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AIRBORNE FUNGI IN THE INDOOR AND OUTDOOR ENVIRONMENTS OF A HIGHER INSTITUTION IN NIGERIA

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ABSTRACT
Airborne fungi play an important role in causing allergy and infection in susceptible people. This study was conducted to assess the level of airborne fungi contamination in different indoor and outdoor sites of Akanu Ibiam Federal Polytechnic, Unwana, Ebonyi State, Nigeria using the open plate method. Colonies grown on Sabouraud dextrose agar and Potato dextrose agar were counted and identified by standard methods. A total of 133 colonies were found comprising of 6 genera. *Cladosporium* sp was the dominant genus (47.4%) followed by *Penicillium* sp (19.5%), *Aspergillus* sp (15.8%), *Alternaria* sp (7.5%), *Rhizopus* sp (6.0%) and *Fusarium* sp (3.8%). Fungi were more prevalent in outdoor sites (57.7%) than indoor sites (42.9%). *Cladosporium* sp, *Penicillium* sp and *Aspergillus* sp were the most common fungi found indoors and outdoors. From the results obtained, there is need for proper attention to the quality of the indoor and outdoor environments.

KEYWORDS: Airborne fungi, *Cladosporium, Alternaria, Aspergillus,* Diseases.

INTRODUCTION

Man requires clean air in his dwellings especially in indoor environments where about 90% of his time is spent working or resting (Lingnel, 2008; Ayanbimpe *et al*., 2010). School age children spend 20% of their time in schools (Clench-Aas *et al*., 1999).Unfortunately; there are strong indications that in many parts of the world, our homes, schools and work places are heavily contaminated with airborne moulds and other biological contaminants (Dales *et al*., 1997; Horner *et al*., 2004). According to Chandeganipour *et al*. (2010), all atmospheric air, whether indoor or outdoor, contains certain varieties and some fungal spores. Previous studies have shown that airborne fungal spores are very important sensitizing agents in allergic respiratory diseases such as asthma and rhino-conjunctivitis (Chapman, 1999; Green *et al*., 2006). Similarly, allergic bronchopulmonary aspergillosis and fungal sinusitis may be found in susceptible or immunocompromised individuals through mould exposure (Ritz and Amman, 2005; Simon-Nobble and Denk, 2008). Also, many different airborne fungi can act as etiologic agents of otomycosis, keratmycosis and onychomycosis (Larone, 1987; Rippon, 1988). The predominant genera of airborne fungi causing health concern are *Alternaria*, *Aspergillus*, *Cladosporium* and *Penicillium* (Su *et al*., 2001; Hung *et al*., 2011).

Public health researchers and practitioners are increasingly aware of the adverse health effects of airborne fungi exposure to the public, and, efforts should be made to enlighten the general public and the government authorities on these. However, in most developing countries like Nigeria, very little is done in this regard. This part of the world present abundant factors which favour dampness of building and concomitant contamination of indoor air by fungi (Ayanbimpe, 2010). According to O'connor *et al*. (2004), higher concentrations of fungi were found in houses with dampness problem, cockroach infestation and cats. There are, however, few studies which have evaluated airborne fungi contamination in this kind of facility in this part of the world, where buildings are sited indiscriminately without consideration for environment hygiene or sanitation. This study is aimed at determining the prevalence of airborne fungi in the indoor and outdoor environments of Akanu Ibiam Federal Polytechnic, Unwana, Ebonyi State, Nigeria, with a view to enlighten the responsible authorities of possible health hazard associated with such fungal exposure.

MATERIALS AND METHODS

The investigation was carried out in Microbiology Laboratory, Department of Science Laboratory Technology, Akanu Ibiam Federal Polytechnic, Unwana, Ebonyi State, Nigeria between September and October, 2011.

The open plate method was adopted for the analysis. A total of forty plates of Sabouraud dextrose agar (SDA) containing chloramphenicol (SC, Merck, Germany) and Potato dextrose agar (PDA, Merck, Germany) were prepared. Twenty plates were exposed in indoor and twenty plates in outdoor environments of hostels and students' sit- outs respectively. The indoor locations were in the rooms of the hostel. Two plates each of the different agar mediums were exposed in rooms 2, 15, 34, 46 and 68. The other twenty plates were exposed two each of the different agar mediums in outdoor locations which include: Alluta bus stop, NYSC bus stop, Mechanical village and Rotract Park. The plates were exposed when students were present in these locations. These plates were exposed in these strategic points on the same day, between the hours of 11a.m-4p.m (4 hours), after which they were

covered, labeled and transported to the laboratory. The culture plates were incubated at room temperature (26-30 ^{0}C) until growth appeared. Physical counts of the fungal colonies were made and averages of the isolation for each set of samples obtained were taken. Isolates were identified based on cultural and microscopic characteristics with the aid of standard mycological texts and manuals (Larone, 1995; DeHoog *et al*., 2004)

RESULTS

A total of 133 colonies were isolated. The genera of isolated airborne fungi depending on frequency in number of colony counts were classified as predominant and less frequent isolates. The dominant species were members of the genera *Cladosporium* sp (47.4%), *Penicillium* sp (19.5%) and *Aspergillus* sp (15.8%). The less prevalent were *Alternaria* sp (7.5%), *Rhizopus* sp (6.0%) and *Fulsarium* sp (3.8%) (Table 1and Figure 1).

TABLE 1: Total mean frequency of airborne fungal isolates from indoor and outdoor environment.

Fungal genera	Average Number isolated	Percentage
Cladosporium sp	63.0	47.4
Penicillium sp	26.0	19.5
Aspergillus sp	21.0	15.8
Alternaria sp	10.0	7.5
Rhizopus sp	8.0	6.0
Fusarium sp	5.0	3.8

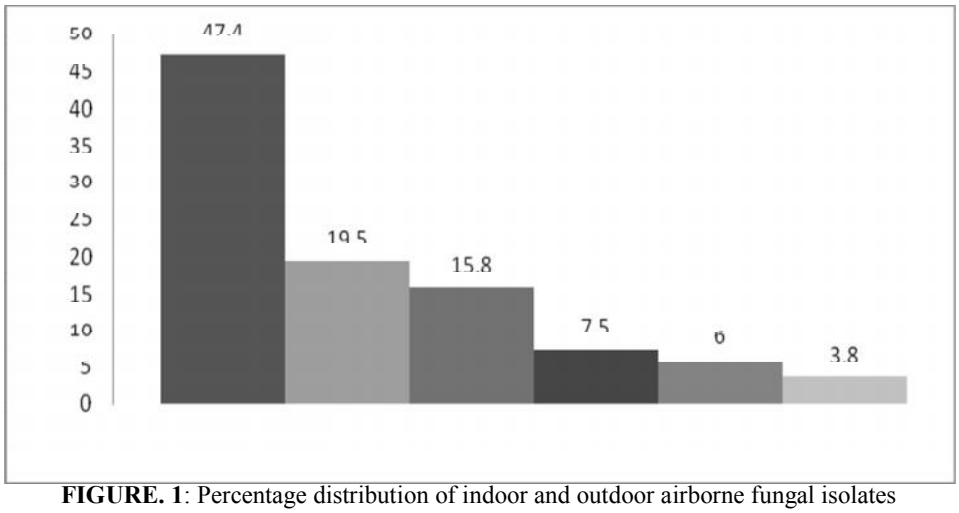

FIGURE. 1: Percentage distribution of indoor and outdoor airborne fungal isolates

Indoor

In indoor environment, *Cladosporium* sp (50.9%) was the dominant genus, followed by *Penicillium* sp (17.5%), *Aspergillus* sp (15.8%), *Alternaria* sp (7.0%), *Rhizopus* sp (5.3) and *Fusarium* sp (3.5%) (Table 2).

TABLE 2: Mean frequency and percentage of airborne fungal isolates from indoor environment.

Fungal genera	Average Number of isolates	Percentage
Cladosporium sp	29	50.9
Penicillium sp	10	17.5
Aspergillus sp	9	15.8
Fusarium sp	4	7.0
Rhizopus sp	3	5.3
Alternaria sp	2	3.5
Total	57	100

Outdoor

In outdoor environment, *Cladosporium* sp (44.7%) was also the dominant genus, followed by *Penicillium* sp (21.1%), *Aspergillus* sp (15.8%), *Alternaria* sp (10.5%), *Rhizopus* sp (6.6%) and *Fusarium* sp (1.3%) (Table 3). The rate of isolation fungi outdoors (57.1%) was higher than indoors (42.9%).

TABLE 3: Mean frequency and percentage of airborne fungal isolates from in outdoor environment.

Fungal genera	Average Number of isolates	Percentage
Cladosporium sp	34	44.7
Penicillium sp	16	21.1
Aspergillus sp	12	15.8
Alternaria sp	8	10.5
Rhizopus sp	5	6.6
Fusarium sp	1	1.3
Total	76	100

DISCUSSION

This study is unique because it described culturable fungi obtained from indoor air and outdoor air of students' hostels and sit-outs, as little or no study have been carried out on this in this part of the world. *Cladosporium* sp (47.4%), *Penicillium* sp (19.5%), and *Aspergillus* sp (15.8%) were the dominant indoor and outdoor fungi in this study. Other fungal isolates include *Alternaria* sp (7.5%), *Rhizopus* sp (6.0%) and *Fusarium* spp (3.8%). These results are comparable to those from previous study (Shelton *et al*., 2002; Ayanbimpe *et al*., 2010; Chadeganipour *et al*., 2010) who also isolated similar fungi in indoor and outdoor environments. Studies carried out in North, South and Central America has shown that *Cladosporium* sp, *Penicillium* sp, *Aspergillus* sp and *Alternaria* were the prevalent indoor and outdoor airborne fungi (Shelton *et al*., 2002).

In a previous study in Germany, *Penicillium* sp and *Cladosporium* sp were dominant (Herbarth *et al*., 2003). *Cladosporium* sp was dominant in Sudan (Al-Tikriti *et al*., 1980). These are similar to this study. In Greece, *Cladosporium* sp., *Alternaria* sp., and *Ustilago* sp were the most common allergens in patients with respiratory allergy (Gioulekas *et al*., 2004). In indoor air mycroflora of residential dwellings in Jos metropolis, Nigeria, Ayanbimpe *et al*. (2010) isolated *Chaetomium globosum*, *Aspergillus fumigatus*, *Stachybotrys alternans*, and *Alternaria alternata* as the predominant fungi species. Shukla and Shukla (2011) reported *Fusarium* sp., *Alternaria* sp., *Rhizopus* sp., and *Aspergillus fumigatus* as the dominant fungi in airborne fungi spores in the atmosphere of Industrial town of Korba-Chhattisgarh, India. This contradicted the present study where *Cladosporium* sp is the most dominant. The of isolation of *Rhizopus* sp in this study may not be unconnected to many refuse dumps in close proximity of hostels and near absence of waste disposal facilities in the school. This fungus is not one of the frequently reported indoor air fungi (Ayanbimpe *et al*., 2010). The rate of fungi isolation outdoors was higher than indoors. This observation is consistent with the hypothesis that outdoor air has an important influence on indoor air quality (Shelton *et al*; 2002). Higher isolation rates were made at the Alluta bus stop, probably due to poor ventilation, poor sanitation, and overcrowding. This corroborates earlier reports that population density affects the quality of environment (King and Pierre, 2002). This is the area where many students sit in wait of lectures and to while away time. Allergenic spores dispersed by airborne fungi play an important role in underlying cause and exacerbation of allergic disease (Chadeganipour *et al*., 2010). The risks associated with toxin producing fungi indoors have been stressed variously (Kuhn and Ghannoum, 2003; Straus and Wilson, 2006). The presence of toxin producing fungi like *Aspergillus* sp and *Alternaria* sp in indoors should be a cause for concern considering the potential risk of mycotoxicosis (Ayanbimpe *et al*., 2010).

Most countries of the world have identified *Aternaria* sp., *Aspergillus* sp., *Cladosporium* sp., *Penicillium* sp and *Ulocladium* sp as the most common allergens in their environment (Chadeganipour *et al*., 2010). These fungi but *Ulocladium* was isolated in this study raising fear of possible allergic respiratory disease in the area under study.

Airborne fungi exposure cannot be completely wiped off but can be reduced. Many people are unaware of the role fungi play in the world around them and researches on fungal diseases are not given the seriousness they deserve especially in developing countries. Hence, there is the need for regular surveillance of the air to ascertain the level of contamination and probable risk of exposure of residents to fungi. Projections of the percentage prevalence of fungi in the school environment, the environment may be prone to some fungi related health issues of various forms and levels, like the superficial mycoses, cutaneous mycoses, subcutaneous mycoses to systematic or deep mycoses; which is able to infect internal organs and become widely disseminated throughout the body, this type is often fatal. (Fungi Diseases, 2011)

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