

# Fungal Flora of Various Libraries: A review

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## Abstract

Available literature was collected to fulfill the requirement of present study during September 2017 to march 2018. Research papers were downloaded with the help of web engines from different sites. So many journals visited to search download and collect documents for the same. It was found that about more than 100 fungal species are responsible for spoiling of library materials. Various researchers isolated and identified fungi that are harmful to library. These fungi require moist condition to grow on books. *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *A. sydowii*, *A. versicolor*, *Acremonium*, *Alternaria*, *Aureobasidium*, *Botrytis*, *Candida albicans*, *Chaetomium*, *Cladosporium*, *Cunninghamella*, *Curvularia lunata*, *Fusarium oxysporum*, *Mucor racemosus*, *Neurospora crassa*, *Penicillium citrinum*, *P. funiculosum* and some other species of fungi isolated and identified by different researchers from different location in India and abroad. Study concluded that *Chaetomium globosum*, *Phoma*, *Aspergillus*, *Botrytis*, *Alternaria*, *Curvularia*, *Fusarium*, *Mucor*, *Penicillium* are frequently isolated from library materials. Isolated fungal species are harmful to human beings. If care is not taken place to maintain library from moisture and dust, these types of fungi can grow on library material and can spread diseases among human population.

**Key Words: Library, Fungal Species, Human Population, Web Engines**

## 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 *Aspergillus* spores. *Cutaneous mycosis* affects skin bones and central nervous system CNS. *Trichophytes* 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 bio deteriorating spores. 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.

### 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 meager information on the indoor fungi with special reference to libraries from tropical semiarid 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 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 bio deteriorating 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 vary widely in library collections, and all of them are potentially dangerous to humans. American standards listed out many of these fungi as dangerous."

### 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 Torun 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 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

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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. Mostafa Chadeganipour et al (2013) isolated and identified 1265 colonies of fungi belonging to 26 genera in the air and different surfaces of books (references and circulation departments) and also surfaces of shelves in libraries. *Cladosporium* sp., *Penicillium* sp., *Aspergillus* sp. and *Alternaria* sp. were the most common isolated fungi in libraries of Isfahan University of medical sciences.

Pawar and Kakade (2016) investigated the fungi like *Aspergillus niger*, *A. flavus*, *A. fumigates*, *Penicillium chrysogenum*, *penicillium* sp., *Chaetomium globosum*, *Torula spp*, *Curvularia lunata*, *C. tetramera*, *Cladosporium herbarum*, *Alternaria alternate*, *Fusarium spp.*, *Rhizopus*, *Mucor spp* from library materials of Elphinstone College, Fort, Mumbai-32, Maharashtra, India. They reported that Among the fungal species *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *Penicillium chrysogenum*, *Cladosporium herbarium*, *Chaetomium globosum* were the most dominant species. Fungi like *Aspergillus niger*, *Chaetomium*, *Penicillium*, *Rhizopus* and *Alternaria* were isolated from the books, leather and binding materials in the library.

## MATERIAL AND METHDOLOGY

Available literature was collected to fulfill the requirement of present study during September 2017 to march 2018. Research papers were downloaded with the help of web engines from different sites. So many journals visited to search download and collect documents for the same. About 25 research papers, books and literature was cited during the present review.

During the reading of literature data was collected in the form of tables using excel and word documents. Excel sheet data was very easy to calculate frequency of the particular fungal species.

## RESULTS AND DISCUSION

At the end of literature survey, it was found that about more than 100 fungal species are responsible for spoiling of library materials. Various researchers isolated and identified fungi that are harmful to library. These fungi require moist condition to grow on books. *Aspergillus niger*, *A. flaves*, *A. fumigates*, *A. sydowl*, *A. versicolor*, *Acremoniu*, *Alternaria*, *aurobacidium*, *Botrytis*, *Candida albicans*, *Chaetomium*, *Cladosporium*, *Cunning ghamella*, *Curvularia lunata*, *Fusarium oxysporum*, *Mucor racemosus*, *Neurospora crassa*, *Penicillium citrium*, *P. funiculosum* and some other species of fungi isolated and identified by different researchers from different location in India and abroad.

Several methods were applied by researchers to isolate fungi from library environment. Some used prepared agar plates with nutrient media. Media plates opened for fixed time to settle down spores on media in library. Some were used wet brush to collect spores from library materials example books, papers etc. it was found that Potato agar media and cellulose agar media were used by researchers to isolate library fungi.

Study concluded that *Chaetomium globosum*, *Phoma*, *Aspergillus*, *Botrytis*, *Alternaria*, *Curvularia*, *Fusarium*, *Mucor*, *Penicillium* are frequently isolated from library materials. Isolated fungal species are harmful to human beings. If care is not taken place to maintain library from moisture and dust, these types of fungi can grow on library material and can spread diseases among human population.

## SUGGESTIONS AND RECOMMENDATIONS TO MAINTAIN LIBRARY ENVIRONMENT

1. Preventive and control methods should be applied time to time to eradicate bio-deteriorating fungi.
2. Ventilation methods can be evaluated.

3. Protection methods can be adapted to prevailing microbial types.
4. Fumigants, pesticides, fungicides can be applied time to time.
5. Purification devices should be installed.
6. While entering into library care should be taken to prevent microbial spores along with shoes, slippers etc.

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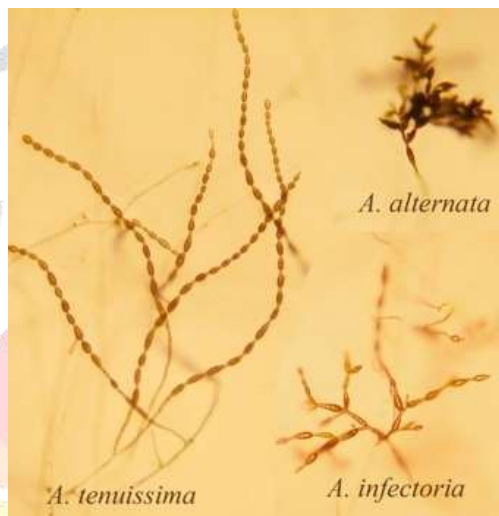
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**PLATE I**



*Penicillium chrysogenum* or *P. notatum*



*Alternaria species*



*Cochliobolus lunatus*



Fungi species isolated on Agar media

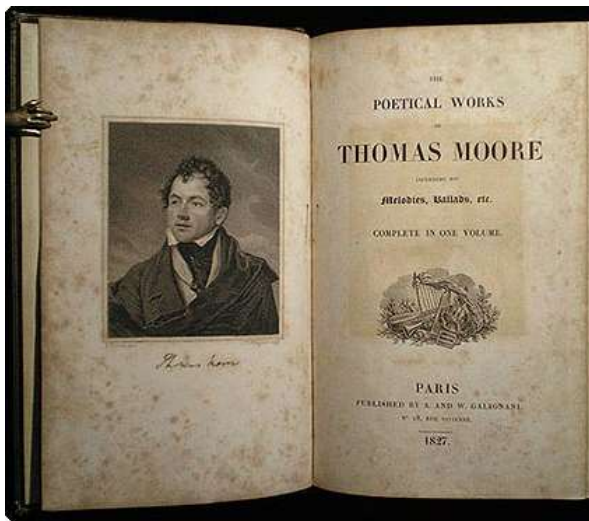


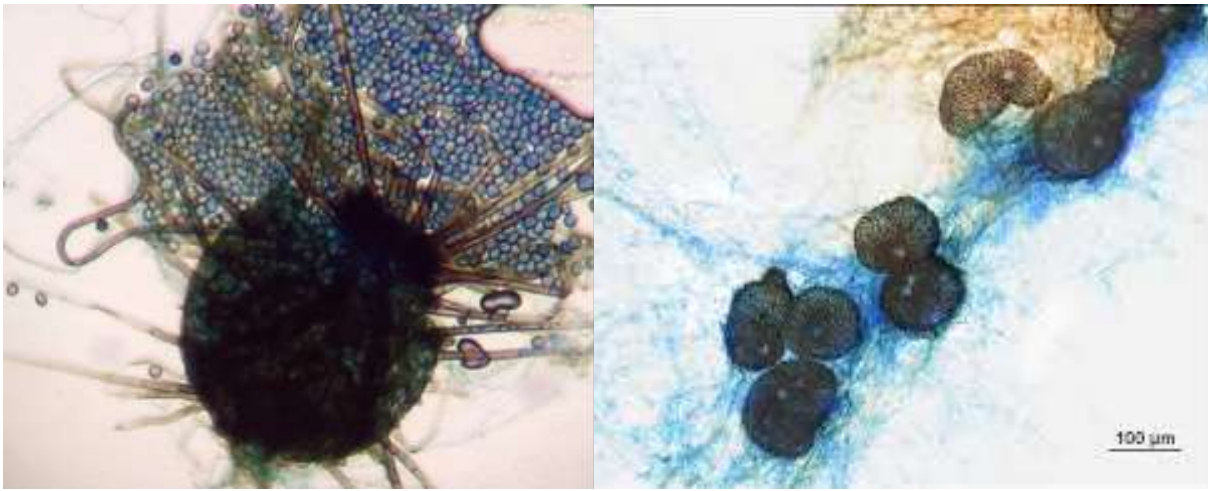
*Aspergillus niger*



*Aspergillus penicilloides*

**Plate II**





*Chaetomium globosum*

*Phoma glomerata*

