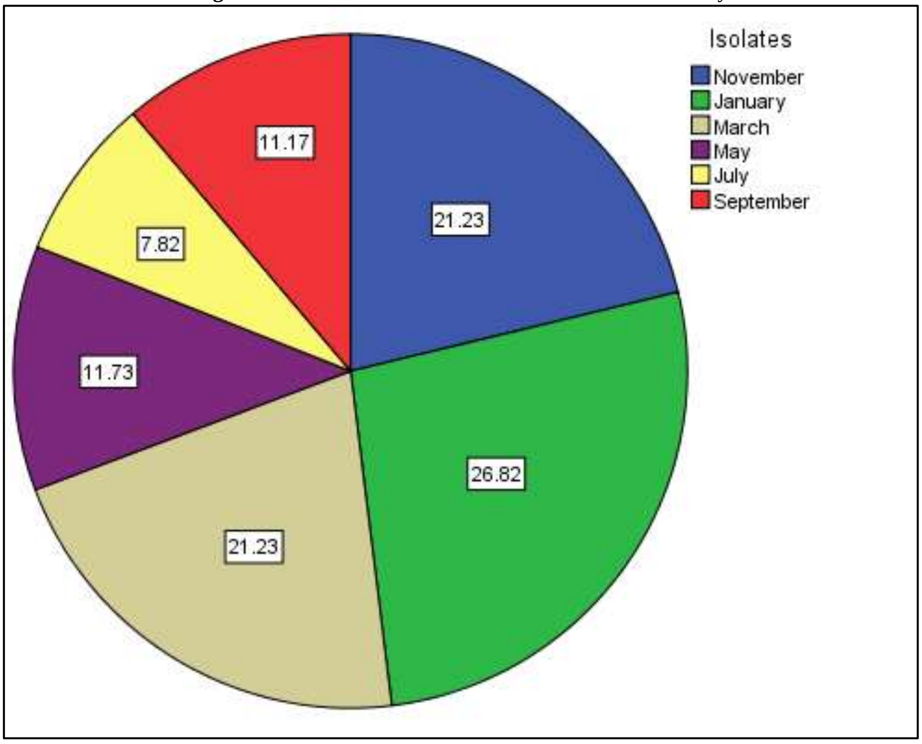


Figure-4. Occurrence of the isolates based on months of study



Based on the number of isolates in a season (Figure 5), most of the isolates have high occurrence in dry season except for *Cladosporium cladosporioides* and *Aspergillus nidulans* that occurred higher in wet season. In both season, the isolates with higher occurrence were *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger*, while *Penicillium* species were high only in dry season.

Figure 6 shows the percentage occurrence of the isolates based on season. *Aspergillus lentulus, Aspergillus fumigatus, Aspergillus flavus, Aspergillus nidulans, Aspergillus niger, Aspergillus terreus, Cladosporium cladosporioides, Fusarium chlamydosporum, Microsporum canis, Penicillium* and *Mucor* species were 0.81%, 31.45%, 26.61%, 0.81%, 16.13%, 2.42%, 0.81%, 4.84 %, 4.03%, 11.29% and 0.81%, respectively (dry season) and 0.56 %, 33.52%, 25.70%, 1.68%, 16.76%, 1.68%, 2.79 %, 4.47%, 3.35 %, 8.94 % and 0.56 %, respectively (wet season).

Figure-5. Number of each isolates according to Season

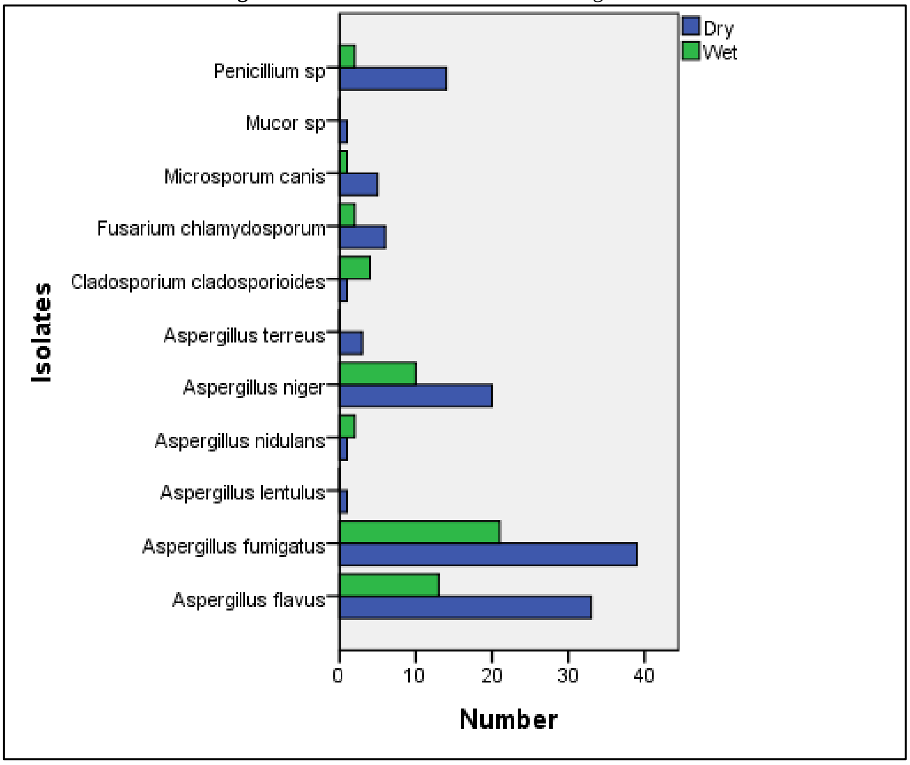
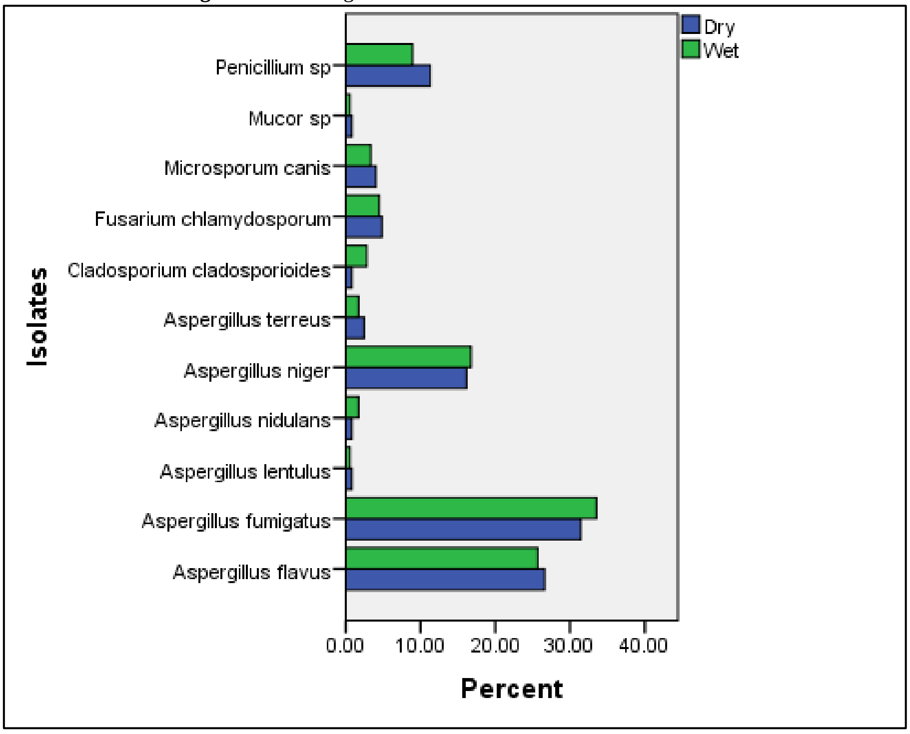


Figure-6. Percentage occurrence of the isolates based on season



4. Discussion

Based on Figures 1 and 2, there is an indication of seasonal influence in the distribution of fungi aerosols around the market The findings of this study agree with previous report that indicates that fungi density in air is higher in dry season compared to wet season [4, 7]. The wet season (characterized by low temperature and high relative humidity) enhances sporulation and subsequent release in the dry season (that is characterized by higher temperature and low relative humidity). Authors have reported that this accounts for higher fungi density in the environment during the dry season [4, 6].

Based on Figures 3,4,5,6, the isolates recorded in this study have been widely reported in different environments including dumpsite [4, 6, 7], University environment (Cafiteria, Toilets, Laboratory and laboratory preparatory rooms) [2], health centres [9, 17]. Studies have shown that *Aspergillus* species has the highest frequency in the ambient environment [2, 6, 7, 17]. This corresponds with findings of this study.

Many of the isolates in this study are found in the environment specially the soil and have been implicated in human and animal diseases especially in immunosuppressed patients. Some of the diseases caused by the *Aspergillus* species isolated include otitis, keratitis, acute and chronic invasive sinusitis, pulmonary and systemic infections and cutaneous aspergillosis, wound infections and osteomyelitis following trauma and inoculation (*Aspergillus flavus*)**;** otomycosis which could lead to pain, temporary hearing loss, and, in severe cases, damage to the ear canal and tympanic membrane (*Aspergillus niger*) [18]; invasive aspergillosis (*Aspergillus lentulus*), while *Aspergillus nidulans* and *Aspergillus terreus* have been occasionally reported as a pathogen of humans and animals [16]. The tendency of *Aspergillus nige*r to cause human disease depends on the amount of spores inhaled as well as the immune system of the exposed individuals.

According to Manisha and Panwar [18], *Aspergillus fumigatus* causes allergic aspergillosis which is characterized by running nose, itchy eyes, or swelling of the throat; and invasive aspergillosis which is characterized by nose stuffiness, headache, facial discomfort, cough, fever, and chest pain. This includes invasion and damage of tissues that can be wide spread and rapidly fatal. The authors further reported that Aspergillosis is the second most common fungal infection that requires hospitalization. In addition, some species are known to produce toxins such as aflatoxins and ochratoxins which could lead to liver cancer and renal tumour [4, 19].

Cladosporium species are frequently isolated in air just like *Aspergillus* species*. Cladosporium cladosporioides* is one of the species of medical interest [16]. Many species of *Fusarium* are plant pathogen, while some are opportunistic pathogens in humans causing hyalohyphomycosis, mycotic keratitis and onychomycosis [16, 20]. Some species are known to produce mycotoxins. Diseases such as Onlyai disease and Leukoencephalomalacia could be caused by *Fusarium* mycotoxins such as Moniliformin and Fumornisins, respectively [19]. According to Ellis, *et al.* [16], *Fusarium chlamydosporum* is commonly isolated in soils and rhizosphere of some vascular plants. Many species of *Penicillium* produce mycotoxin which contaminates food (food poisoning). Some of the toxins include Citrinin and Cyclopiazonic acid which could lead to kidney disorder and Kodua poisoning, respectively [4, 19]. Diseases caused by *Penicillium* species in human is not common, but opportunistic infections leading to mycotic keratitis, otomycosis and endocarditis have been recorded [16, 21]. Some *Mucor* species can cause opportunistic infection and attack the immuno-suppressed patients causing serious human diseases [18]. For instance *Mucor mucedo* can cause zygomycosis [18]. *Microsporum canis* is a common cause of ringworm in humans invading the skin and hair, and animals such as cats and dogs can be carriers of these fungi [16].

All through the study period there was preponderance of *Aspergillus fumigatus, Aspergillus flavus* and *Aspergillus niger*, while others such as *Fusarium chlamydosporum* and *Penicillium* species occurred 66.67% (4 out of 6 months of study). These 5 isolates were considered predominant in the area and may be attributed to human activities within the market vicinity. These predominant isolates have been reported in air and soil. While others that occurred in ≤50% (or ≤3 out of 6 months) of the study period were considered opportunistic. For instance, *Aspergillus lentulus, Aspergillus nidulans, Aspergillus terreus, Cladosporium cladosporioides, Microsporum canis* and *Mucor* species occurred sequentially viz November; March and September; March; January, May and July; November, March and May; and January Their occurrence suggests occasional human activities. For instance, ringworm may have stemmed from someone that have pets at home or an unintentional inoculation of commodities by an individual with ringworm infection.

5. Conclusion

The study evaluated the mycological quality of air environment around a market along East-West road in Bayelsa State Nigeria. The study found seasonal influence in the distribution of fungi-aerosol around the market. Also 5 out of the 11 species isolated throughout the study were predominant occurring in (≥66.67%) of the study months. Most of the species are mainly found in the soil, while others are opportunistic. Some species are known to cause diseases in human and produce toxins that are injurious to health. Hence, there is need to sensitize individuals that buy and sell, and reside around market environments to maintain high personal hygiene and practices that would forestall the preponderance of spores and its inhalation via aerosols in the vicinity.

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