

Studies On Indoor Airborne Fungal Spore Concentrations At Tumkur, India

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KEYWORDS	ABSTRACT
Air Samples, Fungal Spores, Indoor Environment, Andersen	The aim of the study was to evaluate the prevalent species of airborne fungi in the indoor environment of the selected stations of Sri Siddhartha Medical College, Tumkur such as Microbiology Department, Canteen, Boys Hostel, PG Hostel, Quarters and Central Library . Air samples were collected for four months bimonthly by Andersen Two Stage Sampler via Petri Plates with Potato Dextrose Agar culture media during the months of May to September, 2024. In this investigation, among fourteen spore types, <i>Cladosporium</i> was the most prevalent fungal genera followed by <i>Aspergillus flavus</i> , <i>Aspergillus niger</i> , <i>Penicillium</i> , <i>Rhizopus</i> and <i>Fusarium</i> . This investigation indicated to be quite significant for taking prospective corrective recommendation and possible in terms of health to control diseases measures

INTRODUCTION:

Air is an important natural life sustaining resource. Human activities are continuously modifying the air. These modifications have serious effects on animals, plants and humans. Healthy human breaths about 25,000 times per day at a rate of 0.1-0.2 liters of air per breath, hence, air we breathe must be free from pollution and of good quality. 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). The 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 fungi 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 of fungal spores. Previous studies have shown that airborne fungal spores are very important sensitizing agents in allergic respiratory diseases such as asthma and rhinoconjunctivitis (Chapman, 1999; Green *et al.*, 2006). Similarly, allergic bronchopulmonary *aspergillosis* and fungal sinusitis may be found in susceptible or immune compromised individuals through fungal exposure (Ritz and Amman, 2005; Simon - Nobble and Denk, 2008). 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. Efforts should be made to enlighten the general public and the government authorities on these. However, in most developing countries like India, 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. 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.

Airborne fungi are considered to act as indicator of the level of atmospheric bio-pollution. The presence of fungal spores, volatiles and mycotoxins in the air can cause health hazards in all segments of the population (Kakde *et al.*, 2001). Airborne fungal spores are ubiquitous in nature. Much of our knowledge on the behaviors of airborne spores comes from various studies on the epidemiology of plants, animals and human diseases, especially infections of the respiratory tract and allergy. More than 80 genera of fungi have been associated with respiratory tract allergy (Horner *et al.*, 1995). Most of the allergenic fungi are classified under

Ascomycetes and Deuteromycetes with a few in Basidiomycetes (Kurup *et al.*, 2000). Some genera of airborne fungal spores such as *Alternaria*, *Aspergillus*, and *Cladosporium* are found throughout the world. The types of fungi and its number are vary with time of day, weather and seasonal fluctuations, condition of the surrounding areas, climatic conditions and the presence of a local source of spores (Pepeljnjak and Segvic Klaric, 2003).

The objectives of the investigations are determining the fungal load in the air environment of selected indoor stations of Sri Siddhartha Medical College, Tumkur and determining the correlation between microbial load with meteorological parameters such as temperature, humidity and rainfall. The data generated can serve as an air quality Index, indicator of level of pollution with respect to biological factors and thus can be used for establishing newer standards to enhance the air quality and in policy making.

MATERIALS AND METHODS:

Air sampling was carried out at the following Indoor stations of Sri Siddhartha Medical College, Tumkur. Using Andersen two-stage sampler was placed in the center of the sampling site at 1.5 meter above the ground level. Malt extract agar was used as sampling medium (Andersen, 1958). Air flow was 28.3 L/min during the sampling and the sampling time is limited to 5 minutes. The study period was from May to September, 2024 at the Central Library, Canteen, Boys Hostel, PG Hostel and Quarters. The air sampled plates were incubated for 5 to 7 days at room temperature and the identification was based on the detailed study of all the microscopic morphological characters of the fungi and their colonies. The results for each stage of the sampler were expressed as colony forming units per cubic meter of air (CFU/m³), as per the Andersen formula. Identification of fungal colonies was based on morphological characteristics and microscopic observations (Brian Flannigan 2001 and Tsuneo Watanabe, 2002).

RESULTS AND DISCUSSIONS:

The Central Library major fungal species were *Cladosporium* 56%, *Curvularia* 13%, *Rhizopus* 11%, *Fusarium* 7%, *Pencillium* 7%, *A. flavus* 3%, *A. niger* 3% and *A. fumigates* 1% their distribution. Maximum fungal count recorded in September (1997), followed by August (1830), July (1724), Aug (1638) and least in May (542). In the month of May *Cladosporium* showed maximum average monthly distribution (56%), followed by *Curvularia* (13%), *Rhizopus* (10%) and *Pencillium* (7%). In the month of June, *Cladosporium* showed maximum average monthly distribution (88%) followed by *A.niger* 5% *Fusarium* (1%) and *A. flavus* (1%). In the month of July, *Cladosporium* showed maximum average monthly distribution (70%) followed by *Fusarium* (12%) and *Pencillium* (9%). In the month of August, *Cladosporium* showed maximum average monthly distribution (79%) followed by *Curvularia* (5.7%), *Pencillium* (8%) and *Nigrospora* (3%). In the month of September *Cladosporium* showed maximum average monthly distribution (82%) followed by *Rhizopus* (5%), *Fusarium* (4%) and *Mucor* (3.8%).

In the Canteen location *Cladosporium* was the major fungi with 66%, followed by *Nigrospora* 12%, *Rhizopus* 7%, *A. fumigatus* 6%, *A.ochraceous* 5%, *A. flavus* 3% and *Fusarium* 2% and their distribution. September has recorded the highest count (1686), followed by August (1417), July (1380), June (1112) and May (753). In the month of May *Cladosporium* was the dominant with average monthly distribution of 65%, *Nigrospora* with 12%, *Rhizopus* 6.7%, *A. flavus* 3% and *A. fumigatus* 5.71%. In the month of June, *Cladosporium* was the dominant fungi with average monthly distribution of 84%, *A.niger* 5.6% and *Rhizopus* 4.15%. In the month of July *Cladosporium* was the dominant with average monthly distribution of 73.1%, *Pencillium* 9.27% and *Mucor* 3%. In the month of August, *Cladosporium* was the dominant fungi with average monthly distribution of 80 %, *Pencillium* 5%, *Alternaria* 3.2 %, and *A.niger* 3 %. In the month of September *Cladosporium* was the dominant fungi with average monthly distribution of 80%, *Fusarium* 2%, *Pencillium* 2% and *Mucor* 5%.

The Boys Hostel dominant fungal species in this area were *Cladosporium* 62%, *Nigrospora* 9%, *Fusarium* 7%, *Pencillium* 6%, *A. niger* 2%, *A. flavus* 5%, *A.ochraceous* 2%, *Alternaria* 1% and *A. fumigatus* 1%. Fungal count was high in August (1861) followed by June (1677), Sept (1593), July (1394) and least in May (826). In the month of May, *Cladosporium* was dominant with average monthly distribution (61%) followed by *Nigrospora* (9%), *Pencillium* (6%) and *A. flavus* (5.2%). In the month of June, *Cladosporium* was dominant with average monthly distribution (91%) followed by *Fusarium* (0.8%) and *A.niger* (2%). In the month of July, *Cladosporium* was dominant with average monthly distribution (74.48%) followed by *A.niger* (1%), *Pencillium* (9.2%), *Mucor* (1.5%) and *Neurospora* (3.5%). In the month of August, *Cladosporium* was dominant with average monthly distribution (76.3%) followed by *Alternaria* (6%) *Pencillium* (4.13%), *Rhizopus* (4.13%), *Trichoderma* (4.83%). In the month of September,

Cladosporium was dominant with average monthly distribution (79.2%) followed by *Pencillium* (3.5%), *Alternaria* (6.2%) and *A.niger* (2.1%). In boys hostel the dominant fungal species in this area were *Cladosporium* 61%, *Fusarium* 15%, *Trichoderma* 14%, *A. niger* 6%, *A. flavus* 2% and *Mucor* (1%). Fungal count was high in August (2011), followed by September (1948), June (1563), July (1346) and least in May (688). In the month of May, *Cladosporium* was dominant with average monthly distribution (60.6%) followed by *Trichoderma* (14.3%) *Mucor* (1.2%) and *A.niger* (6.25%). In the month of June, *Cladosporium* was dominant with average monthly distribution (89%) followed by *A.niger* (5.4%), *Fusarium* (4.38%) and *A. flavus* (1.15%).

In the month of July, *Cladosporium* was dominant with average monthly distribution (82%) followed by *Pencillium* (6.7%) *Fusarium* (11.1%), *A. niger* (1.4%), *Nigrospora* (2.3%) and *Mucor* (3.63%). In the month of August, *Cladosporium* was dominant with average monthly distribution (86%) followed by *Fusarium* (1%), *Pencillium* (5.2%), *Mucor* (0.2%) and *Rhizopus* (3%). In the month of September, *Cladosporium* was dominant with average monthly distribution (84.5%) followed by *Fusarium* (13.6%), *Pencillium* (5.4%), *Rhizopus* (4%), and *A. niger* (3%).

The PG Hostel major fungal species were *Cladosporium* 51%, *Fusarium* 14%, *A.niger* 17%, *Rhizopus* 9%, *A. fumigates* 3%, *Trichoderma* 2% and *A. flavus* 2%. The fungal count was high in the month of August (1886), followed by July (1881), September (1523), June (1453) and April (500). In the month of May which has low fungal count, *Fusarium* with average monthly % distribution of, *Cladosporium* 51%, *A. niger* (17%), *Fusarium* 14.2% and *Rhizopus*(8.6%). In the month of June *Cladosporium* count was 72.1%, followed by *Rhizopus* 12.67%, *Fusarium* 5.3%, *A. niger* 1%, *Pencillium* 4.4% and *Mucor* 0.6%. In the month of July *Cladosporium* was 80.2%, *Pencillium* 6%, *A. fumigatus* 3%, *Neurospora* 3% and *Mucor* 2.28%. In the month of August *Cladosporium* was 84%, *Trichoderma* 2.65%, *Pencillium* 4.5%, *Fusarium* 1.1% and *Alternaria* 1.48%. In the month of September *Cladosporium* was 79.77%, *Pencillium* 5%, *Fusarium* 1.8% and *Alternaria* 5.05%.

In the Quarters location the dominant fungal species in this area were *Cladosporium* 37%, *Rhizopus* 21%, *A.ochraceous* 23%, *A. niger* 10% and *Alternaria* 10%. Fungal count was high in July (1765), followed by June (1728), August (1679), Sept (1418) and least in May (493). In the month of May, *Cladosporium* was dominant with average monthly distribution (33%) followed by *Rhizopus* (18.6%), *Neurospora* (6.69%), *A. niger* (8.7%), and *Trichoderma* (2.43%). In the month of June, *Cladosporium* was dominant with average monthly distribution (80%) followed by *Rhizopus* (5.7%), *Nigrospora* (2.8%), *Pencillium* (2.5%), *Fusarium* (1.7%) and *Mucor* (3.1%). In the month of July, *Cladosporium* was dominant with average monthly distribution (77.33%) followed by *Rhizopus* (8.44%), *A. niger* (7.5%), *Fusarium* (1.25%) and *Pencillium* (7.25%). In the month of August, *Cladosporium* was dominant with average monthly distribution (77.2%) followed by *Alternaria* (5.3%), *Fusarium* (2.5%) *Mucor* (4.5%) *Nigrospora* (4.5%) and *Rhizopus* (3.8%). In the month of September, *Cladosporium* was dominant with average monthly distribution (75%) followed by *Mucor* (9.87%), *A. niger* (4.9%) and *Rhizopus* (6.98%).

Central Library, Canteen, Boys Hostel, PG Hostel, Central Kitchen and Quarters.

During the study the following fungal species were observed *Alternaria*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus ochraceous*, *Aspergillus terreus*, *Cladosporium*, *Curvularia*, *Fusarium*, *Mucor*, *Neurospora*, *Nigrospora*, *Pencillium*, *Rhizopus*, and *Trichoderma*. Among the sampling stations, Central Library showed highest fungal count (12072), following Canteen, (11776), Boys Hostel (11427), PG Hostel (10963), Central Kitchen (10808) and Quarters (10129).

The main reason for variation of the fungal counts is due to the strength and availability of organic matter, highest count in the Central Library is due large amount of organic matter and poor maintained. In the Boys Hostel is due to poor maintained and dampness in the Building, in the Gymnasium the main source is poor maintained. University canteen area had less count due to less availability of organic matter and good maintained and larger area exposed to outdoor. In the month of May which has the least fungal count, *Cladosporium* was the dominant with average monthly % distribution of 56.32 %, *Fusarium* 8.40 %, *A. flavus* 2.7 %, *A. niger* 5.36% and *Neurospora* 1.4 %, *Nigrospora*4.4%, *Trichoderma* 3.2% and *Rhizopus*(6.36%). In the month of June, *Cladosporium* was the dominant with average monthly % distribution 88%, *Fusarium* 2%, *A. niger* 3.41%, *A. ochraceous*1.26% and *Rhizopus* 2%.

In the month of July, *Cladosporium* was the dominant with average monthly % distribution 78%, followed by *Nigrospora*13.3 % *A. niger* 1%, *Fusarium* 0.9 %, *Pencillium* 6.08% and *Rhizopus* 4.9%. In the month of August, *Cladosporium* was the dominant (79%), *Pencillium* (3.4%), followed by *Neurospora* (2.8%), *Nigrospora* (2.3%), *Alternaria* (2.5%) and *Fusarium* (1%). In the month of September, *Cladosporium* was

the dominant fungi (with average monthly % distribution of 80%), *Mucor* 4.6%, *Penicillium* (3.2 %), *A. niger* (2%) and *Rhizopus* (2.41%).

CONCLUSION:

The microbiological quality of the air in investigated rooms was differentiated and changed significantly in the course of the day. Indoor air samples showed higher fungal contamination among isolated fungi there were also strongly allergenic and toxic species such as *Cladosporium*, *Alternaria alternata*, *Aspergillus flavus*, *Aspergillus versicolor*, *Aspergillus niger*, *Penicillium expansum* and *Rhizopus* are reported. From the previous studies all the major fungi observed were potential allergens and some even pathogenic to human, plants and animals. The fungi spores can be main reason for allergy and bronchial problems. The data generated after complete seasonal and diurnal study could be used as additional parameters in establishing new standards in reference to biological parameters. This could become indicators of sanitary system and health regulatory programs. As well set higher bench mark as an indicator organism to enhance the quality status of our sanitation system, solid waste management program and health regulatory programs.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

This study was supported by the Department of Microbiology, Sri Siddhartha Medical College, Sri Siddhartha Academy of Higher Education, Tumkur – 572 107, Karnataka, India.

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