



International Research Journal of Public Health (ISSN:2573-380X)



Airborne Fungi in Library Environment and Human Health Risks

Rogério Pereira da Silva^{1*}; Livia Caroline Alexandre de Araújo¹; Taimy Cantillo²; Loise Araujo Costa¹

¹Centro de Ciências Agrárias, Universidade Federal da Paraíba – CCA/UFPB

²Programa de Pós-Graduação em Ciências da Terra e do Ambiente, Universidade Estadual de Feira de Santana –PPGM/UEFS

ABSTRACT

Objective: This review aims to approach the impact that airborne fungi have in collections, mainly in libraries, and also their impact in the health of the people who works and visiting there. **Methodology:** The search was made with the most recent papers, with free access in online databases: Pubmed (National Library of Medicine and the National Institutes), Lilacs (Latin-American and Caribbean Literature in Health Science, acronym in Spanish) and Scielo (Scientific Electronic Library Online), by using key words related with the proposed theme. **Results:** Libraries have substrates and residuals that allow the presence and proliferation of airborne fungi. These fungi are biodeteriorators that attack the collections but also can cause respiratory diseases, mycoses, or even systemic diseases. The most common genera are *Aspergillus*, *Penicillium*, *Cladosporium*, *Alternaria*, *Acremonium* and *Fusarium*. These fungi have asexual reproduction by producing tiny dry spores that can remain viable by long periods on the air and can also be transported on it. Preserve collections demands control of air temperature and humidity, to inhibit the airborne fungi proliferation and thus, decreasing the risks to human health. **Conclusion:** The knowledge about airborne fungi as contaminants in libraries environment it is of utmost importance for the development of preventive actions for preservation of the collections and also for the health of people who works in or visit them.


Keywords: Air quality, documentary collections, Biodeterioration. Occupational health.

*Correspondence to Author:

Rogério Pereira da Silva
Centro de Ciências Agrárias, Universidade Federal da Paraíba – CCA/UFPB

How to cite this article:

Rogério Pereira da Silva; Livia Caroline Alexandre de Araújo; Taimy Cantillo; Loise Araujo Costa. Airborne Fungi in Library Environment and Human Health Risks. International Research Journal of Public Health, 2021; 5:53.

 eSciPub
eSciPub LLC, Houston, TX USA.
Website: <https://escipub.com/>

INTRODUCTION

Libraries are the places where historical information are available, housing human knowledge from different times and ages [1]. Thus, libraries practice an important social role in the inclusion of people, in all their diversity and totality, in the culture of information which main values are accessibility, confidentiality, privacy, diversity, education, learning, preservation and services, contributing for formation and research [2]. Thereby, libraries reconstitute their importance by their function of preserve the history while democratizing the knowledge [3].

The efforts to ensure that the collections present in libraries [books, photographs, fine arts and other items related to cultural heritage and memory] perpetuate to other generations have been worthy of recognition. Such collections require special care in storage and packaging, due to the nature of the material they are made of and because they are exposed to a series of factors that can compromise the information, especially when are in paper form [1,4,5,6].

The spectrum of factors that can damage and destroy the collections on paper is varied, with fungi being one of the always present examples [1,4,6]. These microorganisms can lead to the complete destruction of historical information, in addition to compromising the health of employees who work in the environment and of other people who visit the collections [7,8,9]. The presence of spots as well as fungal structures in the collections can cause irreversible damage; on the other hand, allergic processes can affect the population exposed to the action of fungi [1,8,10,11]. The presence or suspicion of contaminating fungi in a library requires immediate attention.

Airborne fungi have great importance because they are the principal constituents of the atmosphere, especially in closed places with low air circulation [12]. Its spores, the main propagules, are easily transported in the air, amid dust, and are deposited on surfaces in libraries [13]. The composition of airborne fungi in

these environments can vary according to their exposure to the external environment and the various internal factors that contribute to their proliferation [14]. Thus, factors such as low air circulation, variations in temperature and humidity, geography of the area, circulation of people and constant handling of books and other objects by employees and users, favor the dispersion, colonization and inhalation of fungal structures [13,15].

The most commonly airborne fungi recorded in literature as contaminants in library environments belong to the genera *Aspergillus*, *Penicillium*, *Cladosporium*, *Alternaria*, *Acremonium* and *Fusarium* [13,15,16,17]. Such taxa produce large amounts of dry asexual spores that, when dispersed in the air and inhaled, become determinants for triggering allergic diseases, such as asthma and rhinitis, and depending on the degree of infestation, exposure time, and the immune system, they can cause more serious diseases, such as fungal bronchopulmonary allergies or hypersensitive pneumonia [12].

The knowledge of airborne fungi as the main polluting agents of library environments is of paramount importance for the development of preventive actions in order to reduce the presence of such microorganisms, favoring the conservation of the collections, especially those on paper, and the health of people who works in or visit them. In this context, the present work aims to address the impacts that airborne fungi cause in a library environment.

METHODS

This study is a systematic review of the impacts caused by the presence of airborne fungi in library collections and the risks and consequences for human health. For this, a bibliographic search was made in free journals available online in the databases of Pubmed [National Library of Medicine and the National Institutes], Lilacs [Latin American and Caribbean Literature in Health Sciences] and Scielo [Scientific Electronic Library Online], using the following keywords: "Documentary collections",

"aeroallergens", "biodegradation", "occupational health", "anemophilic fungi", "health risks" "air quality".

The inclusion criteria for journals in the research were: relevant studies related to the topic; complete articles published in English, Portuguese or Spanish; published from 1990 to 2020. As exclusion criteria, articles that did not meet the proposed theme or outside the selected period were considered.

RESULTS

It is known that library collections are formed by different types of paper, the main component of which is cellulose, a polysaccharide [1]. Starch glue, cloth and leather are also present in these collections. In addition to dirt and grease residues associated with different surfaces, due to the routine handling and poor conservation by the people who use them [1, 4,15]. All of these elements favor the presence and proliferation of macro and microorganisms that cause serious damage to the historical and cultural heritage stored in these locations [1].

Among microorganisms, airborne fungi are well represented since they are excellent degraders of organic matter, including cellulose [16], being further favored by the environmental conditions that many libraries have as little ventilation and poor illumination, in addition to high temperature and humidity [18]. Under these conditions, the metabolism of fungi intensifies, inducing the production of spores, which commonly propagate in the atmospheric air through dust particles [19]. The deposition of dust particles on the different surfaces in the libraries in addition to the absorption of air humidity, creates a microenvironment auspicious to the germination of spores and the growth of these fungi [1,19]. As a result, the formation of yellowish spots on the papers occurs, which are darker in the center and with light edges, due to cellulose degradation, which can easily affect all library collections causing irreparable damage [6, 9,20].

Quantify spores concentration and identify the fungal community of airborne fungi in these

environments are important aspects that should be monitored [16], since in addition to their action as biodegraders, these microorganisms are potential pathogens to man [21], representing great risks to the health of the workers in these spaces, and to the other people that frequent it regularly. These fungi are allergens and, therefore, they have been responsible for different types of health problems with allergic respiratory manifestations, such as asthma and rhinitis, conjunctivitis, some dermatological diseases, and opportunistic mycoses. In addition, they can produce the Sick Building Syndrome [SBS], which has been listed by the World Health Organization [WHO] since 1982 [7,8, 9]. SBS is characterized by the manifestation of several symptoms, like eyes, nasal and throat irritation, chest problems, fatigue, fever, and many others [7].

These diseases are often associated with exposure to large amounts of fungal spores in the air [22]. However, infectious diseases, caused by the inhalation of different fungi, depend not only on the number of spores inhaled, but also on the deposition site in the respiratory system, which is directly related to the aerodynamic diameter of the spores of the fungus [23]. Particulate matter suspended in the air containing fungi smaller than 5 µm is capable of penetrating the alveoli and causing allergic alveolitis and other serious diseases [23,24]. The more frequent genera of airborne fungi in library environments are *Aspergillus*, *Penicillium*, *Alternaria*, *Cladosporium*, *Acremonium* and *Fusarium* [8,13,25,26]. These fungi reproduce asexually and produce small and dry spores in large quantities, facilitating long stays in the air and wide distribution in the environment [23].

The genus *Aspergillus* can be found in several places and has been reported as one of the most frequent and abundant genera in library environments [13,15,16]. Its spores are numerous and very small, which facilitates its suspension in the air, being able to penetrate the human body through inhalation. Opportunistic lung infections [aspergillosis] are the main type of

involvement, but they can also attack auditory canals, sinuses, corneas and cause onychomycosis [27]. In addition, they are capable of producing aflatoxins [harmful to the liver, great carcinogenic power], which can cause disorders to the individual under favorable conditions [16,27]. The literature reports that few species can cause disease in humans, namely *A. fumigatus*, *A. flavus*, *A. nidulans*, *A. terreus* and *A. niger* [28].

The genus *Penicillium* is also present in a wide variety of environments, especially associated with libraries [13,15,16]. This genus mainly affects immunocompromised individuals, and can cause penicilliosis, an opportunistic mycosis [23]. The most clinically important species is *P. marneffei*, a dimorphic fungus whose infection begins with the inhalation of spores and development within the host cell, spreading to the lymph nodes, liver, spleen, lung, marrow and skin [27]. This species has been considered as one of the world's ten most feared fungi [29]. Currently, the genus *Penicillium* has received great attention since studies have shown the relationship of some species with asthma [30,31].

The *Cladosporium* genus has several species with wide distribution, many of them has been associated with different environments and capable to colonize the most diverse substrates present in library collections [paints, wood, textiles, leather, papers] [3]. The highest prevalence of species of this genus is seen in external environments, but its isolation in indoor environments is quite common, being one of the most frequent airborne fungi in libraries and hospitals [31,32]. Although *Cladosporium* species are rare as human pathogens, they can cause skin infections such as phaeohyphomycosis and lung infections [7].

Another common fungus indoors is the genus *Alternaria*, which, although considered a phytopathogen, some species have been linked to cases of infections in humans, especially in immunocompromised individuals [31]. It has great importance as one of the main genera of allergen fungi, with emphasis on the species *A. alternata sensu lato*. The literature has shown

the association of *A. alternata s.l.* with asthma, hypersensitive pneumonitis, allergic rhinitis [33] and cases of cutaneous phaeohyphomycosis [34,35]. This fungus is more prevalent in dry and hot climates [31].

Acremonium is another genus of fungi that can be frequently found indoors and has already been reported in libraries [8,10,32]. In this environment it is present both in the air and on the surface of books, floors, shelves, cabinets and drawers in file rooms [13]. They usually cause infections in immunocompromised individuals, but are also known to affect those without any underlying immunological problems [36]. *Acremonium* infections can be classified as superficial, locally invasive or disseminated. Allergic diseases can also be caused by this fungus [36,37].

Fusarium species are widely distributed and recognized as important plant pathogens. Many species produce mycotoxins, which are toxic secondary metabolites and can affect human health [31]. Indoors, its spores in the air are potential causes of pathologies. These can vary from localized infections of the skin [dermatomycosis], nails [onychomycosis] and eye infections [keratomycosis, commonly affecting contact lens wearers]. More seriously, *Fusarium* infection can result in sinusitis, pneumonia, thrombophlebitis, endophthalmitis, septic arthritis and osteomyelitis [38].

Studies on airborne fungi as polluting agents of the environment, mainly in libraries, due to their importance in the etiology of allergic and opportunistic respiratory diseases, as well as in different clinical cases of mycoses, are of paramount importance. The confirmation of the contamination is based mainly on the collection and cultures of samples taken from the environments [14]. The diversity of these airborne fungi depends directly on local climatic factors, mainly on temperature and humidity [8]. Such factors influence directly the propagation and germination of fungal propagules and the organic matter decomposition process, since higher values of temperature and humidity favor

the growth and colonization of a greater diversity of fungi ^[1,8]. The wrong planning of the physical spaces of some libraries and the lack of control of these environmental variables generate ideal microclimates for the proliferation of such microorganisms ^[39], compromising the information on the different supports, besides compromising the health of people who work or visit library spaces ^[7,8].

CONCLUSION

Libraries have many conditions that support the presence of a variety airborne fungi, such as armored artifacts inside them, dust accumulated in the rooms, local hygiene, as well as climatic conditions of humidity and temperature. The collections supported in paper represent a substrate quite conducive to the colonization of fungi, due to its structures composed mainly by carbohydrates, and containing other polymers such as proteins, thus becoming a favorable medium to the growth of these microorganisms. A numerous and constant presence of airborne fungi compromises the library collections; besides, many species are potential allergens, triggers of respiratory allergies or even more serious pathologies. So, a constant monitoring of the environment to avoid contamination by airborne fungi is required, as well as the control of atmospheric variables and to adopt adequate measures of sanitation and disinfection, aiming at the preventive conservation of the collections, in order to avoid damage to them and to the health of the people.

REFERENCES

1. Vaillant Callol M. Biodeterioração do patrimônio histórico documental: alternativas para sua erradicação e controle. Rio de Janeiro: Museu de Astronomia e Ciências Afins, Fundação Casa de Rui Barbosa; 2013.
2. Domingo MTS. La función social de las bibliotecas universitarias. Boletín de la asociación andaluza de bibliotecários. 2005, 20[80], 43-70.
3. Ferraz MN. O papel social das bibliotecas públicas no século XXI e o caso da Superintendência de Bibliotecas Públicas de Minas Gerais. Perspect Ciênc Inf. 2014, 19, 18-30.
4. Ogden S, Price LO, Valentin N, Preusser F. Emergência com pragas em arquivo de bibliotecas. Projeto de Conservação Preventiva em Bibliotecas e Arquivos. 2 ed. Rio de Janeiro: Arquivo Nacional. 2001.
5. Mendes A, Santos C, Santiago, P. Preservação do acervo histórico da oficina Guaianases de gravuras. Biblionline. 2010, 56-62.
6. Tribunal Superior do Trabalho. Apostila de Processo de Restauração e Materiais Utilizados. Brasília, outubro de 2012. Brasília: Tribunal Superior do Trabalho. 2012.
7. Sterling TD, Collett C, Rumel D. A epidemiologia dos "edifícios doentes". Rev Saúde Públ São Paulo. 1991, 25[1], 56-63.
8. Pereira SS, Silva ACR, Belo RAS, Ribeiro MM, Rodrigues SFC, Cavalcante RR. Controle da microbiota fúngica em uma biblioteca de uma universidade particular e seu impacto na saúde ocupacional. XIV Encontro Latino Americano de Iniciação Científica e X Encontro Latino Americano de Pós-Graduação – Universidade do Vale do Paraíba. 2010.
9. Moura ML. Qualidade microbiológica do ar em bibliotecas e suas implicações na saúde dos usuários. São Paulo, 2011, 116p. TCC [Graduação]. Fundação São Paulo, Pontifícia Universidade Católica de São Paulo, Faculdade de Ciências Médicas e da Saúde.
10. Ribeiro EL. Fungos na biodeterioração de livros em ambientes bibliotecários nos últimos 35 anos [1977 - 2012]. RBBD. 2013, 9[1], 17-27.
11. Martins SCS, Martins CM. Isolamento e controle químico de fungos filamentosos de documentos e obras de arte do estado do Ceará. Enciclopédia Biosfera, Centro Científico Conhecer. 2013, 9, 17, 2822.
12. Mezzari A, Perin C, Santos Junior SA, Bernd LAG, Di Gesu G. Os fungos anemófilos e sensibilização em indivíduos atópicos em Porto Alegre, RS. Rev Assoc Med Bras. 2003, 49, 270-3.
13. Rosa H, Lemos JA, Costa CR, Silva MRR, Fernandes OFL, et al. Ocorrência de fungos filamentosos em acervo da faculdade de medicina da Universidade Federal de Goiás. Rev Patol Trop. 2008, 37[1], 65-69.
14. Toloza-Moreno DL, Lizarazo-Forero LM, Blanco-Valbuena JO. Concentración y composición microbiana en el ambiente de la biblioteca central Jorge Palacios Preciado de la Universidad Pedagógica y Tecnológica de Colombia, Tunja, Colombia. Actualidades Biológicas. 2012, 97, 34, 241-252.
15. Callegari GM, Novais VP, Bianco ME, Gois RV, Sobral FOS, Marson RF. Ocorrência de fungos de superfícies de livros e avaliação da eficácia do

- ozônio na desinfecção de uma biblioteca do norte do país. *Braz J Surg Clin Res.* 2018, 21[3], 27-31.
16. Duo Filho VB, Siqueira JPZ, Colombo TE. Monitoramento de fungos anemófilos no ambiente de uma biblioteca no município de São José do Rio Preto-SP, Brasil. *Arq Cienc Saúde Unipar.* 2020, 24[2], 75-80.
17. Zielinska-Jankiewicz K, Kozajda A, Piotrowska M, Szadkowskastanczyk I. Microbiological contamination with moulds in work environment in libraries and archives storage facilities. *Ann Agric Environ Med.* 2008,15, 71-78.
18. Pantoja LDM, Rizzoli RS, Carvalho BS, Ferreira VC, Galas KS, Fonseca FRM, Paixão GC, et al. Constituição da microbiota aérea de bibliotecas públicas no município de Fortaleza, Estado do Ceará, Brasil. *Rebci.* 2012, 17, 31-41.
19. Pasquarella C, Sacconi E, Sansebastiano GE, Ugolotti M, Pasquariello GY, Albertini R. Proposal for a biological environmental monitoring approach to be used in libraries and archives. *Ann. Agr. Environ. Med.* 2012, 19, 209-212.
20. Sterflinger K, Pinzari F. The revenge of time: fungal deterioration of cultural heritage with particular reference to books, paper and parchment. *Environ Microbiol.* 2012, 14[3]:559-66.
21. Baxi SN, Portnoy JM, Larenas-Linnemann D, Phipatanakul W, Environmental Allergens Workgroup. Exposure and Health Effects of Fungi on Humans. *J Allergy Clin Immunol Pract.* 2016, 4[3], 396-404.
22. Mendell MJ, Mirer AG, Cheung K et al. Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. *Environ Health Perspect.* 2011, 119:748-756.
23. Saad-Hussein A, Ibrahim KS. Health Impact of Airborne Fungi. In: Laher I. [eds] *Handbook of Healthcare in the Arab World.* Springer, Cham. 2020, 1-16.
24. Pastuszka JS, Tha-Paw UK, Lis DO et al. Bacterial and fungal aerosol in indoor environment in Upper Silesia. Poland. *Atmos Environ.* 2000, 34, 3833-3842.
25. Vaillant M, Valentín N. *Principios básicos de la conservación documental y causas de su deterioro.* Madrid: Instituto del Patrimonio Histórico Español, 1996.
26. Gallo F. Aerobiological research and problems in libraries. *Aerobiologica.* 1993, 9, 2-3, 117-130.
27. Zaitz C, Marques AS, Framil VMS, Campbell I, Ruiz LRB. *Compêndio de Micologia Médica.* São Paulo: Guanabara; 2010.
28. Paulussen C, Hallsworth JE, Álvarez-Pérez S, Nierman WC, Hamill PG, Blain D, et al. Ecology of aspergillosis: insights into the pathogenic potency of *Aspergillus fumigatus* and some other *Aspergillus* species. *Microbial biotechnology,* 2016, 10[2], 296-322.
29. Hyde KD, Al-Hatmi MS, Andersen B, Boekhout T, Buzina W, Dawson TL, et al. "The world's ten most feared fungi". *Fungal Diversity.* 2018, 93, 161-194.
30. Pongracic JA, O'Connor GT, Muilenberg ML, Vaughn B, Gold DR, Kattan M, et al. Differential effects of outdoor versus indoor fungal spores on asthma morbidity in inner-city children. *The Journal of allergy and clinical immunology.* 2010, 125[3], 593-599.
31. Nascimento JPM, López AMQ, Mykaella AA, Araujo LA, Filho EAS. Airborne fungi in indoor hospital environments. *Int J Curr Microbiol App Sci.* 2019, 8[1], 2749-2772.
32. Paixão GC, et al. Ocorrência Fúngica em acervo bibliográfico do município de Fortaleza, Ceará, Brasil. *Rev. Digit. Bibliotecon. Cienc. Inf, Campinas.* 2016,14, 1, 180-191.
33. Pastor FJ, Guarro J. *Alternaria* infections: laboratory diagnosis and relevant clinical features. *Clinical microbiology and infection: the official publication of the European Society of Clinical Microbiology and Infectious Diseases.* 2008, 14[8], 734-746.
34. Raza H, Ortiz RU, Anwar K, Muhammad K. Visceral phaeohyphomycosis caused by *Alternaria alternata* offering a diagnostic as well as a therapeutic challenge. *Saudi journal of kidney diseases and transplantation: an official publication of the Saudi Center for Organ Transplantation, Saudi Arabia.* 2015, 26[2], 339-343.
35. Gomes J, Vilarinho C, Duarte M da L, Brito C. Cutaneous phaeohyphomycosis caused by *Alternaria alternata* unresponsive to itraconazole treatment. *Case reports in dermatological medicine.* 2011, 385803.
36. Das S, Saha R, Dar SA, Ramachandran VG. *Acremonium* species: a review of the etiological agents of emerging hyalohyphomycosis. *Mycopathologia.* 2010, 170[6]:361-75.
37. Suda T, Sato A, Ida M, Gemma H, Hayakawa H, Chida K. Hypersensitivity pneumonitis associated with home ultrasonic humidifiers. *Chest.* 1995,107[3], 711-7.
38. Nucci M, Anaissie E. *Fusarium* infections in immunocompromised patients. *Clin Microbiol Rev.* 2007, 20[4], 695-704.
39. Bortoletto ME, et al. Contaminação fúngica do acervo da biblioteca de Manguinhos da Fundação Oswaldo Cruz: Ações desenvolvidas para sua solução. 2002.

-
- Title: International Research Journal of Public Health
 - ISSN: 2573-380X
 - DOI: 10.28933/IRJPH
 - IF: 1.36 (citefactor)
 - Email: IRJPH@escipub.com
 - TEL: +1-281-656-1158
-



About the journal

The journal is hosted by eSciPub LLC. Our aim is to provide a platform that encourages publication of the most recent research and reviews for authors from all countries.

About the publisher

eSciPub LLC is a publisher to support Open Access initiative located in Houston, Texas, USA. It is a member of the largest community of professional publishers in the United States: the Independent Book Publishers Association. It hosts more than 100 Open Access journals in Medicine, Business & Economics, Agriculture, Biological Sciences, Chemistry, Education, Physical Sciences, Sociology, and Engineering and Technology.

Rapid Response Team

Please feel free to contact our rapid response team if you have any questions. Our customer representative will answer your questions shortly.

CC BY 4.0

This work and its PDF file(s) are licensed under under a Creative Commons Attribution 4.0 International License.

Terms of Use/Privacy Policy/ Disclaimer/ Other Policies:

You agree that by using our site, you have read, understood, and agreed to be bound by all of our terms of use/privacy policy/ disclaimer/ other policies (click here for details). This site cannot and does not contain professional advice. The information on this site is provided for general informational and educational purposes only and is not a substitute for professional advice. Accordingly, before taking any actions based upon such information, we encourage you to consult with the appropriate professionals. We do not provide any kind of professional advice. The use or reliance of any information contained on this site or our mobile application is solely at your own risk. Under no circumstance shall we have any liability to you for any loss or damage of any kind incurred as a result of the use of the site or our mobile application or reliance on any information provided on the site and our mobile application. We may publish articles without peer-review. Published articles of authors are open access. Authors hold the copyright and retain publishing rights without restrictions. Authors are solely responsible for their articles published in our journals. Publication of any information in authors' articles does not constitute an endorsement by us. We make no representation or warranty of any kind, express or implied, regarding the accuracy, adequacy, validity, reliability, availability or completeness of any information that authors provided. more.....