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# INFLUENCE OF ENVIRONMENTAL FACTORS ON THE GROWTH OF BUILDING DETERIORATING FUNGI: *ASPERGILLUS FLAVUS* AND *PENICILLIUM CHRYSOGENUM*

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**ABSTRACT**

The performance of whole building depends on many factors: structure, coating, environment, climate, type of use, service etc. Fungi are essential for the survival of our global ecology but they may pose a significant threat to the health of occupants when they grow in our buildings. The most important factor that affect microbial growth on buildings materials are temperature, moisture and nutrients. The moisture conditions connected with temperature and exposure time are the most important factor for the development of biological problems and damage in buildings. *In vitro* studies were conducted on the effect of temperature, pH levels and moisture on the growth of *Aspergillus flavus* and *Penicillium chrysogenum*. Maximum growth was observed on pH level 6 and 7 against *A. flavus* and *P. chrysogenum* respectively after 12 days. The most suitable temperature for the growth of *A. flavus* and *P. chrysogenum* was observed on 25°C and 30°C respectively. The fungus showed maximum growth at 90% relative humidity.

**INTRODUCTION:** Biodeterioration and "bioremediation" are the two aspects of biodegradation with an anthropomorphicemphasis. Biodeterioration is the breakdown of economically useful substances, often the term is used narrowly to refer to the deterioration of substances that are normally resistant to biological attack such as metals, plastics, drugs, cosmetics, paintings, sculpture, wood products, electrical equipment, fuels and oils, and other objects [1, 2].

The performance of whole building depends on many factors: structure, coating, environment, climate, type of use, service etc. Fungi are essential to survival of our global ecology but they may pose a significant threat to the health of occupants when they grow in our buildings. The most important factor that affect microbial growth on buildings materials are temperature, moisture and nutrients. The humidity (moisture conditions) connected with temperature and exposure time is the most important factor for the development of biological problems and damage in buildings. Moisture problems mostly occur as a consequence of leaks in roofs or in plumbing , capillary movement of water in the structure, but also condensation may takes place in case of poor ventilation [3, 4].

Moisture can be difficult to control in buildings because changes in building design that incorporative vapor and water barriers in walls and heavy insulation reduce the airflow and ventilation.

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The overall functionality of a building is important to keep in mind during design, the structures should be functional, and the ventilation plumbing system together with automation should support the overall functionality [5]. The organic building materials such as paper and wood are sensitive to mould growth when exposed to humidity conditions. Microbes are ubiquitous in building materials, and microbial growth starts when the moisture conditions permit. The source strength of microbial contamination depends on type, extent, age and location of the moisture damage.

Fungi differ in their optimum temperature requirements, but for most the range about 20-30°C. The temperature in buildings, typically 20-25°C, promotes mainly mesophilic microbes that have their optimal growth temperature 20-< 45°C [6, 7]. Most of the fungi grows best in rather neutral circumstances, optimally in pH range 5-6.5 [6]. The growth of mould fungi on buildings is often an early indication of increased humidity and moisture levels, problems caused by mould fungi are mainly discoloration, odor and health disadvantages. Typically, mould fungi in water damaged, finished building are *Alternaria, Aspergillus, Fusarium, Penicillium, Trichoderma* species. The moisture problems in the buildings have been related to the adverse respiratory symptoms, asthma and allergy [8].

## MATERIALS AND METHODS:

**Collection of building materials:** The fungal samples were collected from three different locations i.e. industrial, religious and educational buildings. The sites or walls which have been continuously moist or damaged for a long period of time were chosen for the sampling. The moist spots on the walls were scratched with the help of sterile spatula and then transfer in a sterile polythene bags and stored at 4°C in refrigerator.

**Isolation and identification of building Fungi:** For the isolation of building fungi, culture media such as Sabouraud Dextrose Agar medium (SDA) was prepared and the building fungi were isolated with the help of serial dilution method [9] and direct plate method [10]. The fungus identified with the help of Lactophenol cotton blue staining method [11].

**Effect of Temperature, pH and Moisture on the growth of building deteriorating Fungi:** Sabourand Dextrose Agar medium was prepared and used to evaluate the growth of different isolates. All the experiments of physiological studies were performed in liquid medium [12].

**Temperature:** The temperatures at which the growth of different isolates were studied are 10, 15, 20, 25, 30, 35 and 40°C. A mycelial disc of 5mm diameter of the isolates was inoculated into 100 ml flask containing 20 ml SDA broth. For each treatment three replications were maintained and these flasks were incubated at different temperature levels as motioned earlier for 12 days.

**pH:** The pH at which the growth of different isolates were studied at 5, 6, 7, 8 and 9. SDA broth was prepared and the pH was adjusted by adding either HCL or NaOH to obtain different pH levels. The flask were inoculated with 5mm disc of different isolates, each treatment was replicated three times. These flasks were incubated at 27±1°C for 12 days.

The growths were examined after 12 days and mycelial growth was harvested by filtering through previously dried and weighed Whatman's filter paper No. 42. Filter paper along with the fungal growth was dried in an electronic oven at 60°C for 48 hours, cooled in desiccators and weighed in an electronic balance.

**Moisture** The different relative humidity i.e. 30%, 45%, 60%, 75% and 90% were also maintained with the help of desiccators by using respective salt solutions and acids according to each humidity parameters. Each treatment was replicated three times; the plates were inoculated by placing 5mm disc of different isolates the growth was examined after 12 days.

**RESULTS AND DISCUSSION:** The growth of test fungi have been summarized in **Table 1, 2, 3 and graph 1, 2**. The growth of the *A. flavus* was obtained at all the pH levels tested but it was maximum at pH 6 after 12 days of incubation at 28°C. The pH 5 and pH 7 were also favorable. *P. chrysogenm* showed maximum growth at pH level 7. Growth of the fungus decreased by increasing or decreasing the pH level from the natural level. *Aspergillus flavus* and *Penicillium chrysogenum* showed maximum growth at temperature 30°C.

The fungus grew at the temperature range of 10-35°C. However growth of the fungus was drastically reduce below 20°C and started to decline above 35°C, as these temperatures did not favor for growth of the fungus. The growth of the *A. flavus* was obtained maximum at 25°C and 30°C after 12 days of incubation at 28°C. *P. chrysogenum* grew best at 25°C and 30°C. 75% and 90% relative humidity was showed maximum growth against *A. flavus* and *P. chrysogenum*. Relative humidity 30% and 45% was critical for the growth of *A. flavus* and *P. chrysogenum*. The fungal growth was decreased with decrease in relative humidity.

The optimum temperature for wood decay generally between 20-35°C [13, 14]. Fungi become dominant below at temperature 5°C, upper growth limit is 46°C, but many fungi are not killed at 67°C [13].

"Modelling of mould growth" model based on relative humidity and temperature conditions: Relative humidity 97%/22°C, RH 97%/ 5°C, RH 90%/22°C and RH 90%/5°C [15]. Modeling the time factor in the development of mould fungi in wood the effect of critical humidity and temperatures conditions [16]. Evaluate the growth and sporulation of *Chrysosporium tropicum* and *Trichophyton mentagrophytes*. Both fungi isolated from public parks soil. These fungi showed their maximum growth at 28-30°C and sporulation at 25-35°C temperature. *Chrysosporium tropicum* and *Trichophyton mentagrophytes* showed maximum growth and sporulation at 75%, 50-95% and 95%, 62-95% respectively [17]. It was found that the relative humidity 75% was critical for fungal growth after 12 weeks on different building material [18].

**TABLE 1: DRY MYCELIUM WEIGHT OF *ASPERGILLUS FLAVUS* AND *PENICILLUM CHRYSOGENUM* AT DIFFERENT pH LEVELS (AVERAGE OF THREE REPLICATES).**

| S. No. | pH | *Aspergillus flavus* (gm±SD) | *Penicillium chrysogenum* (gm±SD) |
|---|---|---|---|
| 1 | 5 | 0.460±.036 | 0.332±.022 |
| 2 | 6 | 0.506±.030 | 0.310±.020 |
| 3 | 7 | 0.392±.011 | 0.356±.013 |
| 4 | 8 | 0.355±.022 | 0.322±.036 |
| 5 | 9 | 0.357±.045 | 0.330±.017 |

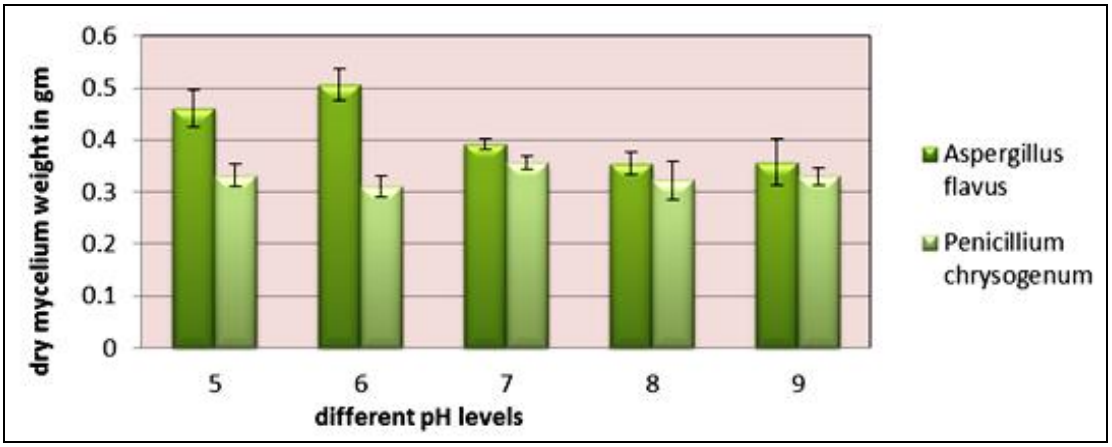
**TABLE 2: DRY MYCELIUM WEIGHT OF *ASPERGILLUS FLAVUS* AND *PENICILLIUM CHRYSOGENUM* AT DIFFERENT TEMPERATURE LEVELS (AVERAGE OF THREE REPLICATES)**

| S. No. | Temperature (°C) | *Aspergillus flavus* (gm±SD) | *Penicillium chrysogenum* (gm±SD) |
|---|---|---|---|
| 1 | 10 | 0.165±.007 | 0.260±.054 |
| 2 | 15 | 0.189±.038 | 0.287±.027 |
| 3 | 20 | 0.196±.002 | 0.314±.015 |
| 4 | 25 | 0.228±.030 | 0.344±.024 |
| 5 | 30 | 0.220±.029 | 0.393±.015 |
| 6 | 35 | 0.193±.029 | 0.279±.012 |

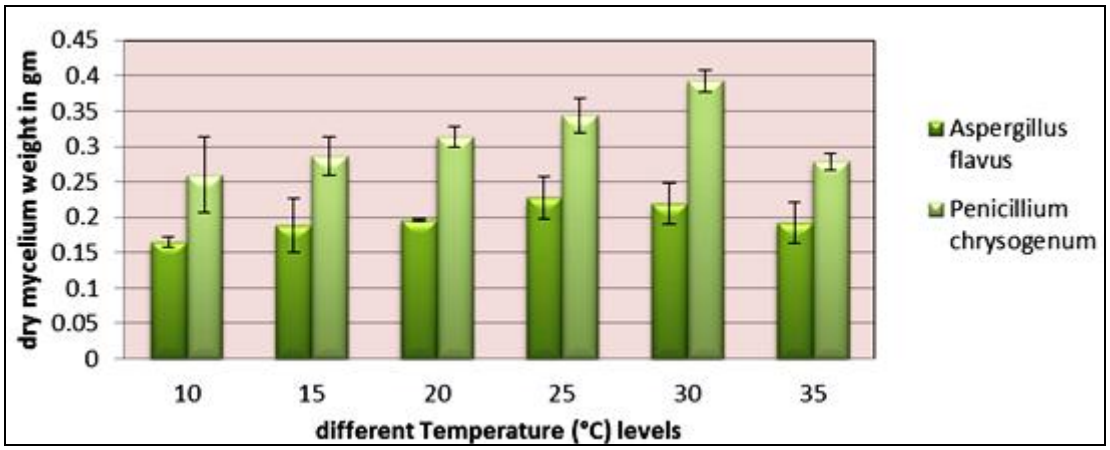
**TABLE 3: EFFECT OF MOISTURE ON THE GROWTH OF *ASPERGILLUS FLAVUS* AND *PENICILLUM CHRYSOGENUM* AT DIFFERENT MOISTURE LEVELS (AVERAGE OF THREE REPLICATES).**

| S. No. | Moisture levels | *Aspergillus flavus* | *Penicillium chrysogenum* |
|---|---|---|---|
| 1 | 30 | + | + |
| 2 | 45 | ++ | ++ |
| 3 | 60 | +++ | +++ |
| 4 | 75 | ++++ | ++++ |
| 5 | 90 | +++++ | +++++ |

+++++ (Excellent), ++++ (Best), +++ (Good), ++ (Poor), + (Very poor) growth of fungi




**GRAPH-1- EFFECT OF pH ON *ASPERGILLUS FLAVUS* AND *PENICILLIUM CHRYSOGENUM***




**GRAPH 2: EFFECT OF TEMPERATURE ON *ASPERGILLUS FLAVUS* AND *PENICILLIUM CHRYSOGENUM***

**CONCLUSION:** A conclusion derived from the data presented in this research work is that building material supporting fungal growth must be remediated so as to ensure a healthy indoor environment. Fungi play an important role in our global ecology, but can also pose a significant health risk when they are allowed to grow in buildings.

A wide range of fungal species can normally be cultured in air and dust sample in all buildings, as spores are brought in on the air, or tracked in by animal or occupants. Many of these fungi will colonize building material, if given the right conditions like moisture, temperature, and food sources. Recent survey conform the association between adverse human health effect and dampness in building.

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**REFERENCES:**

1. Sarkar, S., Martínez, A.T. and Martínez, M.J. Biochemical and molecular characterization of Manganes peroxidase from *Pleurotus ostreatus. Biochim. Biophys. Acta*. 1997, 1339: 23-30.
2. Ravikumar, H.R., Rao, S.S. and Karigar, C.S. Biodegradation of paints: a current status. *Indian Journal of Science and Technology* 2012, vol. 5 (1). 1-11.
3. Nevalainen, A., Partenen, P., Jaaskelainen, E., Hyvarinen, A., Koskinen, O., Meklin, T., Vahteristo, M., Koivisto, J. and Husman, T. Prevalence moisture problems in Finnish house. *Indoor Air* 1998. 4: 45-49.
4. Haverinen, U., Husman, T., Toivola, M., Suonketo, J., Pentii, M., Lindberg, R., Leinonen, J., Hyvarinen, A., Meklin, T. and Nevalainen, A. An approach to management of critical indoor air problems in schools buildings. *Environ Health Perspect* 1999, 107(3): 509-514.
5. Airaksinen, M., Jarnstrom, H., Kovanen, K., Viitanen, H. and Seerela, K. Ventilation ad building related symptoms. Well Being Indoors- CLIMA 2007. Helsinki, 10-14.
6. Ingold, C.T. and Hudson, H.J. The biology of fungi. Sixth Edition, Chapman & Hall, London, Great Britain 1993, 7-24.
7. Atlas, R.M. and Bartha R. Microbial ecology. Fundamentals and applications. 3rd edition. The Benjamin/Cummings Publishing Company, Inc., Redwood city, CA, USA 1993, 215-220.
8. Bornehag, C.G., Blomquist, G., Gyntelberg, F., Jarvholm, B., Malmberg, P., Nordvall, L., Nielsen, A., Pershagen, G. and Sundell, J. Dampness in buildings and health. *Indoor Air* 2001, 11: 72-86.
9. Waksman, S.A. *J. Bact.* 1922, 7:339-341.

10. Warcup, J.H. *Trans Br Mycol Soc.* 1951, 34: 376-399.
11. Barnett, H.L. Manual for Hypomycetes Fungi. The APS, St. Paul, Minnesota, U.S.A 2003.
12. Pratibha, V.H., Nanjegowda, D. and Nagaraju, N. Effect of pH and temperature on the growth of different isolates of *Alternaria helianthi* (Hansf.) Tubaki and Nishihara on Sunflower. *Mysore J. Agri. Sci.* 2008, 42(1): 139-142.
13. Morris, P.I. Understanding biodeterioration of wood structures. Forintek Canada Crop, Vancouver, B.C. 1998, 16.
14. Brischke, C., Bayerbach, R. and Rapp, A.O. Decay-influencing factors: A basis for service life prediction of wood and wood-based products. Wood Material Science and Engineering 2006. 1: 91-107.
15. Lahdesmaki, K., Vinha, J., Viitanen, H., Salminen, K., Peuhkuri, R., Ojanen, T., Paajanen, L., Litti, H. and Strander, T. Development of an improved model for mould growth: Laboratory and field experiments. Proceedings of 8th Nordic Symposium on Buildings Physics 2008, Copenhagen.
16. Viitanen, H. Modeling the time factor in the development of mould fungi in wood-the effect of critical humidity and temperature conditions. Holzforschung 1997, 51(1): 6-14.
17. Sharma, M. and Sharma, M. Influence of environmental factors on the growth and sporulation of Geophilic Keratinophiles from soil samples of Public Park. *Asain j. Sci.* 2009, Vol. 23, No. 1, 307-312.
18. Johansson, P., Tobin. A.E. and Sevensson, T. Mould growth on building material under different climate conditions: determining the critical moisture level. International biodeterioration and biodegradation 2012. 1-119.

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