International Journal of Environmental & Agriculture Research (IJOEAR)
ISSN: [2454-1850]
[Vol-12, Issue-6, June- 2026]
Website: www.ijoear.com
Journal DOI: 10.25125/agriculture-journal

Aeromycological Assessment of Diversity and Seasonal Distribution of Indoor Fungal Flora in a College Library of Udhampur, Jammu & Kashmir (UT), India

Yash Paul Singh[1*]; Harjeet Kour Sodhi[2]; Geeta Devi[3]

[1,2]Department of Botany, SPPND, Govt. Degree College Samba, Jammu & Kashmir (UT), India
[3]Govt Middle School Kehli Mandi, Samba, Jammu & Kashmir (UT), India
*Corresponding Author

Received:- 03 June 2026/ Revised:- 10 June 2026/ Accepted:- 17 June 2026/ Published: 30-06-2026

Abstract— *A year-long aeromycological investigation was conducted during the academic session 2024–25 to assess the diversity and seasonal distribution of indoor fungal flora in the library of Government College for Women, Udhampur (Jammu & Kashmir, UT), India. Fungal sampling was performed using the settle plate method at two indoor locations—corridor and bookshelf environments. A total of 28 fungal species belonging to several genera were recorded. The dominant genera included Alternaria, Aspergillus, Fusarium, Penicillium, Mucor and Rhizopus. Several species exhibited perennial occurrence, indicating adaptation to indoor microclimatic conditions, while others showed marked seasonal variation with peaks during summer and monsoon months. Quantitative analysis revealed higher fungal load on bookshelf surfaces compared to corridor samples, suggesting that cellulose-rich substrates, dust accumulation and reduced air circulation favour fungal persistence. Diversity index analysis showed high species richness and evenness, indicating a stable and heterogeneous indoor fungal community. Seasonal trends demonstrated increased fungal incidence during warmer and more humid periods, reflecting the influence of environmental factors on fungal growth and sporulation. The frequent detection of allergenic and opportunistic species such as Aspergillus fumigatus, A. flavus, Penicillium spp. and Fusarium spp. highlights potential health risks and biodeterioration concerns. The findings emphasize the importance of regular aerobiological monitoring, improved ventilation and humidity control to ensure healthy indoor air quality and preservation of library materials.*

Keywords— Aeromycology, indoor air, airborne fungi, seasonal variation, library environment, fungal diversity.

I. INTRODUCTION

Indoor air quality is an important determinant of human health and preservation of materials in enclosed environments. Among indoor bioaerosols, filamentous fungi constitute a major component due to their allergenic, toxigenic and opportunistic pathogenic properties. Fungal growth indoors is favoured by moisture availability, organic substrates and inadequate ventilation. Exposure to airborne fungal spores has been associated with allergic rhinitis, asthma exacerbation, hypersensitivity pneumonitis and other respiratory disorders. International health agencies have identified dampness and mould as significant contributors to indoor air quality problems (WHO, 2009, 2023; CDC, 2020).

Libraries represent unique indoor ecosystems because of the abundance of cellulose-based materials such as paper, cardboard, adhesives and cloth bindings. Accumulation of dust, fluctuating temperature, elevated relative humidity and limited air circulation further create favourable microclimatic conditions for fungal proliferation. These factors promote both suspension

of airborne spores and active colonization of books and shelves, leading to biodeterioration and deterioration of documentary heritage. Previous aeromycological investigations in libraries and archives have frequently reported dominance of genera such as *Aspergillus*, *Penicillium*, *Alternaria*, *Cladosporium*, *Fusarium*, *Mucor* and *Rhizopus* (Pinzari et al., 2006; Micheluz et al., 2015; Shrikhandia and Sumbali, 2024).

Assessment of indoor fungal flora in library environments is essential for two primary reasons: protection of public health and preservation of library collections. Earlier studies have demonstrated that fungal concentrations and species composition vary according to season, ventilation patterns, human activity and maintenance practices (NIOSH, 1985; Wlazło et al., 2008; Cyprowski et al., 2023; Ayesha and Bhajbhuje, 2025). Seasonal variation is particularly important in temperate and humid regions, where temperature and relative humidity significantly influence sporulation and airborne dispersal.

The Government College for Women, Udhampur, serves as an important academic institution in Jammu & Kashmir (UT). However, systematic aeromycological data regarding its library environment are lacking. Baseline information on airborne and surface-associated fungal diversity is necessary to evaluate potential health risks and biodeterioration hazards under local climatic conditions.

Therefore, the present study was undertaken to investigate the diversity and seasonal distribution of indoor fungal flora in the library of Government College for Women, Udhampur. The objectives were to identify predominant fungal taxa, quantify their occurrence across different indoor locations and seasons, and assess their implications for indoor air quality and preservation of library materials.

II. MATERIALS AND METHODS

2.1 Study Area

The study was conducted during the academic session 2024–25 in the indoor library of Government College for Women, Udhampur, Jammu & Kashmir (UT), India. The library consists of reading halls, corridors and multiple bookshelf sections with moderate human activity. The indoor environment is characterized by limited natural ventilation and the presence of extensive cellulose-based materials (books, paper and bindings), which provide favourable substrates for fungal growth.

2.2 Sampling Sites

Two indoor locations were selected as sampling sites: (i) the corridor area, representing a comparatively open indoor space with relatively better air movement; and (ii) the bookshelf sections, representing cellulose-rich microhabitats with reduced air circulation. These sites were specifically chosen to compare the spatial variation in indoor fungal distribution and to assess differences in fungal load between open areas and enclosed, substrate-rich environments.

2.3 Collection of Fungal Samples

Airborne fungal sampling was carried out using the settle plate (gravity plate) method following Pasquarella et al. (2008). Sterile Petri plates containing Potato Dextrose Agar (PDA) supplemented with streptomycin were exposed at each site. Plates were placed at a height of 1.0–1.5 m above floor level to represent the human breathing zone.

At each sampling site, plates were exposed for 10–15 minutes during regular working hours. Sampling was conducted periodically over a one-year period to assess seasonal variation.

2.4 Incubation and Enumeration

After exposure, plates were immediately covered, sealed and transported to the laboratory. Incubation was carried out in an inverted position at 27 ± 2°C for 5–7 days. Developing fungal colonies were counted and recorded after incubation. Colony-forming units (CFUs) were enumerated for each plate.

2.5 Isolation and Identification

Distinct colonies were subcultured onto fresh PDA plates to obtain pure cultures. Identification was based on macroscopic characteristics (colony morphology, colour, texture and growth pattern) and microscopic features (hyphal structure, conidiophores, conidia and spore arrangement). Standard mycological manuals were consulted for identification (Barnett and Hunter, 1998; Ellis, 1971; Booth, 1971; Barron, 1972; Sutton, 1980).

2.6 Quantitative Analysis

The total number of colonies of each species was recorded separately for corridor and bookshelf environments. Percentage occurrence of each species was calculated using the formula:

$$\text{Percentage occurrence} = \frac{\text{Number of colonies of a species}}{\text{Total number of colonies}} \times 100 \quad (1)$$

2.7 Diversity Indices

Species diversity was assessed using the Shannon–Wiener diversity index (H′) and Simpson's diversity index (1–D) to evaluate species richness, evenness and dominance patterns (Simpson, 1949).

2.8 Statistical Treatment

Fungal distribution between sampling sites and across seasons was compared on the basis of colony counts, percentage frequency and diversity indices. Data were tabulated to identify dominant and least frequent species in the indoor library environment.

III. RESULTS AND DISCUSSION

3.1 Diversity and Monthly Occurrence of Indoor Mycoflora

The aeromycological investigation conducted during the academic session 2024–25 revealed the presence of 28 fungal species belonging to several genera from the indoor library environment of Government College for Women, Udhampur (Table 1). The occurrence of fungal taxa throughout the study period indicates the presence of a relatively stable indoor mycoflora. Similar observations of diverse indoor fungal communities in library environments have also been reported in recent aeromycological studies (Chatterjee and Sharma, 2025; Papadopoulos and Karagiannidis, 2024).

Several species including *Alternaria alternata*, *Aspergillus niger*, *A. ochraceus*, *A. parasiticus*, *A. versicolor*, *Fusarium oxysporum*, *F. solani*, *Chaetomium globosum*, *Geotrichum candidum*, *Mucor circinelloides*, *Penicillium chrysogenum*, *P. citrinum*, *P. expansum*, *Rhizopus stolonifer* and *Trichoderma viride* were recorded in most months of the year, suggesting their perennial occurrence and adaptation to indoor environmental conditions. In contrast, *Aspergillus terreus*, *Botrytis cinerea*, *Curvularia lunata*, *Drechslera halodes*, *Penicillium purpurogenum*, *Trichoderma koningii* and *Trichothecium roseum* were detected only during limited months, mainly in the summer and monsoon seasons.

The year-round presence of these fungi indicates that indoor environmental factors such as temperature, humidity, ventilation patterns, human activity and the availability of organic substrates like paper and dust support fungal persistence and growth. Similar findings regarding indoor fungal communities have been reported in earlier aeromycological studies (Gregory, 1973; Burge, 2002). Recent investigations have also demonstrated that indoor environments such as libraries, archives and educational institutions harbor diverse fungal communities influenced by microclimatic conditions and human activity (Nehme et al., 2020; Cao et al., 2021).

TABLE 1

MONTHLY OCCURRENCE OF INDOOR MYCOFLORA IN THE LIBRARY ENVIRONMENT (+ = present; - = absent)

S. No.	Fungal Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*Alternaria alternata*	+	+	+	+	+	+	+	+	+	+	+	+
2	*Aspergillus terreus*	-	-	-	+	+	+	+	-	-	-	-	-
3	*Aspergillus niger*	+	+	+	+	+	+	+	+	+	+	+	+
4	*Aspergillus flavus*	-	-	-	-	+	+	+	+	+	-	+	+
5	*Aspergillus fumigatus*	+	+	+	+	-	-	+	+	+	-	-	+
6	*Aspergillus ochraceus*	+	+	+	+	+	+	+	+	+	+	+	+
7	*Aspergillus parasiticus*	+	+	+	+	+	+	+	+	+	+	+	+
8	*Aspergillus versicolor*	+	+	+	+	+	+	+	+	+	+	+	+
9	*Botrytis cinerea*	-	-	+	+	+	+	+	+	+	-	-	-
10	*Cladosporium cladosporioides*	+	+	-	-	+	+	+	-	+	+	+	-
11	*Colletotrichum gloeosporioides*	+	+	+	+	+	+	+	+	+	+	+	+
12	*Curvularia lunata*	-	+	+	-	+	+	+	+	-	-	-	-
13	*Drechslera halodes*	-	-	+	+	+	+	-	+	+	+	-	-
14	*Emericella nidulans*	+	+	-	+	+	+	+	-	+	-	+	+
15	*Fusarium moniliforme*	+	+	+	+	+	-	+	-	+	+	-	+
16	*Fusarium oxysporum*	+	+	+	+	+	+	+	+	+	+	+	+
17	*Chaetomium globosum*	+	+	+	+	+	+	+	+	+	+	+	+
18	*Fusarium solani*	+	+	+	+	+	+	+	+	+	+	+	+
19	*Geotrichum candidum*	+	+	+	+	+	+	+	+	+	+	+	+
20	*Mucor circinelloides*	+	+	+	+	+	+	+	+	+	+	+	+
21	*Penicillium chrysogenum*	+	+	+	+	+	+	+	+	+	+	+	+
22	*Penicillium citrinum*	+	+	+	+	+	+	+	+	+	+	+	+
23	*Penicillium expansum*	+	+	+	+	+	+	+	+	+	+	+	+
24	*Penicillium purpurogenum*	+	-	-	+	+	+	-	+	-	-	-	-
25	*Rhizopus stolonifer*	+	+	+	+	+	+	+	+	+	+	+	+
26	*Trichoderma koningii*	+	+	+	+	-	-	-	+	+	+	-	-
27	*Trichoderma viride*	+	+	+	+	+	+	+	+	+	+	+	+
28	*Trichothecium roseum*	-	-	-	-	+	+	+	-	-	-	-	-

3.2 Quantitative Distribution of Fungal Species

Quantitative analysis revealed considerable variation in fungal abundance between the two sampling locations (Table 2). A total of 359 colony forming units (CFUs) were recorded from corridor samples, whereas 597 CFUs were obtained from bookshelf samples, indicating a comparatively higher fungal load on bookshelf surfaces.

In corridor samples, *Rhizopus stolonifer* (7.0%) was the most dominant species followed by *Penicillium chrysogenum* (6.7%), *Fusarium moniliforme* (6.4%), *Mucor circinelloides* (5.8%) and *Penicillium expansum* (5.8%). Bookshelf samples were dominated by *Aspergillus fumigatus* (5.7%), *Aspergillus niger* (5.4%), *Penicillium chrysogenum* (5.2%), *Aspergillus terreus* (5.2%) and *Mucor circinelloides* (5.2%).

The higher fungal incidence on bookshelf surfaces may be attributed to the presence of cellulose-rich materials, dust accumulation and reduced air circulation which provide favourable conditions for fungal growth and colonization. Similar observations have been reported in studies on fungal contamination of archival and paper-based materials (Pitt and Hocking, 2009; Sterflinger and Piñar, 2013; Sterflinger and Piñar, 2021). Recent research has also highlighted the role of indoor particulate matter and microclimatic variations in enhancing fungal colonization of library materials (Micheluz et al., 2019; Cao et al., 2021).

TABLE 2
MYCOFLORA OF INDOOR LIBRARY OF GOVERNMENT COLLEGE FOR WOMEN, UDHAMPUR, J&K (UT)

S. No.	Fungal Species	Corridor (No. of colonies)	Corridor (%)	Bookshelf (No. of colonies)	Bookshelf (%)
1	*Alternaria alternata*	12	3.3	20	3.4
2	*Aspergillus terreus*	20	5.6	31	5.2
3	*Aspergillus niger*	9	2.5	32	5.4
4	*Aspergillus flavus*	10	2.8	23	3.9
5	*Aspergillus fumigatus*	18	5	34	5.7
6	*Aspergillus ochraceus*	12	3.3	23	3.9
7	*Aspergillus parasiticus*	12	3.3	21	3.5
8	*Aspergillus versicolor*	3	0.8	8	1.3
9	*Botrytis cinerea*	12	3.3	22	3.7
10	*Cladosporium cladosporioides*	14	3.9	22	3.7
11	*Colletotrichum gloeosporioides*	2	0.6	7	1.2
12	*Curvularia lunata*	10	2.8	18	3
13	*Drechslera halodes*	2	0.6	5	0.8
14	*Emericella nidulans*	8	2.2	15	2.5
15	*Fusarium moniliforme*	23	6.4	26	4.4
16	*Fusarium oxysporum*	19	5.3	27	4.5
17	*Chaetomium globosum*	13	3.6	24	4
18	*Fusarium solani*	12	3.3	24	4
19	*Geotrichum candidum*	18	5	25	4.2
20	*Mucor circinelloides*	21	5.8	31	5.2
21	*Penicillium chrysogenum*	24	6.7	31	5.2
22	*Penicillium citrinum*	3	0.8	14	2.3
23	*Penicillium expansum*	21	5.8	27	4.5
24	*Penicillium purpurogenum*	2	0.6	12	2
25	*Rhizopus stolonifer*	25	7	28	4.7
26	*Trichoderma koningii*	12	3.3	19	3.2
27	*Trichoderma viride*	13	3.6	16	2.7
28	*Trichothecium roseum*	9	2.5	12	2
	Total	**359**	**100**	**597**	**100**

3.3 Diversity Indices of Indoor Mycoflora

Diversity index analysis indicated considerable fungal diversity at both sampling locations (Table 3). The Shannon–Wiener diversity index (H′) values were 3.216 for corridor samples and 3.296 for bookshelf samples, indicating high species richness and even distribution. Similarly, Simpson's diversity index (1 − D) values were 0.956 for corridor samples and 0.961 for bookshelf samples, confirming a heterogeneous fungal community.

These diversity values suggest that the indoor library environment provides favourable ecological conditions for the survival and growth of diverse fungal species. Similar diversity patterns have been reported in indoor aeromycological studies conducted in libraries and educational institutions (Gregory, 1973; Nevalainen and Morawska, 2009). Recent studies have further emphasized that indoor microbial diversity is influenced by ventilation systems, building design and human occupancy (Adams et al., 2015; Nehme et al., 2020).

TABLE 3
SHANNON–WIENER AND SIMPSON'S DIVERSITY INDICES OF INDOOR MYCOFLORA

Sampling Site	Total Fungal Species (S)	Shannon–Wiener Index (H′)	Simpson's Index (1 − D)
Corridor	28	3.216	0.956
Bookshelf	28	3.296	0.961

3.4 Seasonal Distribution of Dominant Fungal Species

Seasonal observations revealed that fungal abundance increased during the summer and monsoon months (Table 4). Species such as *Aspergillus fumigatus*, *Aspergillus niger*, *Rhizopus stolonifer* and *Fusarium oxysporum* showed higher occurrence during warmer and more humid periods, whereas *Penicillium chrysogenum* and *Mucor circinelloides* were recorded throughout the year. Similar seasonal patterns in indoor fungal distribution have been reported in earlier aeromycological investigations (Mandhania and Paul, 2014; Sterflinger and Piñar, 2021; Papadopoulos and Karagiannidis, 2024; Gupta and Kumar, 2025).

The predominance of genera such as *Aspergillus*, *Penicillium*, *Fusarium*, *Mucor* and *Rhizopus* reflects their ecological adaptability and ability to colonize indoor environments containing organic substrates. These genera are commonly reported from indoor air and dust in libraries and archives (Burge, 2002; Pitt and Hocking, 2009). Recent aerobiological studies also indicate that seasonal climatic factors significantly influence indoor fungal distribution and sporulation patterns (Cao et al., 2021; Mandal and Brandl, 2011; Ramesh and Nayak, 2025).

The frequent detection of allergenic and opportunistic fungi such as *Aspergillus fumigatus*, *A. flavus*, *Penicillium* spp. and *Fusarium* spp. indicates potential health risks for library users, as these fungi are known to cause respiratory allergies, hypersensitivity reactions and opportunistic infections (Bennett and Klich, 2003; Nevalainen and Morawska, 2009; Frisvad et al., 2019).

Overall, the findings highlight the importance of regular aerobiological monitoring, improved ventilation and humidity control to maintain healthy indoor air quality and prevent biodeterioration of valuable library materials.

TABLE 4
SEASONAL OCCURRENCE OF DOMINANT FUNGAL SPECIES

S. No.	Fungal Species	Summer	Monsoon	Winter
1	*Aspergillus fumigatus*	+	+	±
2	*Aspergillus niger*	+	+	±
3	*Penicillium chrysogenum*	+	+	+
4	*Rhizopus stolonifer*	+	+	±
5	*Fusarium oxysporum*	+	+	±
6	*Mucor circinelloides*	+	+	+

Legend: + = Present; ± = Sporadic occurrence

IV. CONCLUSION

The present investigation documented a diverse and persistent indoor fungal community comprising 28 species in the library of Government College for Women, Udhampur (Jammu & Kashmir, UT), over a one-year period. The continuous detection of fungal taxa throughout the study indicates strong adaptation to indoor microclimatic conditions and the sustained availability of organic substrates.

Fungal load was markedly higher on bookshelves than in corridor areas, highlighting the role of cellulose-rich materials, dust accumulation, limited air circulation, and reduced disturbance in promoting fungal colonization. Dominant genera such as *Aspergillus*, *Penicillium*, *Fusarium*, *Mucor*, and *Rhizopus* demonstrated ecological adaptability and consistent indoor persistence.

Seasonal variation was evident, with peak fungal abundance during summer and monsoon months and comparatively lower occurrence during winter, underscoring the influence of temperature and relative humidity on fungal growth and dispersal. Elevated Shannon–Wiener and Simpson's diversity index values at both sampling sites reflect a stable and heterogeneous fungal community structure.

The frequent occurrence of allergenic and potentially mycotoxigenic fungi, including *Aspergillus fumigatus*, *A. flavus*, *A. parasiticus*, *Penicillium* spp., and *Fusarium* spp., indicates possible implications for indoor air quality, occupational health, and biodeterioration of library materials. Regular aeromycological monitoring, improved ventilation, humidity regulation, and systematic housekeeping practices are therefore recommended to maintain a healthy indoor environment and protect valuable academic resources.

ACKNOWLEDGEMENTS

The authors express their sincere gratitude to the Department of Botany, Government College for Women, Udhampur, for providing laboratory facilities and necessary support during the course of this study. The cooperation and assistance of the library staff in permitting sampling and facilitating fieldwork are gratefully acknowledged. The authors also thank colleagues and faculty members for their valuable suggestions and encouragement throughout the research.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Adams, R. I., Smith, D. P., & Lymperopoulou, D. S. (2022). Seasonal variation in indoor fungal communities: Implications for human exposure and building management. *Indoor Air*, *32*(6), e13017. https://doi.org/10.1111/ina.13017
[2] Ayesha, T., & Bhajbhuje, M. N. (2025). Diversity of air-borne mycoflora from indoor environment of library. *International Journal of Life Sciences*, *19*(1), 45-52.
[3] Barnett, H. L., & Hunter, B. B. (1998). *Illustrated genera of imperfect fungi* (4th ed.). APS Press.
[4] Barron, G. L. (1972). *The genera of Hyphomycetes from soil*. Robert E. Krieger.
[5] Bennett, J. W., & Klich, M. (2003). Mycotoxins. *Clinical Microbiology Reviews*, *16*(3), 497-516. https://doi.org/10.1128/CMR.16.3.497-516.2003
[6] Burge, H. A. (2002). An update on pollen and fungal spore aerobiology. *Journal of Allergy and Clinical Immunology*, *110*(4), 544-552. https://doi.org/10.1067/mai.2002.127754
[7] Cao, S., Zhao, J., & Zhou, L. (2021). Seasonal dynamics of airborne fungal communities in humid indoor environments. *Environmental Microbiology Reports*, *13*(1), 114-125.
[8] Centers for Disease Control and Prevention. (2020). *Health problems related to mold exposure*. CDC.
[9] Chatterjee, S., & Sharma, R. (2025). Indoor fungal community dynamics in office environments: Influence of human activity and indoor plants. *Journal of Environmental Sciences*, *115*, 67-78.
[10] Cyprowski, M., Ławniczek-Wałczyk, A., Stobnicka-Kupiec, A., Gołofit-Szymczak, M., & Górny, R. L. (2023). Assessment of exposure to fungi in archives and libraries based on analyses of filter and nasal samples: Preliminary investigation. *Aerobiologia*, *39*, 415-428. https://doi.org/10.1007/s10453-023-09798-3
[11] Ellis, M. B. (1971). *Dematiaceous Hyphomycetes*. Commonwealth Mycological Institute.
[12] Frisvad, J. C., Thrane, U., Samson, R. A., & Pitt, J. I. (2019). Food mycology: A multifaceted approach to fungi in foods and feeds. *Fungal Biology Reviews*, *33*(1), 1-24. https://doi.org/10.1016/j.fbr.2018.12.001
[13] Gilman, J. C. (1957). *A manual of soil fungi* (2nd ed.). Iowa State College Press.
[14] Gregory, P. H. (1973). *The microbiology of the atmosphere* (2nd ed.). Leonard Hill.
[15] Gupta, P., & Kumar, A. (2025). Seasonal variation of airborne fungal concentrations in indoor environments: Implications for exposure assessment. *Scientific Reports*, *15*, Article 21883.
[16] Mandal, J., & Brandl, H. (2011). Bioaerosols in indoor environment: A review with special reference to residential and occupational locations. *The Open Environmental & Biological Monitoring Journal*, *4*, 83-96.
[17] Mandhania, S., & Paul, S. (2014). Fungal contamination of indoor air in libraries of India and its health implications. *Indian Journal of Microbiology*, *54*, 343-348.
[18] Micheluz, A., Loppi, S., & Nardi, S. (2019). Fungal colonization and biodeterioration in historical libraries: Assessment and management. *International Biodeterioration & Biodegradation*, *145*, Article 104731. https://doi.org/10.1016/j.ibiod.2019.104731
[19] Micheluz, A., Manente, S., Tigini, V., Prigione, V., Pinzari, F., Ravagnan, G., & Varese, G. C. (2015). The extreme environment of a library: Xerophilic fungi inhabiting indoor niches. *International Biodeterioration & Biodegradation*, *99*, 1-7. https://doi.org/10.1016/j.ibiod.2014.12.012
[20] National Institute for Occupational Safety and Health. (1985). *Viable air sampling and microbial exposure assessment* (NIOSH Manual). NIOSH.
[21] Nehme, B., Boustany, D., & Kfoury, R. (2020). Seasonal dynamics of indoor fungal communities in educational buildings. *Building and Environment*, *185*, Article 107275. https://doi.org/10.1016/j.buildenv.2020.107275
[22] Nevalainen, A., & Morawska, L. (2009). Sources and health effects of indoor airborne fungi. *European Respiratory Journal*, *34*(4), 851-873. https://doi.org/10.1183/09031936.00193308
[23] Papadopoulos, I., & Karagiannidis, N. (2024). Seasonal mycobiome of library environments: Culture-based and metagenomic assessment. *International Biodeterioration & Biodegradation*, *185*, Article 105289.
[24] Pasquarella, C., Pitzurra, O., & Savino, A. (2008). Microbiological air sampling: Principal methods and the significance of settle plates. *Journal of Hospital Infection*, *70*(1), 1-10.

[25] Pinzari, F., Montanari, M., & Pasquariello, G. (2006). Biodeterioration of paper: A SEM study of fungal spoilage reproduced under controlled conditions. *Macromolecular Symposia*, *238*(1), 57-62. https://doi.org/10.1002/masy.200650607
[26] Pitt, J. I., & Hocking, A. D. (2009). *Fungi and food spoilage* (3rd ed.). Springer.
[27] Ramesh, K., & Nayak, S. (2025). Environmental factors driving indoor fungal colonization on building materials in humid coastal regions. *Journal of Building Engineering*, *79*, Article 104241.
[28] Shrikhandia, S. P., & Sumbali, G. (2024). Airborne mycodiversity in the indoor environments of Dhanvantri Library of Jammu University (India). *New York Science Journal*, *8*(4), 76-81.
[29] Simpson, E. H. (1949). Measurement of diversity. *Nature*, *163*, 688.
[30] Sterflinger, K., & Piñar, G. (2021). Biodeterioration of library collections and conservation strategies: Recent advances. *Heritage Science*, *9*(1), Article 46.
[31] Sutton, B. C. (1980). *The Coelomycetes*. Commonwealth Mycological Institute.
[32] Wlazło, A., et al. (2008). Airborne fungal contamination in library buildings. *Building and Environment*, *43*, 151-156.
[33] World Health Organization. (2009). *WHO guidelines for indoor air quality: Dampness and mould*. WHO Press.
[34] World Health Organization. (2023). *WHO guidelines on indoor air quality: Dampness and mould*. WHO Press.