SEASONAL AND TEMPORAL VARIATION IN AIRBORNE FUNGAL SPORES IN INDOOR AND OUTDOOR ENVIRONMENTS OF TEMPLES IN UJJAIN, INDIA

Sharma H., Vyas A.¹ and Vyas H.*²

1. School of Studies in Microbiology, Vikram University, Ujjain, Madhya Pradesh (INDIA)
2. Department of Botany, Government Kalidas Girls College, Ujjain, Madhya Pradesh (INDIA)

Received October 09, 2015
Accepted February 10, 2016

ABSTRACT

Aeromicrobiology is the study of sources, dispersion and effects of airborne biological materials like pollen, spores and microorganisms. A significant fraction of bioparticles consists of fungal spores and they are recognized as major bio-pollutants. The infestation of indoor domestic and working environments with microbiological contaminants or other bio-pollutants is a major health problem in a tropical country like India. The exposure to fungal spores in houses, markets, tourist places, occupational environments and other areas is responsible for various health problems like respiratory and allergic disorders. In order to systematically evaluate the relationship between airborne fungi and their adverse health effects, the fungal types and their relative frequencies in both indoor and outdoor air need to be determined. Ujjain is one of the sacred cities of India and it is famous for various holy temples which are visited by numerous devotees throughout the year. Moreover, a large number of people work in temples and earn their livelihood. Very little information is available regarding fungal aeroflora of temples. We have studied the aeromycoflora in the indoor and outdoor environments of some important temples of Ujjain during different times of the day and during different seasons.

Key Words: Aeromicrobiology, Bio-pollutants, Temples, Fungal spores, Aeromycoflora

INTRODUCTION

The presence of bio-pollutants in indoor and outdoor air of domestic and working environments is of major concern at present time. Fungi are important part of airborne microflora and are hazardous for human health. The fungal spores or the metabolites produced by them can cause allergies, infections and other health problems in humans.¹⁻³ There is positive correlation between the respiratory allergy cases and the fungal air-spora concentrations.⁴ Indoor air bio-pollution is much worse than outdoor air bio-pollution and excessive increase in microflora of indoor air leads to sick building syndrome. Microorganisms enter indoor air either by passive ventilation or by means of ventilation systems. Aeromycological study in the indoor air of certain residential dwellings in Imphal, Manipur, India revealed that and fungal spores are responsible for serious health hazards.⁵ The outdoor and indoor aeromycoflora of the residential houses was studied and the investigation demonstrated a close correlation in the occurrence of fungal spore types of outdoor and indoor air.⁶ In a study conducted in Israel over an entire year indicated that the total fungal spore concentration vary throughout the year although the species variability was nearly the same.⁷ An aeromycological study was conducted at three different localities of Gorakhpur district in India to identify and quantify fungi. It was found that there is variation in number as well as in composition of fungal species in different areas.⁸ Very little information is available regarding fungal aeroflora of temples. The air quality of Shri Siddhivinayak temple in Mumbai, India was studied and it was found that indoor microbial load was significantly higher than the microbial load in outdoor air.⁹ The study of

*Author for correspondence
microorganisms in atmosphere still represents a challenging area for microbiologists as airborne microbial quality vary with time of day, year and location and affects the quality of human life. Ujjain is holy city which has more than 1000 temples but the major temples are Mahakal temple, Triveni temple (Shani Mandir), Mangalnath temple, Harsiddhi temple, Kalbhairav temple etc. A large number of people work in these temples as pujaris, administrators, cleaners etc. and earn their lively hood. Moreover, devotees from all over the country visit these temples daily. During festivals and religious faires, the numbers of devotees increase excessively. It was of interest to assess the load of fungal aero-flora in outdoor and indoor environments of important temples as it will help in generating baseline data and estimating the health risk of people working in temples.

AIMS AND OBJECTIVES
This investigation was undertaken for quantitative analysis of fungal spores in indoor and outdoor area of three major temples in Ujjain, India.

MATERIAL AND METHODS

Study site
Three different temples of Ujjain selected for the study were, Triveni Temple (Shani mandir or Navgrah mandir), Mangalnath temple and Harsiddhi temple. The control site for the study was campus of Vikram University, Ujjain, M.P., India. The basis of selecting these temples for the study was their strategic location and importance during different festivals. Triveni temple is located on the starting point (Upstream) of Kshipra River. This temple is visited by the various devotees throughout the year, however, there is extreme rush during Saturday’s and Amavasya. Mangalnath temple is located at the end point (Downstream) of Kshipra River. This temple is very famous for Bhat puja and there is extreme rush of devotees on Tuesday’s. Harsiddhi temple is one of the oldest temple of Ujjain and it is regularly visited by various devotees and there extreme rush during Navratri. This temple is located in the crowded area of the city, whereas Shani and Mangalnath temples are located at the two ends of the city. Vikram University was chosen for the study as control site as it is situated in relatively unpolluted zone of the city.

Sampling method
Air sampling for monitoring load of fungal spore in indoor and outdoor premises of temples was done using settle plate exposure method. Indoor sampling was done inside temple premises in the main temple hall or at place where devotees spend their time during meditation or performed rituals. Outdoor sampling was done in the compounds of temples. Petri plates containing chloramphenicol rose bengal potato dextrose agar were used for sampling. Petri plates were exposed for 10 minute at all the sites and incubated at 28 ± 2°C and number of cfu (Colony forming units)/ plate were counted after 24-48 hours of growth. Air sampling was done in the morning (8.00 AM to 9.00 AM) as well as in the evening (6.00 PM to 7.00 PM). Sampling was done during different seasons over two year period (2013 - 2014). Winter season sampling was done between the months of November to February, rainy season sampling was done between July to September and summer season sampling was done between April to June. At all the sites sampling were done in triplicate and average values were calculated.

RESULTS AND DISCUSSION
The seasonal and temporal variation in load of airborne fungal flora were studied in indoor and outdoor premises of three different temples of Ujjain namely, Triveni temple, Mangalnath temple and Harsiddhi temple, Madhya Pradesh, India.

The monitoring of fungal spores in indoor and outdoor air was done in morning as well as in the evening to study the temporal variation in the fungal spores. The results of our study show that quantity of fungal spores in air varied with the time of the day. The load of fungal spores in air was less in the morning in comparison to evening. The similar trend was seen at all the sites and in all the seasons. It was seen that number of cfu/ plate increased 3-8 folds during the evening in comparison to
morning. A significant increase in load of airborne fungal spores in afternoon from morning has also been reported earlier. Thus it appears that in the morning the air is relatively clean as it has less number of fungal pollutants. **Fig. 1** shows a representative photograph of cfu/plate during morning and evening sampling.

**Fig. 1**: Photograph showing cfu/plate during air sampling. (A) Morning air sampling, and (B) Evening air sampling.

The results of air sampling in outdoor air of temples during different seasons are shown in **Fig. 2** and the results of air sampling in indoor air of temples during different seasons is shown in **Fig. 3**. It can be seen that during summer season cfu/plate were less in indoor air than outdoor air in Mangalnath temple whereas in Triveni and Harsiddhi temples cfu/plate were almost equal in indoor and outdoor air. The sampling in the control site of Vikram University shows that cfu/plate were less indoor air than outdoor air. During rainy season, it was seen that of cfu/plate were almost equal in outdoor and indoor environments of Harshiddhi temple and Mangalnath temple, however, cfu/plate were less in the indoor air than the outdoor air in Triveni temple and in control site of Vikram University. During winter season, it was seen that cfu/plate were almost equal in indoor and outdoor air of Harshiddhi and Triveni temple and were slightly less in indoor air in comparison to outdoor air in of Mangalnath temple and Vikram University control site.

**Fig. 2**: Outdoor air sampling in different temples of Ujjain during different seasons.
It thus appears that in all the temples the outdoor air is either more contaminated with fungal pollutants than indoor air of temples or both indoor and outdoor environments are equally contaminated. The control site had always less number of fungal spores in indoor environment than the outdoor environment which suggests that there is proper ventilation and number of occupants are limited. The variation in amount of fungal load in the indoor air could be due to increase in number of devotees due to festivals. It is interesting to note that indoor air is not excessively contaminated with fungal pollutant in comparison to outdoor air which indicates that all these temples are properly ventilated and there could be possible efflux of fungal spores from the inside of temples due to high wind and good ventilation. This is in contrast to air sampling in Shri Siddhivinayak temple in Mumbai where indoor microbial load is higher than outdoor air possibly due to poor ventilation in the temple.

The study also revealed seasonal variation in load or airborne fungal flora at different sites. It was seen that at Mangalnath temple and Vikram University control site the highest number of cfu/ plate were seen in summer season followed by winter and rainy season both in indoor and outdoor air. A study in Bangalore reported similar trend. The highest fungal load in air was seen during summer season which could be due to high wind speed. Moreover, summer season is dry and it has been seen that dry spores are released under conditions of decreasing humidity and increasing airflow. Decrease in fungal counts during wet season has been observed by other workers also. During outdoor and indoor air sampling at Harsiddhi and outdoor sampling at Triveni temples the highest fungal load in air was seen in winter followed by rainy and summer season. During indoor sampling at Triveni the highest fungal load in air was seen in winter followed by summer and rainy season. This could be due presence of ambient temperature for fungal growth and local factors like increase in number of devotees or increase in solid waste around temples which are pockets for growth of fungi and contribute to bio-pollution or due to change in wind velocity. It thus appears that premises of temples should be kept clean and temple waste should not be dumped nearby so that bio-pollution in outdoor and indoor environments of temples can be managed.

**CONCLUSION**

This is the first study conducted on aero-microbiology of temples in Ujjain to the best of our knowledge and it will act as baseline data for further studies. In this study, it has been found that bio-pollution in indoor premises of three major temples of Ujjain due
to fungal spores is almost equal or less than outdoor air. Fungal pollution was less in morning air as compared to evening air at all the sites. A seasonal variation in airborne fungal load was observed and it was found that at most of the sites airborne fungal spores were more in dry season than in wet season but the wind speed may be major factor in increasing fungal load in air. It appears that all the temples are properly ventilated but premises of temples should be kept clean and free from solid and floral waste generated in temples so that bio-pollution and health hazards to workers and devotees may be reduced.

ACKNOWLEDGEMENT

We acknowledge the financial assistance received in the form of Minor Research Project form UGC-CRO, Bhopal, India (No. MS-31/107024/XII/14-15/CRO).

REFERENCES


