

## Fungal Infections Associated with Libraries

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**Abstract** - The aim of the study is to reveal and identify the harmful effects caused by fungi, and the various causes and types of fungi which are prevalent in the library environment. The inside spores in the air and the outside environment usually mixed with the weather conditions and lead to the generation of newly formed fungi. The survival of library staff and the users now days are challenging phenomena, though there is a remarkable use of electronic sources and the use of World Wide Web. It alarms the professionals to be very cautious and take remedial measures to subside the fungal infections.

**Keywords:** Indoor air, fungal infections, bacteria, airborne fungi, toxic products, fungal diseases.

### I. INTRODUCTION

Libraries are the walled in areas with environment different from outdoor air, polluted with substances posing health hazards. The Indoor air quality is one of the most significant factors affecting the health and well-being of the library professionals who inhale 10m<sup>3</sup> of the air every day and spent between 80-90% of their lives in indoors. The air inhaled by people is abundantly populated with microorganisms like bacteria, viruses and fungal spores. Biological contamination of indoor air is mostly caused by moulds (fungi) they are dangerous as pathogenic living cells by secreting substances harmful for health.

They release of toxic metabolic products, even at a low concentration of microorganisms can cause serious diseases. Librarians and archivists who work with old books and papers are exposed to a wide variety of molds and other microorganisms, some of which are known causes of disease. Some of those diseases are chronic, some fatal. They can affect anyone, whether or not they have been previously sensitized to the organism.

Fungal infections are deep within the body. They are not restricted to any particular part of the body and destroy number of tissues and organs. Nearly many library professionals in the world are infected by fungi. The infections on skin, nails, hair, parts like the respiratory tract, lungs, bones, intestine, liver, kidney, nasal sinuses, eyes and brain are badly affected by fungal infections. Histoplasma (Tuberculosis) is caused by inhalation of spores of

Histoplasma Capsulatum. Cryptococcosis is caused by the inhalation of spores Cryptococcus. Brain abscess (Meningitis) is caused by the inhalation of Aspergillum spores. Cutaneous mycosis affects skin bones and central nervous system CNS. Trichophyteses can affect the intestines causing gastroenteritis. Fungal infections of the nails are also known as onychomycosis, as tinea Unguium, and as ringworm of the nails. Owing to the presence of abundant water, high carbohydrate level and easily available nitrogen compounds in the form of amino acids and proteins in the human body. The presence of moisture or high relative humidity is a sufficient catalyst for the germination and growth of fungal spores. The recent investigation by Wszelaki and Kuzminska 2009 reports that the diseases of vulva and vagina in women are caused by micotic spores which dwell largely in libraries. Pagani and Libshitz 2010 reports that fungal pneumonias in 92 cancer patients is caused by Candida spores, which are the available fungi in many libraries. A 28 year old reader's death revealed by brain biopsy reports the infection of fungal spores (Aspergillosis) died of Aspergilla fungi that can also leads to liver damage and cancer. Trichoplion can cause skin disease. Fungi saprophytes along with bacteria, decay the substance, the growth of fungi enormously multiplied in colonies and lives continuously for more than 400 years in suitable conditions. The role of the fungi in deteriorating the library professional's health and wealth of the library by decomposing the cellulose as biodeteriorating spores. The the mortality rate of library professionals got affected by fungi is very high.

The American Medical Association's Family medical guide "Fungal Diseases of the Lungs" stated that there are several diseases that are caused by fungi, and they primarily infect the lungs. They include blastomycosis, cryptococcosis, histoplasmosis and Coccidioidomycosis. (The fungus causing the last of these diseases is found, oddly enough, in semi-arid desert soil.) Fungal diseases (mycoses) often clear up without treatment, but may spread throughout the body in the bloodstream and cause dangerous complications. Sometimes there are no symptoms; sometimes there are flu-like symptoms; and sometimes a rash, ulcer or warts may appear on the skin. The infection may settle in parts of the body not directly exposed to the pathogen: the meningitis

(membranes surrounding the brain), liver, prostate gland or other organs.

## II. NEED FOR THE STUDY

Although there have been studies on indoor Mycelia (fungal infections) on hospital environment, residential environment, roadside environments, industrial environment. Libraries have received little attention though there is a special need. Specific information on the infections by fungi in library environment and the dire consequences are rarely revealed.

The number of readers spending their time in libraries is growing in a fast phase. Libraries form important habitats for indoor Aeromycoflora and in-depth studies are needed to find out the diseases caused by fungal type and remedial methods to prevent the outgrowth of fungi and their infections. There is a meager information on the indoor fungi with special reference to libraries from tropical semi-arid to tropical zones. Epidemiological studies shows that high concentration of microorganisms in the air can be allergenic. The number of different fungal and bacterial species that can be found in the indoor environment is variable, depending upon the sampling and on the peculiarities of the examined environment.

It is also revealed that 30% of health problems relevant to the indoor air quality are the result of a moulds. Fungal flora can be hazardous for health particularly in rooms with heating, ventilation and air-conditioning and can breed allergies. Symptoms (sick building syndrome) causing irritation of mucous membranes, bad physical condition, tiredness, headaches, vertigo, decrease of concentration, memory and intellectual work ability, dermatitis, respiratory diseases and cancers. Cost effective analysis by the World Health Organization has shown the reduction in indoor air pollution (fungi and bacteria) are cost effective considering the costly treatments of allergies and mortal diseases caused by aggravated indoor air biodeteriorating agents. By continuous promotion of improved indoor air quality in libraries is necessary; an ounce of prevention is worth a pound of cure.

Yulia. P. Nyuksha of the Library of the Russian Academy of Sciences in St. Petersburg has written on this subject and commented in the "Cons Distils" "One of the sources of professional health problems among librarians may be mycoses of lungs and skin. Certain fungi, molds and their spores are spread very widely in library collections, and all of them are potentially dangerous to humans. American standards listed out many of these fungi as dangerous."

## III. REVIEW OF LITERATURE

Realizing the importance of fungal infections associated with library professionals and readers many individual researchers etc, have undertaken several studies at various

libraries under different conditions. A review of available studies presented below.

Agnieszka Kalwasińska, Aleksandra Murkowski, Iwona Walk (2012) in their article "Microbial air contamination in indoor Environment of a university library" expressed that the study was aimed at evaluating the number of bacteria and mould fungi in the indoor and outdoor environment of Toruń University Library.

The sampling sites were located in the rooms serving the functions typical of libraries (i.e. in the Main Reading Room, Current Periodicals Reading Room, Collections Conservation Laboratory, and Old Prints Storeroom, in rooms serving other (non-library) functions (i.e. main hall, cafeteria, and toilet) as well as outside the library building.

The analyses reveal that the concentrations of bacterial as well as fungal aerosols estimated with the use of the impaction method ranged between 101-103 CFU·m<sup>-3</sup>, which corresponds to the concentrations normally observed in areas of this kind. Evaluation of the hygienic condition of the studied areas was based on the criteria for microbiological cleanliness in interiors submitted by the European Commission in 1993. According to this classification, the air was considered to be heavily or moderately contaminated with bacteria, while the air contamination with mould fungi was described as low or moderate. The air in the Old Prints Storeroom was considered the least contaminated with microbial aerosol.

R.N.Tripathi (2009) in his article "Fungal air-spora inside the central library of Gorakhpur university" expressed that the study of the air-spora in the Central Library of Gorakhpur University indicated the presence of 19 different types of fungal spores. Amongst these fauves *Cladosporium* spp, *Curvularia* spp, *Paecilomyces* spp, *penicillium* spp, and *periconia* spp. were more than 80.5% followed by species of *Absidia*, *Alternaria*, *Chaetomium*, *Mucor* *Rhizopus*, *Trichophytona* and *Cercospora*. Fungal spores showed time trends during the study period. The fungal spore concentrations gradually increased from July to September and attained their maximum in September to October and thereafter decreased. Besides fungal spores, small pieces of paper, dust particles and insect derivatives loaded with fungal mycelium and bacterium were also observed throughout the investigation period.

Burge HP, Boise JR Solomon WR, Bandera E (2007) in his article "Fungi in Libraries: an aerometric survey" reveals the possible role of fungi as allergic contaminants in book collections has been investigated in eleven University of Michigan Libraries. Air in the stacks of each of the eleven libraries was sampled on three occasions (2 or 4--10 minute samples on each occasion) with Andersen Volumetric viable particle samplers. Books were handled during sampling in

half the samples each day. In addition on each sampling day a location in the same building away from book storage and an outdoor location were sampled. Library spore levels were generally low. Outdoor levels consistently exceeded indoor levels. Air conditioned (AC) libraries had lower spore levels and indoor/outdoor ratios than conventionally ventilated (CV) libraries. Handling books during sampling increased spore counts in all libraries, but strikingly in CV libraries. Fungus taxa recovered were similar to those encountered in domestic interiors and outside locations in our area. The overall low spore levels and lack of a distinctive library mycoflora suggest that other sources should be sought for library-based respiratory symptoms.

John M. Goldsmith (2006) in their article "Parasitic and Fungal infections of the CNS" stated that there are a considerable number of parasitic infections that can involve the human Central Nervous System "(including the brain, the spinal cord and the eyes). Of these, some infect the CNS as their primary infection site, but many others may only involve then as an uncommon/rare complication or as an ectopic site of infection. Many of these infections are worldwide, some are confined to the tropics and others are more common in areas with poor hygiene and sanitation which is usually found in closed building like libraries and developing areas be they in temperate or tropical regions. There are also a number of fungal pathogens and opportunists that can cause deep (systemic) mycotic infections which may involve the CNS. Most of these fungi have wide geographical distribution although tending to result in sporadic infections only.

Edith Arbach (2006) in their article "Air pollution in Libraries" expressed that another dangerous pollutant in libraries is dust. Since libraries hold large print collections in confined spaces, dust accumulated on books tends to catch and hold high numbers of bacteria and fungi. A survey of dust samples from hospitals, libraries, and institutes in Upper Silesia (Poland) in 1998 showed that the highest mite densities per gram of dust were found on library bookshelves. In 2006, another survey of 219 employees from libraries, archives, and public services in Germany found more complaints of allergies of the respiratory system and the skin among employees of libraries and archives, with dermatitis (inflammation of the skin) diagnosed significantly more often in employees of archives and libraries.

Araujo Reis –Menezes (2003) in their article "A Survey of Fungal Contamination of Books in Public Libraries with Mechanical and Natural Ventilation" stated that the libraries are very propitious environments for the growth of fungi. The great concentration of organic material available for these microorganisms, and often with the lack of adequate ventilation or climate control, would favor this situation. This study was conducted in 2003 to determine the predominant genera of fungi in public libraries by a survey

of fungi contaminating the upper surface of books, with and without air conditioning in the city of São Paulo, Brazil, in the winter and summer, during the respective periods with high and low levels of airborne fungi in that city. Six libraries were chosen, located on the campus of the University of São Paulo, three of them with air conditioning and the other three with natural ventilation. In these six libraries, 31 genera of fungi were identified in total. The genera and frequency of contaminant fungi recovered differed significantly between the libraries with and without air conditioning and in the samples collected in the summer as opposed to the winter. *Cladosporium* was the most frequent in the libraries with and without air conditioning, and in the winter. *Aspergillus* was isolated more often in the summer.

Abby newsletter (1994) in this article "Mould as a Threat to Human Health" stated that the present study was aimed at evaluating the number of bacteria and mould fungi in the indoor and outdoor environment of Toruń University Library. The sampling sites were located in the rooms serving the functions typical of libraries (i.e. in the Main Reading Room, Current Periodicals Reading Room, Collections Conservation Laboratory, Old Prints Storeroom, in rooms serving other (non-library) functions (i.e. main hall, cafeteria, and toilet) as well as outside the library building. The analyses reveal that the concentrations of bacterial as well as fungal aerosols estimated with the use of the impaction method ranged between 101-103 CFU·m<sup>-3</sup>, which corresponds to the concentrations normally observed in areas of this kind. Evaluation of the hygienic condition of the studied areas was based on the criteria for microbiological cleanliness in interiors submitted by the European Commission in 1993. According to this classification, the air was considered to be heavily or moderately contaminated with fungi while the air contamination with mould bacteria was described as low or moderate. The air in the Old Prints Storeroom was considered the most contaminated with microbial aerosol.

The American Medical Association's Family Medical Guide (1987 edition) discusses "Fungal Diseases of the Lungs" on p. 571, saying that there are several diseases that are caused by fungi, and they primarily infect the lungs. They include Blastomycosis, Cryptococcosis, Histoplasmosis and Coccidioidomycosis. (The fungus causing the last of these diseases is found, oddly enough, in semi-arid desert soil.) Fungal diseases (mycoses) often clear up without treatment, but may spread throughout the body in the bloodstream and cause dangerous complications. Sometimes there are no symptoms; sometimes there are flu-like symptoms; and sometimes a rash, ulcer or warts may appear on the skin. The infection may settle in parts of the body not directly exposed to the pathogen.

#### IV. OBJECTIVES OF THE STUDY

1. To estimate the airborne fungi.
2. To identify and determine the factors influencing the growth of fungi and fungal infections.
3. Creating self help methods (protection)
4. To find out integrated dust management methods.
5. To find out toxicological information of fungal types
6. Hazards identification
7. To find out first aid methods, appropriate clinical aid.
8. To find out the resistant mechanism and preventive medicine and biomarks.
9. To find out regulation of environment (controlled defreezing and oxygen deprivation)
10. Handling and keeping methods, shelving, lighting, binding, and boxing, preservation and
11. circulation mechanism and weeding out considerations.

#### V. HYPOTHESIS

1. Extermination, Prevention and control methods have to be worked out to eradicate biodeteriorating fungi.
2. Evaluation of Ventilation methods
3. Protection methods have to be adopted according to the prevailing microbial types.
4. Use of Fumigants, pesticides, use of A Bios system. Installation of purification devices.
5. Use Fungicides.

#### VI. MATERIAL AND METHODOLOGY

- a. The modified Rot rod sampler method for sampling the type of fungi available in the different locations and conditions. Tilak sampler method,
- b. Identification of various spores of fungi and biodeteriorating agents in the library.
- c. Observation of fungal types and growth in colony form units CFU in regular intervals
- d. ANOVA (analysis of variance) to investigate the number of colony forming units relevant to sampling times and locations.

#### VII. SCOPE OF THE STUDY

The research area is confined within the state of Andhra Pradesh. Different libraries located at different locations at different atmospheres are the sampling places for collecting samples of fungi. The study also confines to finding out the samples types, effects and eradication and prevention of fungal deceases.

#### VIII. RESULTS AND DISCUSSION

##### *Spore number and Abundance of fungi*

Almost 16 fungal spores with the spores of unidentified fungi were found through air samples collected from the

sample libraries. The data indicated that there is a great number of Alternaria, Aspergillus Cladosporium, drechslera and Pencillum spore types available on the total spore count and percentage of abundance.

##### *Dust Mycoflora*

The dust samples collected from the floor region and also from the surface of the books were shown for the analysis of fungi both quantitatively and qualitatively by diluting plating and using half a dozen agar media. Six months survey shows the presence of 28 fungal species mostly dominated by Aspergilli, cladosporium, Curvularia, drechslera, Pencillium Rhizopus and various fungi.

##### *Indoor Environment*

The Library situated on the elevated places also suffered maximum book deterioration and health hazards. A range of temperature was observed. The outcome of fungi is aggravated during monsoon and winter seasons. In spite of greater ventilation the fungal diseases were abundant.

##### *Sources and Factors*

Dust, packed material, human interface, surrounding vegetation, poor maintenance of books, no fumigation is seemed to be the major factors in influencing the indoor mycelia.

##### *Deteriorating spore types*

The biological spores and the deterioration in regard to the library books has been worked out. The sampling air inside the libraries shows the presence of many saprophytes which are the well established cellulose decomposers. The elaboration of cellulolytically enzymes and the dry weight loss in paper exhibited by Aspergillums and the evidence of deterioration of books is clearly shown.

Library Indoor environment can be considered as independent ecological area and the investigation would be of immense help not only in detecting the hazardous fungi and also suitable methods to control their effects of varied substances.

##### *Health hazards and Allergenic effects*

The six month survey of mycelia from the indoor library environment reveals the presence of 28 ungal species. From which Alternaria, Aspergillus, Cladosporium, Curvularia, Fusarium, Pencillium and Rhizopus were allergic and causing cold, irritation of eyes nose ears, itching, skin eruptions, fever, headache, vaginal irritation, nervous disorder, mussels slackening, lung infections were found among the visitors of the library.

TABLE 1 MYCELIA ASSOCIATED WITH DUST

Name of the fungi	1.Dust On the floor	2.Dust On the books	3.Dust On the racks
Alternaria alternate	+	+	+
Arocobasidium	+	+	+
Aspergillus	+	-	+
A.flaves	+	-	+
A.fumigatus	-	+	+
A.sydwil	+	-	+
Aversicolor	-	-	+
Cladosporium	+	+	-
C.berbarum	+	-	+
Cunning hamella	+	-	+
Curvularia lunata	-	+	+
C.pallescent	+	-	+
Drechslera halodes	+	+	-
D.rostrata	+	-	+
Fusarium oxysporum	+	+	-
Histoplasma	+	+	+
Mucar racemosus	+	+	+
Neurospora crassa	-	+	+
Penicillium citrium	+	+	+
P.funiculosum	+	-	+
Pestalotiopsis mangiferae	+	+	+
Rhizopus nigricaus	+	+	+
Syncephalastrum	+	+	+
Sterile mycelium	-	+	+
Ttichoderma viride	-	+	+

- 1. Dust on the Library floor
- 2. Dust on the Books
- 3. Dust on the Racks

TABLE 2 PSHYCO – CHEMICAL DATA OF THE DUST

Sampling month	pH			Organic carbon			Moisture		
	1	2	3	1	2	3	1	2	3
Jan	8.5	6.5	8.5	20	10	8	8	6	9
Feb	8	9	7	8.5	20	8	8	7	8
March	11	7	7.5	8.5	15	20	6	8	8
April	11	8	9	9.5	8	9.5	6	6	6
May	15	14	12	20	18	18	6	8	6
June	16	16	8.5	20	18	18	6	6	8

- 1. Lirary floors
- 2. Library books
- 3. Library racks

TABLE 3 FUNGAL SPORE COUNT AND PERCENTAGE

Fungi type	Library floor		Library books		Library racks	
	spores	%	spores	%	spores	%
Alternaria	280	18	345	22.5	225	22.5
Aspergillus	30	1.9	245	18.5	110	8.5
Cladosporium	390	25.4	100	12.5	90	7.5
corynospora	190	12.2	145	9.5	124	9
curvularia	45	2.8	49	2.5	25	3.5
Dresehslera	15	1.0	345	22.5	320	22
Fusarium	15	1.5	5	1.5	20	2
Helminthosporium	35	2.5	5	1	55	4
Monodietys	20	2	75	8.5	20	4
Pencilium	375	26.5	475	26.5	400	26
Pestiotia	45	2.8	-	-	20	4
Pithomyces	55	3.5	20	4	15	2.5
Popularia	110	8.5	-	-	80	7.5
Pithomyces	20	2	-	-	55	4.5
Spegazzinia	110	8	20	5	75	7
Sporidesmium	-	-	10	2.5	25	5
Tetraploa	-	-	4	1	6	2
Torula	40	2.5	35	6	30	5
Unidentified Fungi	220	14.5	200	12.5	225	14.5

Estimated through air sampling

## IX. CONCLUSION

Precautionary measures are to be taken to prevent the outcome of fungal infections contracted in the library to the readers and the staff working in this affected environment. There is a greater need to develop the library environment through the new innovative technological tools and diagnostic preventive steps. There is also a greater need to study the air polluted fungal infections and to make the environment congenial for study .

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