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Occurrence of Allergenic Fungi in the Ambient Air of Bhadravathi Town, Shimoga District, Karnataka State, India

Kambalagere Yogendra[1] • Sharma Prabhakar Arpana[2*] • Eralagere Thimmanaik Puttaiah[1] • Reddy Aall Hanumanthareddy Manjunatha[3]

[1] Department of P. G Studies and Research in Environmental Science, Kuvempu University, Shankarghatta-577451, Karnataka, India
[2] Department of Biotechnology, New Horizon College of Engineering, Bangalore – 560087, Karnataka, India
[3] Department of Biotechnology, R. V college of Engineering, Bangalore – 560059, Karnataka, India

Corresponding author: * **arpanapsharma@gmail.com**

ABSTRACT

It has been established that about 80 genera of fungal species cause allergic disorders and these reactions are further aggravated by factors like environment, age and sex. The present study area is an industrial town having several major industries, which are responsible for many chemicals circulating in the air. The inhabitants of this industrial town are susceptible to a variety of health hazards usually associated with deteriorating air quality. The investigation revealed that various allergenic fungi like *Nigrospora sphaerica*, *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *Fusarium solani*, *F. moniliforme*, *Candida albicans*, *Cladosporium herbarum*, *Penicillium digitatum*, *Trichophyton rubrum* and *Alternaria alternate* were abundant in Bhadravathi town and their diversity fluctuated with seasonal variation. This paper deals with the preliminary information about the occurrence of the various allergenic fungi in the selected sites.

Keywords: abundance, air sampling, allergic reactions, environmental factors, fungal species, occurrence, pollutants, seasonal variations

INTRODUCTION

The respiratory diseases such as asthma and rhinitis are mainly associated with the aeroallergens. Fungi, pollen and domestic mites are the aeroallergens responsible for the respiratory diseases (Singh and Kumar 2004). Pollens are widely studied as allergens among the other allergens. The fungi are more persuasive in causing the respiratory diseases because of their nature of growth and distribution. Fungi are ubiquitous in nature among the indoor and outdoor environments. Fungi spread frequently by airborne spores with the congenial environmental conditions like moisture and the food source (Curtis *et al*. 2006). The high prevalence of allergies in the developed countries contributes to the increased public concern about indoor air quality. It has resulted in an increase in demand for environmental assessments and there is an increase in assessment of fungal growth (Codina *et al*. 2008). The prevalence of allergic diseases and asthma has increased dramatically during the recent 3 decades in industrialized countries. Asthma and allergic rhinitis have become more prevalent mainly among school children and young people (Emeryk *et al*. 2004).

The term allergy was coined by Von Pirquet (1907) to describe an altered reactivity of immune system in living beings. Allergy or hypersensitivity can be divided into 4 types – Type I (immediate), Type II (cytotoxic), Type III (phagocytosis) and Type IV (cell-mediated). Allergens stimulate IgE antibodies during interaction with fungal antigen.

Air is the primary mode of dispersion for the microorganisms. Changes in the atmosphere chemistry and climate that enhance the presence of air-borne pollen and/or fungi contribute to a high risk of allergic rhinitis and related asthma (Beggs 2004). Sensitization to airborne fungal spores varies and is dependent upon the allergenic potency of the fungal proteins, human genetic predisposition to disease (atopy) and levels of exposure to allergens (Okten *et al*. 2007).

Table 1 List of fungal genera and type of allergy caused by them.

Genus	Type of allergy produced
Alternaria	Respiratory allergy
Aspergillus	Respiratory allergy
Cladosporium	Skin allergy and respiratory allergy
Helminthosporium	Skin allergy
Fusarium	Skin allergy
Penicillium	Respiratory allergy and skin allergy
Trichophyton	Asthma
Candida	Skin allergy

Sources: Horner *et al*. (1995) and Deuell *et al*. (1991).

Allergic symptoms are caused by release of mediators (particularly histamine and leukotrienes) from mast cells and basophils sensitized by binding to allergen-specific IgE that is then cross-linked by allergen. Allergic symptoms therefore reflect histamine release that include itching, sneezing, rhinorrhoea, bronchospasm, laryngeal oedema with subsequent hoarse voice and upper airway obstruction, urticaria with or without angioederma and hypotension. Symptoms are characterized by allergen exposure and reproducibility within individuals, although, the spectrum of symptoms depends on the extent of exposure to allergen (Murphy *et al.* 1993). Some of the common genera, which were recognized as allergenic and were observed among the study sites are represented in **Table 1**.

MATERIALS AND METHODS

Study Site: Bhadravathi: It is a town in the Shimoga district of Karnataka state, India, with a spread over an area of 67 km². It lies in the central part of the Karnataka state, in the south-east corner of the Shimoga district. The latitude and longitude coordinates of Bhadravathi town are 13° 50' N and 75° 42' E. It is having two major industries Mysore Paper Mills Ltd. and Vishweshwaraya Iron and Steel Ltd.

Until today, no long-term records of allergenic fungal spores circulating in the atmosphere have been conducted in Bhadravathi

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Research Note

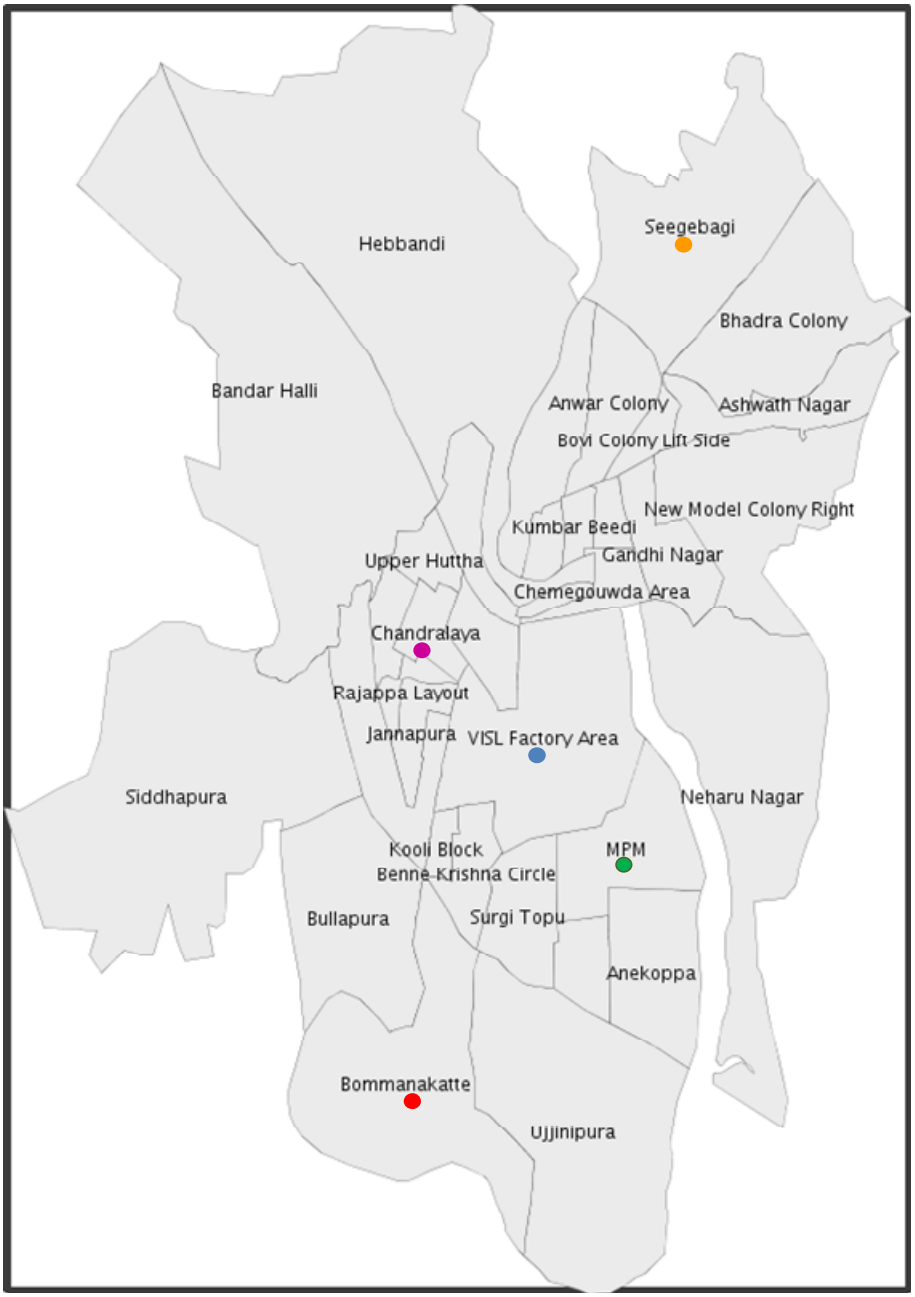

Fig. 1 Study sites selected for the sampling of aeroallergens in and around Bhadravathi. Figure not to scale. ● - Bus stand area (Site I); ● - MPM Industrial area (Site II); ● - Bommankatte (Site III); ● - VISL Industrial area (Site IV); ● - Seegebhagi (Site V). Source: http://www.bhadravathicity.gov.in/pgr/Reports/getBoundaryWiseSimpleMap.jsp

town. The study sites *viz*., Site I (near the Bus station), Site II (Mysore Paper Mills industrial area), Site III (Bommanakatte, a residential area with vegetation around), Site IV (Vishweshwaraya Iron and Steel Ltd., industrial area) and Site V (Seegebhagi a residential area with vegetation around) (**Fig. 1**) were selected randomly considering the highest pollution and population interactions. The identification of allergenic fungal distributions in the air of Bhadravathi town is made through Petri Plate Exposure Method, by using Sabouraud's Dextrose Agar media. The Petri dish was exposed in open fields at about 3 feet above the ground level in the selected study sites. This method was followed at an interval of 15 days and the numbers of fungal colonies, which are responsible for the allergic reaction, were enumerated (Okten *et al*. 2007). A Roto-rod sampler was used to extract the fungal species in the study area. The distribution frequency, which is the number of colonies observed in the Petri dishes, which were exposed in the study sites and the percentage of colonies of different species of fungi were estimated.

RESULTS AND DISCUSSION

Investigation of fungal species diversity in the ambient air of Bhadravathi was performed. During the study period, 12 species of allergenic fungi were identified. The dominant species among them was *P. digitatum*, which causes respiratory and skin allergy (Horner *et al*. 1995). The distribution frequency, which is the number of colonies observed in the sampled agar plate in different species. During the study, a total of 1316 colonies were observed among all the study sites. The percentage of distribution frequency is represented in **Table 2**. *P. digitatum* was dominant with the distribution frequency during the study period (15.20%) followed by *A. niger* (12.69%), which causes respiratory allergy. *T. rubrum* (0.76%), which is responsible for asthma, was least frequent (Horner *et al*. 1995).

The occurrence of the species among the various seasons was estimated. During the monsoon season, the highest occurrence of the species was observed. All the species showed a similar trend followed by the pre-monsoon season.

Table 2 Air-borne fungal species in the atmosphere of Bhadravathi.

Spores	Distribution frequency (Relative %)
Aspergillus niger	12.69
Aspergillus flavus	8.66
Aspergillus fumigates	12.01
Fusarium solani	8.74
Fusarium moniliforme	10.26
Candida albicans	4.79
Cladosporium herbarum	5.78
Nigrospora sphaerica	11.85
Helminthosporium halodes	2.36
Penicillium digitatum	15.20
Trichophyton rubrum	0.76
Alternaria alternata	6.91

Table 3 Relative percentage occurrence of most common fungal species by seasons in Bhadravathi (n =1316) from 2007-2009.

Species	Pre-monsoon %	Monsoon %	Post-monsoon %
Aspergillus niger	38.92	46.1	15.56
Aspergillus flavus	34.58	49.07	16.35
Aspergillus fumigatus	35.44	42.41	22.15
Fusarium solani	41.86	43.26	14.88
Fusarium moniliforme	37	46	17
Candida albicans	32.73	40.11	27.16
Cladosporium herbarum	32.9	43.42	23.68
Nigrospora sphaerica	28.85	58.97	12.18
Helminthosporium halodes	32.26	38.71	29.03
Penicillium digitatum	37.21	39.02	23.77
Trichophyton rubrum	30	60	10
Alternaria alternata	36.27	37.36	26.37

During the post-monsoon the number of colonies observed was less than all the other seasons (**Table 3**). Reason for the greater concentration of fungi during monsoon may the highest moisture level present in that season because fungi requires 60-70% of moisture to grow (Dubey 2000).

As the study area includes two major industries, the chemicals released by them may also facilitate the increment of these fungal species by providing an acidic environment to them. The study showed the highest concentration of fungal species during rainy season, due to high moisture content and acid rain because of industrial chemicals.

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