

Study of Aeromycoflora and Related Allergic Diseases of Raipur, Chhattisgarh

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Abstract: A study of Aeromycoflora of Raipur city was conducted during the year March 2013 to February 2014 to identify the major fungal allergens in air causing allergic diseases. The air of outdoor and other environments contain a variety of biotic air pollutants. Biotic pollutants include bacteria, fungi, pollen-grains, trichomes, mites, algae, and spores of bryophytes, Pteridophytes and other particles of biological origin. These airborne bio particles/ pollutants transported through air current are the main cause of human allergic diseases. These bio-pollutants are toxic and cause serious health hazards in human beings and create environmental pollution. Among these bio-pollutants fungal forms were taken into consideration to find out the status of various types of allergic and pathogenic fungal spores at various places and their role in causing allergic diseases.

An aero mycological study was conducted in 3 indoor and 4 outdoor sites. Indoor sites were inside houses, commercial complexes, hospitals and outdoor sites were premises of hospitals, vegetable markets, railway station and bus stand. A total of 52 species belonging to 26 fungal genera in addition to 5 sterile types were recorded. *Aspergillus*, *Penicillium*, *Curvularia*, *Cladosporium*, *Fusarium* and *Alternaria* were found present in all most all the sites throughout the year which are known to be the major allergic fungus causing various diseases like Allergic Sinusitis, Allergic Rhinitis, Allergic Asthma in summer and Allergic Rhinitis, Allergic Sinusitis, Asthma, Eczema, Atopic Dermatitis, Mycoses, Urticaria etc in rainy and winter seasons. Experimental survey proved that 80% of the people in Raipur city are exposed to fungal spores both in indoors and other environments which are allergenic in nature and may pose serious health problems.

Keywords: Aermycoflora, Biotic-pollutants, Allergic diseases, sterile.

1. INTRODUCTION

Raipur city after being formation of capital of Chhattisgarh has lead to the rise of population and industrialization resulting in lots of air pollution. Air contains a variety of Microorganisms mainly fungal spores which are considered to be very dangerous, causing many health hazards to humans, plants and animals. Fungal spores are part and parcel of air and their quality and quantity depends on time of day, weather, seasons, climatic conditions of the surrounding area and presence of local source of spores (Pepjlinjak and Klaric 2003). The identification and quantification of atmospheric fungal spores is of great interest from clinical point of view as many species are triggers for allergic reactions. In view of increasing allergic diseases due to environmental pollution the survey of Aeromycoflora of Raipur city has assumed a great significance. Air borne fungal spores have been widely recognized as major allergens capable of causing Asthma, Allergic Sinusitis, Allergic Rhinitis, Allergic Bronchopulmonary Aspergillosis, Eczema, Atopic Dermatitis, Mycoses, Urticaria etc. The main objective of the present study was to survey the Aeromycoflora of both indoor and outdoor environments of Raipur city and its relation with the allergic diseases prevalent in Raipur city. Indoor and outdoor sites where people are much exposed to air borne allergens (fungal spores) which might be the cause of allergic diseases. 2 to 30% of respiratory allergies are due to fungal spores and *Alternaria* and *Cladosporium* as producing highest number of allergies (Tilak, 1991). There is an increase in dermal and respiratory diseases among the residents of Raipur city with every change in weather fluctuations thousands of people of different ages visit hospitals and doctors indicating different types of allergic diseases and respiratory problems. There have been several studies in relationship between fungal spores causing allergic diseases and asthma attacks. The inhalation of fungal spores and their interaction with the lung structures

are important for the development of respiratory allergies due to the aeroallergens (Geisen *et al.*, 2000) Apart from their direct allergenic effect many fungi produce mycotoxins and volatile metabolites (Miller, 1998) Inhalation of mycotoxins such as aflatoxins, secalonin acid, zearalenone and tricothecenes produced by *Aspergillus*, *Penicillium* and *Fusarium* sp. may affect the immunological response of the lung tissues or cause other serious health hazards to human (Gerberick, 1984). Humidifier, air conditioning systems, carpeting, damp walls are the major sources of indoor fungal allergens. Till now no attempts have been made to record the seasonal distribution of fungal spores and their relation in causing allergic diseases in Raipur city. In light of above knowledge present investigation was planned to study of Aeromycoflora and related allergic diseases of Raipur, Chhattisgarh.

2. MATERIALS AND METHODS

In present study, 7 different sites were selected for sampling Aeromycoflora like Indoor sites: inside houses, inside commercial complexes and inside hospitals and outdoor sites premises of hospitals, vegetable markets, Railway station and Bus stand. The study was carried out during March 2013 to February 2014. The culture plate exposure method was adopted for trapping the mycoflora. PDA (potato, Dextrose and Agar) was used as cultural medium. 10 ml of sterilized PDA medium was aseptically poured in petridishes and allowed to solidify. These petridishes were then exposed in triplicates for five to ten minutes at 1 meter above the ground level at the above mentioned sites. The study was conducted in interval of 15 days in every month. The exposed petridishes were sealed with the help of cello tape and brought to the laboratory and incubated for 3 to 5 days at $26 \pm 1^\circ\text{C}$. After incubation fungal colonies were counted, isolated and identified with the help of literature (Ellis, 1971 and Barnett, 1969). For species identification microscopic slides were prepared using glycerin gel as mounting media and lacto phenol and cotton blue stain. (Jadhav and Tiwari 1994) The results were recorded separately for different sites / season. For the survey of prevalent allergic diseases in Raipur city. Raipur city was divided into 5 major parts like North Raipur, South Raipur, East Raipur, West Raipur and Central Raipur. In all these major parts of Raipur city, selected Hospitals, Nursing homes and Government hospitals were taken for the survey. Information from 50 doctors and 90 patients of these hospitals were recorded with the help of Questionnaire and interview. Medical shops of these areas were also visited to record the monthly sale of drugs in treatment process. Demographic survey of this area season wise, age and sex were also done to note the number, age group of people suffering from allergic diseases.

3. RESULT AND DISCUSSION

A total of 26 fungal genera belonging to 52 species were recorded from all the sites as shown in Tables I and II.

Table-I: Seasonal occurrence of Aeromycoflora in indoor sites of Raipur, Chhattisgarh

S.No	Name of Fungi	Inside Houses			Inside Commercial Complexes			Inside Hospitals		
		Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter
1	<i>Aspergillus niger</i>	+	+	+	+	+	+	+	+	+
	<i>Aspergillus flavus</i>	+	+	+	+	+	+	+	+	+
	<i>Aspergillus parasiticus</i>	+	+	+	+	+	+	+	+	+
	<i>Aspergillus nidulances</i>	+	+	+	+	+	+	+	+	+
2	<i>Absidia sp.</i>	-	+	+	-	-	+	+	+	-
3	<i>Acremonium sp.</i>	-	-	+	-	-	+	-	+	+
4	<i>Arthrimum sp.</i>	+	-	+	+	+	+	+	+	+
5	<i>Alternaria alternata</i>	+	+	+	+	+	+	+	+	+
	<i>Alternaria tenuissima</i>	-	-	+	+	+	-	+	+	+
	<i>Alternaria radicina</i>	+	+	+	-	+	-	+	+	+

	<i>Alternaria crassa</i>	+	-	+	-	+	+	+	+	+	
	<i>Alternaria citri</i>	+	+	+	+	+	+	+	+	+	
6	<i>Cladosporium oxysporum</i>	+	+	+	+	+	+	+	+	+	
	<i>Cladosporium herbarum</i>	+	+	+	-	+	+	+	+	+	
	<i>Cladosporium sphaerospermum</i>	+	-	+	-	+	+	+	+	-	
7	<i>Curvularia lunata</i>	+	+	+	-	+	+	+	+	+	
	<i>Curvularia oryzae</i>	+	+	+	-	+	+	+	+	+	
8	<i>Chaetomium sp.</i>	+	-	-	-	-	-	-	-	-	
9	<i>Dreschlera sp.</i>	+	+	+	-	-	+	-	+	+	
10	<i>Epicoccum sp.</i>	-	-	+	-	-	-	-	+	+	
11	<i>Fusarium monaliformis</i>	+	+	+	+	+	+	+	+	+	
	<i>Fusarium pallidoroseum</i>	+	+	+	+	+	+	+	+	+	
	<i>Fusarium solani</i>	-	-	+	+	+	+	+	+	+	
12	<i>Helminthosporium sp.</i>	-	-	+	-	-	+	-	+	+	
13	<i>Mucor sp.</i>	+	+	+	+	+	+	+	+	+	
14	<i>Myrothecium sp.</i>	+	+	+	+	-	+	-	-	+	
15	<i>Monallia sp.</i>	-	-	+	+	-	+	+	-	+	
16	<i>Nigrospora sp.</i>	-	+	+	-	-	+	+	-	+	
17	<i>Penicillium sp.</i>	+	+	+	+	+	+	+	+	+	
18	<i>Rhizopus sp.</i>	+	+	+	+	+	+	+	+	+	
19	<i>Periconia sp.</i>	+	-	+	+	-	-	-	+	+	
20	<i>Eupenicillium sp.</i>	+	+	+	-	+	+	+	-	+	
21	<i>Emericella sp.</i>	+	+	+	-	-	-	-	-	+	
22	<i>Cunninghamella sp.</i>	-	-	+	-	-	+	+	-	+	
23	<i>Tricothecium sp.</i>	-	-	+	-	-	-	-	-	+	
24	<i>Tricoderma sp.</i>	-	+	+	-	-	-	-	-	+	
25	<i>Phoma sp.</i>	-	+	+	-	+	-	+	+	+	
26	<i>Neosartorya sp.</i>	-	-	+	-	-	-	-	-	+	
27	<i>Sterile type</i>	-	+	+	-	+	-	+	-	+-	
28	<i>Unidentified type</i>	-	-	+	-	-	-	-	-	-	
Total		14	16	21	10	12	16	14	16	19	
Grand Total		51			38			49			

Table-II Seasonal occurrence of Aeromycoflora in outdoor sites of Raipur, Chhattisgarh

S.no	Name of Fungi	Premises of Hospital			Vegetable Market			Railway Station			Bus Stand		
		S	R	W	S	R	W	S	R	W	S	R	W
1	<i>Aspergillus niger</i>	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Aspergillus flavus</i>	+	+	+	+	+	-	+	+	+	-	+	+
	<i>Aspergillus parasiticus</i>	+	+	+	+	+	-	+	+	+	-	-	-
	<i>Aspergillus nidulances</i>	+	+	+	+	+	+	+	-	+	-	+	+
2	<i>Absidia sp.</i>	-	+	+	+	+	+	+	-	+	-	-	+
3	<i>Acremonium sp.</i>	-	+	+	-	+	+	-	+	+	-	-	-
4	<i>Arthrimum sp.</i>	-	+	+	-	+	+	+	+	+	-	-	+
5	<i>Alternaria alternata</i>	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Alternaria tenuissima</i>	-	-	+	+	-	+	+	+	+	-	-	-
	<i>Alternaria radicina</i>	-	-	+	+	-	+	+	+	+	-	+	-
	<i>Alternaria crassa</i>	+	+	+	+	+	+	+	-	+	+	-	-
	<i>Alternaria citri</i>	-	+	+	+	-	+	+	-	+	+	+	+
6	<i>Cladosporium oxysporum</i>	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Cladosporium herbarum</i>	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Cladosporium sphaerospermum</i>	-	+	+	+	-	+	-	-	+	-	-	+
7	<i>Curvularia lunata</i>	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Curvularia oryzae</i>	+	+	+	+	+	+	+	+	-	+	+	+
8	<i>Chaetomium sp.</i>	+	-	-	-	-	-	+	-	-	+	-	-
9	<i>Dreschlera sp.</i>	-	+	+	+	+	+	-	+	+	-	+	+
10	<i>Epicoccum sp.</i>	-	+	+	+	+	+	-	+	-	-	-	+
11	<i>Fusarium monaliformis</i>	+	+	+	+	+	+	+	+	+	-	+	+
	<i>Fusarium pallidoroseum</i>	+	+	+	+	+	+	-	+	-	-	+	+
	<i>Fusarium solani</i>	+	+	+	+	+	+	-	-	+	+	+	+
12	<i>Helminthosporium sp.</i>	+	-	+	+	+	+	-	+	+	-	-	-
13	<i>Mucor sp.</i>	+	+	+	+	+	+	+	+	+	+	+	+
14	<i>Myrothecium sp.</i>	+	+	+	+	+	+	+	+	+	-	-	+
15	<i>Monallia sp.</i>	-	+	+	+	+	+	-	+	+	-	-	-
16	<i>Nigrospora sp.</i>	-	+	+	+	+	+	-	+	+	-	-	+
17	<i>Penicillium sp.</i>	+	+	+	+	+	+	+	+	+	+	+	+
18	<i>Rhizopus sp.</i>	+	+	+	+	+	+	+	+	+	+	+	+
19	<i>Periconia sp.</i>	-	+	+	-	-	+	+	-	-	-	-	-

20	<i>Eupenicillium sp.</i>	+	+	+	+	+	+	-	+	+	-	+	+
21	<i>Emericella sp.</i>	+	+	+	-	-	-	-	-	+	-	-	-
22	<i>Cunninghmella sp.</i>	-	-	+	-	-	-	-	+	+	-	-	-
23	<i>Tricothecium sp.</i>	-	-	+	-	+	+	-	-	-	-	-	-
24	<i>Tricoderma sp.</i>	-	-	+	-	-	+	-	-	+	-	-	-
25	<i>Phoma sp.</i>	+	+	+	+	+	+	+	+	+	-	-	+
26	<i>Neosartorya sp.</i>	+	-	-	-	-	-	-	-	-	-	-	-
Total		16	20	22	16	20	24	16	19	23	10	10	16
Grand Total		58			60			58			36		

S-Summer, R-Rainy, W-Winter, (+) indicates presence of Species and (-) indicates absence of Species

Aspergillus, *Penicillium* and *Cladosporium* species were found dominant in all the seasons. A majority of fungi were members of Deutromycotina, while 4 fungal spores were recorded from zygomycotina and 3 from Ascomycotina. The seasonal variation in the aeromycoflora was observed. Summer season recorded 14 fungal genera in indoor and 16 fungal genera from outdoor sites. The important genera comprising were *Aspergillus*, *Penicillium*, *Cladosporium*, *Curvularia*, *Dreschera*, *Rhizopus*, *Mucor* and *Fusarium* known to be allergenic in nature and cause allergic diseases like allergic rhinitis, allergic sinusitis and allergic asthma. In rainy seasons the number of fungal spore's increased to 19 in indoor and 21 fungal spores in outdoor sites, comprising genera like with *Aspergillus*, *Penicillium*, *Cladosporium*, *Curvularia*, *Alternaria* and *Fusarium* species as dominant. In winter season the number of fungal spores further increased to 24 in indoor sites and 26 in outdoor sites. In summer seasons higher count of fungal spores inside houses was due to hot conditions which are favorable for the growth of *Aspergillus* and *Penicillium* and maximum use of air conditioning system in homes. In commercial complexes like Malls, Restaurants and other commercial buildings from where sample were collected, recorded less no. of fungal spores due to frequent cleaning, dusting and extreme hygiene conditions over there.

In rainy Seasons maximum number of fungal spores was recorded from premises of hospitals and vegetable markets due to damp and moist conditions favored the growth of fungus like *Aspergillus*, *Rhizopus*, *Mucor* and *Penicillium* etc. In market area maximum number of spores was recorded due to decaying and rotting of vegetables and other food items. In hospitals number of fungal spores increased due to lack of cleanliness of premises and proper disposal of garbage's and hospitals discards from premises. In Bus stand area less number of spores were observed due to dispersal of fungal spores with fast moving vehicles in that area. Hence, in summer seasons Allergic Sinusitis, Allergic Rhinitis, Allergic Asthma were recorded as prevalent allergic diseases and Allergic Rhinitis, Allergic Sinusitis, Allergic Asthma, Eczema, Atopic Dermatitis, Mycoses and Urticaria etc were prevalent allergic diseases in rainy and winter seasons. Survey of medical shop showed that monthly sell of anti allergic drugs and respiratory disorders related drugs becomes high in rainy and winters seasons than the summer. Demographic survey of the area revealed that children, adult and female get more affected by the allergic diseases than the old age persons and males.

In this study *Aspergillus* was observed as most frequent and dominant species, similar results were also found by earlier workers Kakde and Choudhari (1999), Kakde *et al* (1999) Saoji and Chanti (1999) at Nagpur, Murthy and Mullaiah (1999) at Nagarjunagar, Guntur, Nayak and Nanda (2010) at Pondicheery. Similarly *Cladosporium cladosporiodes* were predominant and most frequent airspora at different places reported by Agashe *et al* (1999) at Bangalore, Appanna and Janaki Bai (1999) at Visakhapatnam, Kakde *et al* (1999) at Nagpur, Patil *et al* (1999) at Osmanabad, Tiwari (1999) at Raipur, Devi *et al* (2002, 2007) at Guwahati, Sahni and Purwar (2002) at Allahbad, Dahia and Gupta (2003-2011), Kochar (2011) at Rohtak, Peerally and Rao (2003) reported common genera at air of Mauritius, Uday prakash (2005) in Austin Texas, U.S.A., Pund *et al* (2007) at Amravati, Potty (2007) at Mumbai, Saroja and Bhagyalaxmi (2007) at Hyderabad, Mishra *et al* (2008) in Sonbhadra (U.P.) Hazarika *et al* (2008) at Assam, Giri and Sawane (2010) at Nagpur, Khan and Shrivastava (2011) at Bilaspur. Similarly *Curvularia lunata* was most frequent species found during this study period, this is in agreement with earlier works carried out by Mishra *et al* (1991) at Gaya, Arora and Jain (2003) in Bikaner, Tiwari *et al* (2006) at Raipur, Ahire *et al* (2007) at Pune, Kalkar and Tatte (2007) at Nagpur, Mahajan and Cholke (2007) at Pune, Pund *et al* (2007) at Amravati, Saroja and Bhagyalaxmi (2007) at Hyderabad.

4. CONCLUSION

Present study conducted through questionnaires in different Hospitals and Nursing homes showed that 60% people suffered from respiratory disorders. Studies indicated that fungal spores causes Allergic Rhinitis, Allergic Sinusitis and Allergic Asthma in Summer season and maximum allergic diseases caused during the rainy and winter seasons like Allergic Rhinitis, Allergic Sinusitis, Allergic Asthma, Eczema, Atopic Dermatitis, Mycoses and Aspergillosis . In rainy seasons and winter season higher concentration of fungal spores in the atmosphere was responsible for the allergic diseases. Verma and Khare (2009) Studied the Aeromycoflora in the houses of allergic Patients , Giri and Sawane(2010)and Sathavahana Chowdary *et al* (2011) also found that fungal spores were responsible for many allergic reactions . Fungal spores in the atmosphere may cause a number of allergic reactions .The contaminated air and water are believed to be responsible for gradual increase in the incidence of dermal and respiratory diseases. Touqeer Ahmed *et al.* (2011) .

Allergenic nature of *Aspergillus*, *Penicillium*, *Alternaria*, *Cladosporium* and *Curvularia* etc has already been established. Effective disposal of solid wastes may improve the air quality of the market and hospital area. Regular cleaning of carpets and air conditioning system and dusting will minimize fungal spore load in indoor sites. The spores of deutromycotina were the large contributors of the total air borne fungal spores. Thus *Aspergillus*, *Cladosporium*, *Alternaria* and *Penicillium* which were dominant in the outdoor air also recorded in significant concentrations in the indoor air. The allergic fungal spores recorded in both sites were *Aspergillus*, *Alternaria*, *Chaetomium*, *Cladosporium*, *Curvularia*, *Dreschlera*, *Fusarium*, *Mucor*, *Penicillium* and *Rhizopus*. Monitoring of air borne fungi can be helpful in prevention of fungal allergic diseases. Experimental survey proves that higher concentration of allergic fungal spores in the atmosphere which can cause allergic diseases. Study of this kind is highly interdisciplinary in nature and has tremendous scope to find the significant application in human health. Exposure to outdoor and indoor air borne inhalant mold allergens develops respiratory disorders and allergic diseases in human. Thus clean environment is necessary to reduce the fungal spore load in the air. Indoor mold levels could be decreased by preventing outdoor molds from entering the home by keeping doors and windows closed and using air conditioning equipped with allergen grade air filters. Indoor moisture can be controlled by using dehumidifiers. Water leaks could be fixed in washrooms, Kitchens and Basements. Ensuring adequate ventilation of moist areas. Clean contaminated surface with diluted chlorine bleach solution is necessary to reduce indoor spore load in air. Utilization of HEPA filters on Vaccuums and limitation of indoor house plants and ensuring that those were present are free of molds could reduce indoor spore levels.

Regular nebulization (steaming) with hot water and before going outside, wearing of nose mask may reduce allergic fungal diseases to some extent. Anti allergic drugs like Mon Deslor, Monlevo, Cetrizet, Starcet, Zyncet, Neoloridin, and Winolep are recorded beneficial against allergic rhinitis , allergic sinusitis and allergic asthma. Antifungal agents have shown mixed results in the treatment of allergic fungal sinusitis. Present survey showed amphotericin B and Ketoconazole to be most effective agents in Vitro. Supportive data regarding the usage of these agents are pending. Fluconazole spray has been used with Encouraging results. More such studies may help in better understanding of the conditions which lead to proper diagnosis and management of allergic diseases.

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REFERENCES

- [1] Ahire , Y.R. and Sangale, M.K. (2010). Survey of Aereomycoflora present in Vegetable market. Elixir. Appl. Botany. 52. 11381-11383.
- [2] Arora ,A. and Jain, V.K.(2003).Fungal air spora of Bikaner.Ind. J.Aero., 16 (1&2): 1-9.
- [3] Barnett, H.L. (1969).Illustrated genera of imperfect fungi. Mins Burgess Pub. Co.,166.
- [4] Dahia , P. and Gupta, R. (2003). Aeromycoflora of Rohtak City .Ind. J. Aero. 16 (1&2).
- [5] Devi, N., Dhar , B. and Sharma , G.C.(2002). Air spora of semi Urban areas of Guwahati City.Ind. J. Aero., 15 (1&2): 20-31.
- [6] Devi ,N., Deka ,G. Sharma ,G.C.(2007). Fungal spora in the industrial units of Guwahati refinery (IOCL) Noonmati. Abst. 14th Nat. Con. Aero.

- [7] Ellis, M.B., (1971). Dematiaceous hypomycetes. Common Wealth Mycological Institute. Kew, Surrey, England.
- [8] Geisen, M., Lyeupin, N., Maye, I., Hof, V.I. and Gehr, P. (2000). Interaction of fungal spores with the lungs: distribution and retention of inhaled puffball (*calvatia excipuliformis*) spores, *J. Allergy Clin. Immunol.* 106(1): 92-100.
- [9] Gerberick, G.F. (1984). The effects of T2 toxin on alveolar macrophage function in vitro, *Environ Res.* 33: 246-260.
- [10] Giri, S.K. and Sawne, A.M. (2010). Airborne Culturable fungi in hospital environment of Nagpur. *Ind. J. Aero.* 23 (2): 80-85.
- [11] Hazarika, S., Bugar Baruah, D. and Sharma, G.C. (2008). Air borne fungal spores in a paper mill complex at Jagri road, Assam-India. *Indian J. Aero.* 21: 28-35.
- [12] Jadhav, S.K. and Tiwari, K.L. (1994). Aeromycoflora of Ravan village. *Ind. Bot. Report*, 13 (1+2): 33-36.
- [13] Kakde, U.B., Kakde, H.U. and Saoji, A.A. (1999). Fungi as air contaminant in Vegetable market. *Abst. 10th Nat. Conf. Aero.*, 18.
- [14] Kalkar, S.A. and Tatte, M.P. (2007). Aeromycological survey of indoor environment in hospitals. *Abst. 14th Nat. Conf. Aero.*, 41.
- [15] Khan, N.S. and Shrivastava, D.K. (2011). Biodiversity of Aeromycoflora from Bilaspur city of Chhattisgarh. *Abst. Nat. Sem.*, 6.
- [16] Kochar, S., Dahiya, P. and Choudhari, D. (2011). Fungal spectra of Rohtak city- A two year survey. *Ind. J. Aero.*, 24(2): 82-90.
- [17] Mahajan, M.C. and Cholke, P.B. (2007). Study of Aeromycoflora inside Poultry shed. *14. Nat. Conf. of Aero.*
- [18] Miller, J. D. (1998). Fungi and Fungal products in some Canadian houses, *Int. Biodeter.* 24: 103-120.
- [19] Mishra, K.B., Sahay, R.R., Ojha, A., Prasad, S.B. and Singh, A.B. (1991). Survey of bioaerosol around Gaya (Bihar). *Abst. Nat. Conf. Aero.* 37.
- [20] Mishra, K.N., Singh, D. B. and Kumar, A. (2008). Fungal spores content in the atmosphere of different sites of Obra- Sonbhadra (U.P.). *India. Indian J. Aero.*, 21: 42-47.
- [21] Nayak, B.K. and Nand, A. (2010). Fungal spores in the bed rooms of homes in Pondicherry City. *Ind. J. Aero.*, 23 (2): 73-79.
- [22] Pepeljnjak, S. and Segvic Klaric, M. (2003). Occurrences of fungi in air and on plants in vegetation of different climatic regions in Croatia. *Aerobiologia* 19: 11-19.
- [23] Peerally, A. and Rao, V. (2003). A Study of the Aeromycoflora of Mauritius in relation to allergy and asthma. *Ind. J. Aero.*, 16 (1&2): 57.
- [24] Potti, S.K. and Sasi Kumar, S. (2000). Vertical distribution of air spora at the high rise residential buildings in the Western Suburbs of Mumbai. *Abst. 14th Nat. Conf. Aero. Raipur*, 39.
- [25] Pund, Smita, B., Tidke, J.A. and Patil, G. V. (2007). Preliminary observations on aeromicrobiota at Amravati City (M.S.). *Abst. 14th Nat. Conf. Aero.*, 35.
- [26] Sahney, M. and Purwar, A. (2002). Incidence of fungal air spora in the market area of Allahabad. *Ind. J. Aero.*, 15 (1&2): 32-46.
- [27] Saroja, P.V. and Bhagyalakshmi, O. (2007). Mycoflora of Hyderabad- A metro City. *Abst. 14th Nat. Conf. Aero.*, 47.
- [28] Sathavana Chowdary, V., Prasanna, L., Sangram, V., Rani, S. Vinay Kumar, E.C. (2011). Role of fungi (molds) in allergic airway disease – An Analysis in a South Indian Otolaryngology Center. *Ind. J. Allergy Asthma Immunol.* 25 (2): 67-78.
- [29] Tiwari, P. (1999). Aerobiological studies of Raipur with special reference to fungal spores (Thesis), Pt. R.S.U., Raipur.
- [30] Tiwari, K.L., Jadhav, S.K. and Kunjam, S. (2006). Aeromycoflora of Slum area of Raipur, (C.G.). *Ad. Plant Sci.*, 19 (II): 387-390.
- [31] Tilak, S.T. (1991). Fungal spores and allergy. *J. Palynol.* 27: 369-386.
- [32] Toqueer, A.R., Abdul H.S., and Moinuddin, A. (2009). Airborne fungal flora of Karachi, Pakistan. *Pak J. Bot.*, 41(31): 1421-1428.
- [33] Uday Prakash, N.K. (2005). A preliminary Survey on atmospheric fungal spores in Austin, Texas, U.S.A. *Abst. 13th Nat. Conf. Aero.*, 43.
- [34] Verma, K.S. and Khare, D. (2009). Aeromycoflora in the houses of allergic patients. *J. Basic Appl. Mycol.* 8 (1&2), 117-118.