International Journal of
Life Sciences
International Peer Reviewed Open Access Refereed Journal

Int. J. of Life Sciences, 2025; 13 (1): 41-46
ISSN:2320-7817(p) | 2320-964X(o)

Research Article Open Access

Bioparticle monitoring and its significance in Public Health

Jayshree Thaware

Associate Professor of Botany, S.K.Porwal College of Arts and Science and Commerce, Kamptee Dist-Nagpur (MS)
Email: jsthaware@gmail.com

Manuscript details:

Received: 05.11.2024
Accepted: 02.02.2025
Published: 15.02.2025

Cite this article as:
Jayshree Thaware (2025) Bioparticle monitoring and its significance in Public Health, *Int. J. of Life Sciences*, 13 (1): 41-46.

Available online on http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

ABSTRACT

Our environment has a great influence on public health. The atmosphere is loaded with essential and non-essential particles of biological and a-biological origin. The particles of biological origin are often referred to as bioparticles. Pollen grains released from the anthers of flowering plants and spores from lower plants constitute the airborne bioparticles/aerosol. In the atmosphere, the fungal spores are most predominant. The ratio of pollen to fungal spore goes up to 1:30 in certain seasons. Aerobiological survey of pollen/spore monitoring is carried out by operating a volumetric Rotorod Air Sampler (Model-40) installed at about 15 meters above the ground level on the rooftop of the terrace of S.K.Porwal College, Kamptee from June 2018 to May 2019. Respiratory diseases like asthma and chronic pulmonary obstructive diseases are mostly related to fungal bioparticles. A questionnaire method was used to facilitate the testing and monitoring appraisal of airborne bioaerosols and their impact on human health.

Keywords: Bioparticles, Fungal spores, Pollen grains, Public health, Rotorod air sampler.

INTRODUCTION

Aerobiology is concerned with the character and behaviour of a suspension of bioparticles in the atmosphere, viable or not whose transfer from one site to another is controlled by atmosphere. The airborne particles mainly of biological origin are microorganisms which consist of mainly pollen grains, fungal spores, bacteria, viruses, algae, leaf hairs, small seeds, and plant fragments etc. which occur in varying concentrations in the atmosphere depending on climatic factors, height from the ground level, location indoor or outdoor, altitude and proximity to large and small water bodies. When dispersed in the air they are known as aerosol. Pollen from trees is perhaps the most common source of aeroallergens.

It has been proved substantially that environmental bio-pollution has a significant role to play in human health hazards. The connection

between airborne pollen and fungal spores with allergy symptoms has been convincingly established (Agashe and Elfadi, 1989).

When a consortium of airborne microorganisms of numerous sizes and types are present in the air in association with PMs, they are called airborne particles or bioaerosols (Caruana, 2011). It combines solids and semi-solid material in association with biotic and abiotic pieces with sizes ranging from 0.001nm to 100µm (Humbal *et al*., 2018). Bioaerosols can result in infectious diseases and respiratory and chronic health issues. Considering the recent COVID-19 pandemic, bioaerosols might have a significant role in transmitting Coronavirus (Noorimotlagh *et al*., 2020). A growing quantity of data implies that the particulate matter's airborne microbial portion is responsible for critically escalating adverse effects on public health (Gandolfi *et al*., 2013).

It has been noted for some years that although many patients were sensitive to pollen grains and fungal spores, many of them also had seasonal allergic symptoms. These symptoms of hay fever or asthma were often severe and frequently sudden in occurrence. The timing of symptoms and close relationship with weaker changes suggested fungal spores as a cause. For instance, the importance of fungal spores as seasonal allergens has already been indicated by Hyde (1960). The preliminary work has been carried out to identify and quantify airborne pollen and fungal spores on a daily basis and to prepare weekly, seasonal and annual pollen /spore calendars.

MATERIAL AND METHODS

Detection, quantification and characterization of particles of biological origin in aerosols, including microbes, pollen, fungal spores, planktons, plant propagules and animal debris, is necessary to understand the role and the effects of bioaerosol in several processes like atmospheric chemistry, ecology and health effects. To address these aspects, we need a clearer picture of the composition, seasonal fluctuation, regional diversity and evolution of bioaerosol. From a meteorological perspective, it is important to know the actual composition of a bioaerosol to evaluate the role of individual components.

Aerobiological survey of pollen/spore monitoring is carried out by operating a volumetric Rotorod Air Sampler (Model-40) installed at about 10 meters above the ground level on the rooftop of the terrace of S.K.Porwal College, Kamptee where the premises are lush green due to a lot of vegetation for the period of one year from June-2018 to May-2019. Kamptee is a satellite town of Nagpur and is known for its Big Friday market, many types of small, mediate industries of tanning and dying, bakeries, and Butcheries.

Volumetric Rotorod Air Sampler (Model-40) is an intermittent power-driven impacting sampler in which adhesive-coated plastic rods suspended from the pivot rotate for one minute. This is repeated every 10 minutes for a one day i.e. 24 hours. Airborne pollen, fungal spores and other particulate matter get impacted on the silicone grease-coated rods. The rods are brought to the laboratory mounted in the grooved plastic slide holder and thoroughly screened microscopically. Identification of pollen and fungal spores was followed by quantitative analysis. The slides were prepared and observed under the microscope in low and high magnification and identified with reference slides and standard literature (Gilman, 1945; Funder, 1953; Barnett, 1960; Ellis, 1971; Gregory, 1973; Nagmani *et al*., 2006; Bhattacharya *et al*., 2006; Anathanarayana and Paniker, 2009).

Monitoring the airborne Bioparticles is the primary aim of the study, the secondary aim of the study in the relevance of public health was achieved by preparing a survey report from people belonging to different classes of the locality by questionnaire method.

RESULTS

Percentages of allergically significant pollen and fungal spores are determined (Table 1) and depicted in a pie diagram (Figure 1 and 2).

Although, in this chapter, we have emphasized on bioparticles detection in the outdoor environment, protecting indoor spaces such as homes, offices, schools, and hospitals, should also be brought under strict and continuous monitoring of bioaerosols.

The health survey was undertaken for nearly 1 year visiting the patients at the Government Sub-district hospital, Kamptee. The questionnaire was developed

with 26 questions, in Hindi-English language directly addressed to the patients who came for their symptoms mostly of cough and cold at the Government sub-district hospital. The questions were mostly referred to patients with respiratory diseases or symptoms suggesting respiratory allergies, mostly allergic rhinitis, asthma, and skin-related. We collected 895 on-site completed questionnaires in one year. Data sets, graphs and statistical analysis using chi-square for more than 2 variables were done using Microsoft Office Excel 2021. A p-value of <0.05 was considered statistically significant.

Characteristics of the responders' group

The mean age is 35.4 years (range between 8 years to 80 years old), with female predominance 69.4% and 30.6% over the men. Middle class people were around 10%, Lower middle-class people were around 31%, low-income group people around 35% and below poverty-line visitors/patients around 24% (on the basis of their Ration card type) . By critically evaluating the data (n=895) obtained after the survey, the most frequent chronic diseases of registered patients are Cardiovascular diseases (Chest pain, shortness of breath, cardiac diseases, high blood pressure, coronary artery disease, dizziness, and fatigue) for 227 (25.36 %) followed by Respiratory chronic diseases (asthma, COPD, airways blockages nasal and throats, lung diseases, etc.) 204 (22.79 %), Osteoarticular diseases (bones and joints related, osteoporosis, rheumatoid arthritis, etc.) 163 (18.21 %,), Metabolic disorders (Diabetics and endocrinological diseases) 143 (15.97 %), Pediatric and Gynecological disorders 75 (8.37 %), Skin/eye infections 54 (6.03%), Cancer 18 (2.01 %), and 11 (1.22%) with other ailments (Figure 3).

Table 1: Percentages of allergically significant pollen and fungal spores from June-2018 to May-2019

Pollen Watch		Fungal spores Watch	
Parthenium hysterophorus	20.37%	*Cladosporium* sp.	19.88%
Poaceae members	20.05%	Smut spores	16.15%
Cassia pollen	12.34%	*Aspergillus/Penicillium* sp.	14.37%
Casuarina equisetifolia	10.52%	*Periconia* sp.	11.72%
Eucalyptus sp.	10.45%	*Nigrospora* sp	9.02%
Amaranth, Chenopod pollen	3.22%	*Helminthosporium* sp.	8.96%
Other pollen types	23.05%	*Sterilia mycelia* (black, white, pink)	5.80%
		Other fungal types	14.1%

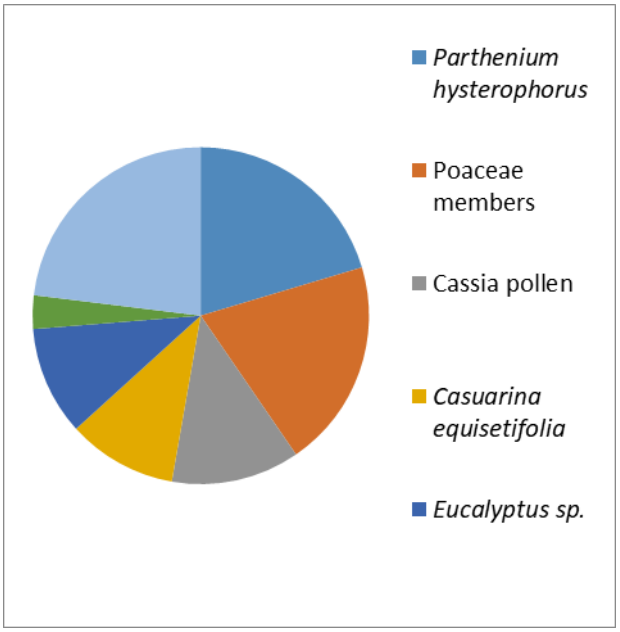

Fig 1: % of allergically significant pollen

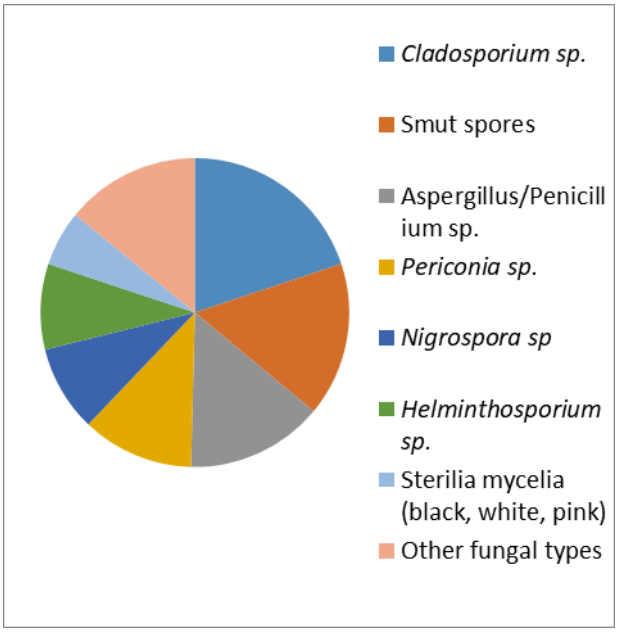

Fig 2: % of allergically significant fungal spores

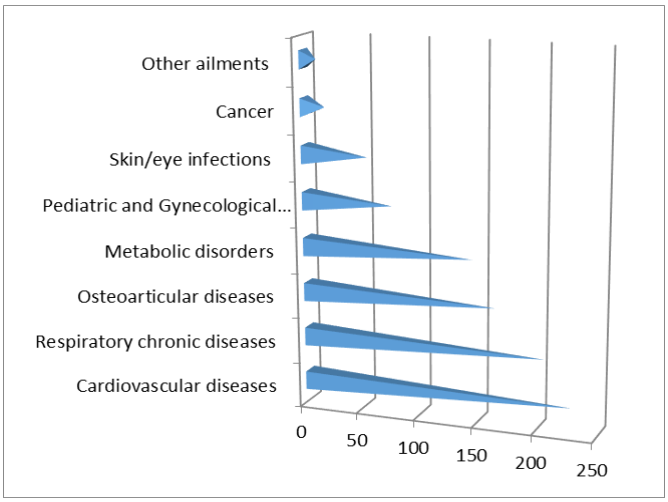

Fig. 3: Various ailments recorded in patients visited to the Government hospital in study period (n=895)

Respiratory chronic disease patient and Skin and eye infection patients questionnaires were further studied in detail (n=258). The most evocative signs and symptoms of allergic manifestation in those patients was sneezing for 23 % responders, rhinorrhoea (running nose) for 17%, nasal obstruction (nasal passage swollen with excess fluid) for 12 %, nasal pruritis (itching inside the nose) 10 %, Ocular symptoms (itching and involuntary movement of eyeballs) for 7 %, cough for 13 %, asthma symptoms in 10 %, skin itching and irritation in 8 % responders.

Regarding epidemiological aspects of respiratory allergies, 88% of responders considered an increased incidence of allergic or respiratory in our country. 12% considered it as stable. The possible factors responsible for the increased prevalence of respiratory allergies were air pollution for 29 % of the responders, climate /environment change for 17 %, smoking for 32 %, pollen and mould for 21%, atopy for 6 %, and lifestyle for 5%.

The most important aeroallergen considered responsible for respiratory allergies was pollen and dust mites by 81 and 43 responders respectively, moulds by 47, pets by 33 and 56 responders didn't know.

Aerobiological studies carried out so far have brought to light several facts, which are very useful from the point of creating awareness among the public about environmental biopolution. Predominant types of pollen grains and fungal spores in the Kamptee, Nagpur atmosphere compiled recently indicate several types of allergically significant pollen and fungal spores (Thaware 2019 and 2023; Dhole (2024)). Weed pollens of plant species encountered in the air include Amaranth, Chenopod, *Mimosa pudica*, members of Poaceae and *Parthenium hysterophorus*. Tree pollens like Caesalpiniaceae members like *Cassia* sp., *Caesalpinia* sp., *Casuarina equisetifolia*, *Eucalyptus* sp., Moraceae members, and Poaceae members achieve the peak of pollen in the atmosphere.

Particles suspended in air are called aerosols. These pose a threat to human health mainly through respiratory intake and deposition in nasal and bronchial airways. In addition, soil or dust particles can act as a "raft" for biological entities known as bioaerosols. Smaller aerosols travel further into the respiratory system and generally cause more health problems than larger particles (Fatahinia *et al*., 2018).

Atmospheric monitoring of mould spores showed that there are several predominant types of fungal spores viz. *Alternaria* sp., *Aspergillus* sp., *Cladosporium* sp., *Curvularia* sp., *Helminthosporium* sp., *Nigrospora* sp., *Penicillium* sp., *Periconia* sp., Smut spores, Ascospores and Basidiospores. The peak of mould spores in the atmosphere is achieved by spores of *Cladosporium* (19.88%) and Smut spores (16.15%) followed by other typical fungal spores, *Periconia* (11.72%), *Nigrospora* sp. (9.02%), *Helminthosporium* sp. (8.96%), and *Aspergillus-Penicillium* spores (14.37 %). Fungal spores are ubiquitous in nature and they are at least 1:30 times more abundant than pollen in the atmosphere. Types and abundance of fungal spores are influenced by meteorological factors. Precipitation

accompanied by low temperature is highly favourable for the liberation of fungal spores. Fungal spores are also clinically important as some of them cause respiratory allergy (Agashe and Vidya, 2000), respiratory disorders and other adverse health effects such as infections, hypersensitivity pneumonitis and toxic reactions. In addition, long-term contact of people with bioaerosols can influence personal's mental power and learning ability (Ghosh *et al*., 2015; Naruka and Gaur, 2019). Different environmental conditions such as temperature, UV light, dryness and humidity, play a role in controlling the growth of airborne particles.

Moreover, frequent causes of asthma, respiratory allergies, hypersensitive rhinitis and chronic obstructive pulmonary disease (COPD), and others are associated with airborne fungal pathogenic exposure owing to their omnipresence (Kallawicha *et al*., 2015; Priyamvada *et al*., 2017). *A-fumigatus* is implicated in numerous well-being difficulties in people compromised by immune deficiencies or broncho-pulmonary aspergillosis. *Stachybotrys chartarum,* on the other hand, colonizes in damps and produces mycotoxins. Fungal bioaerosols considerably influence the oxidative ability and chemical composition of the ambient PM in the presence of *A-fumigatus* spores (Samake *et al.,* 2017). Also, bioaerosols accelerate reactive oxygen species (ROS) in human lungs in response to different microorganisms and concentrations. For example, fungal spores generated up to 10 times more ROS than bacterial cells (Shammi *et al*., 2021). Pathogenic bioaerosols in outdoor environments are responsible for various allergens and respiratory diseases among children and adults, and the response is not identical. For public health safety, it is essential to detect and control the pathogenic bioaerosol loads, along with the spatiotemporal distribution in Asian megacities. Particular emphasis should be given to developing on-site automated bioaerosol monitoring systems and bioaerosol deactivation or reactivation mechanisms.

After critically analyzing the survey report, the missing factors like the way of living, poor knowledge of sanitation, non-awareness about health hazards, use of mosquito coils, smokers in the family, previous /family history of any kind of allergy etc. led to promotion of severe level of hypersensitive symptoms to the people. There are also pollen grains in high concentration in the air as bio-pollutants causing human health hazards. The survey and bio-monitoring results ultimately prove that the pollen grains were also promoting respiratory troubles and allergic symptoms in the Kamptee locality.

CONCLUSIONS

A large number of airborne pollen, come in contact with the eyes, nose, mouth and skin of susceptible/sensitive individuals and cause allergic manifestations. The allergy symptoms produced due to airborne pollen and fungal spores include itching of the nose, and skin, watering of the eyes, choking of the nose and blocking of tracheal tubes resulting in asthma and breathlessness. The primary objective of aero biologists is to monitor air continuously for airborne pollen and spores. On the basis of family history, atopic and skin prick tests with allergenic extracts from pollen and fungal spores will be performed. Once the offending allergen is established the patient has to undergo immunotherapy, which involves decentralization of allergy patients to get relief from airborne allergically significant pollen and fungal spores. For Palynological and Mycological surveys and assessment of allergenicity, continuous monitoring of atmospheric pollen and fungal spores is essential.

It can be concluded that,

- Pollen and fungal spores prevalent in Kamptee, Nagpur atmosphere are responsible for causing various types of allergies.
- It is necessary to carry out the ring of continuous atmospheric pollen/spores monitoring of the environment.
- Pollen and fungal spore spectrum keeps changing in the atmosphere depending on several meteorological factors.
- The awareness has to be created not only among the allergy sufferers but also for the successful diagnosis and treatment of pollen and fungal spore allergies.
- Air sampling allows the allergist to get a first-hand understanding of the local aeroallergens, their concentration, and seasonal occurrence.
- Several years of sampling will allow for the development of a pollen/spore calendar which can benefit the physicians and patients.
- For public warning, precaution and communication, and policy-making on bioaerosols, effective health policy research is needed for public health safety.

Acknowledgement
The present work is an extension of Major Research Project which was granted to the Author by University Grants Commission, New Delhi and also thankful to the Principal and Staff of Seth Kesarimal Porwal College, Kamptee for their kind support.

Conflict of Interest: The authors declare no conflict of interest in relation to this research.

Data Availability Statement: Not applicable.

Correspondence and requests for materials should be addressed to **Jayshree Thaware**

Orcid id : https://orcid.org/0000-0002-2350-5752

Peer review information
IJLSCI thanks the anonymous reviewers for their contribution to the peer review of this work. A peer review file is available.

Reprints and permissions information is available at https://www.ijlsci.in/reprints

REFERENCES

Agashe SN and Elfadil AG (1989) Atmospheric biopollutant monitoring in relation to meteorological parameters. *Grana,* 28: 87-104.

Agashe SN and Vidya MP (2000) Bio-pollution in the Bangalore urban environment and its implication on public health. *Proceedings of the Ninth National Symposium on Environment,* pp. 40-42.

Anathanarayana R and Paniker C (2009) *Textbook of Microbiology*. University press, Delhi

Barnett H (1960) *Illustrated genera of imperfecti fungi*. Burgess Publishing Co.

Bhattacharya K, Majumdar MR and Bhattacharya SG (2006). *A textbook of Palynology.* New Central Book Agency, Kolkata.

Caruana D J (2011) Detection and Analysis of Airborne Particles of Biological Origin: Present and Future. *Analyst* 136 (22):4641–4652. https://www.doi.com 10.1039/c1an15506g

Dhole P (2024) Monitoring environment for bioparticles and its significance in public health. In: Aerobiology, Allergy and Immunotherapy. Dr Jayshree Thaware [Ed.] ABS Books, New Delhi pp.96-106.

Ellis MB (1971) *Dematiaceous Hyphomycetes* Kew Commonwealth Mycological Institute, Kew, U.K.

Fatahinia M, Zarei-Mahmoudabadi A, Shokri H, and Ghaymi, H (2018) Monitoring of Mycoflora in Outdoor Air of Different Localities of Ahvaz, Iran. *J. de Mycologie Médicale* 28 (1): 87–93. https://www.doi.com10.1016/j.mycmed.2017.12.002

Funder Sigurd (1953) *Practical Mycology; manual for identification of fungi.* Broggers Boktr. Forlag, Oslo Norway.

Gandolfi I, Bertolini V, Ambrosini R, Bestetti G, and Franzetti A (2013) Unraveling the Bacterial Diversity in the Atmosphere. *Appl. Microbiol. Biotechnol*. 97 (11): 4727–4736. https://www.doi.org10.1007/s00253-013-4901-2.

Ghosh B, Lal H, and Srivastava A (2015) Review of Bioaerosols in Indoor Environment with Special Reference to Sampling, Analysis and Control Mechanisms. *Environ. Int*. 85: 254–272. https://www.doi.com10.1016/j.envint.2015.09.018.

Gilman JC (1945) *Manual of Soil Fungi*. The Iowa State College Press Ames, Iowa.

Gregory PH (1973) *The microbiology of the atmosphere.* New York, Halstead Press.

Humbal C, Gautam S, and Trivedi U (2018) A Review on Recent Progress in Observations, and Health Effects of Bioaerosols. *Environ. Int*. 118:189–193. https://www.doi.com10.1016/j.envint.2018.05.053.

Hyde HA (1960) Aerobiology and Medicine. *Nature.* 188: 182-183.

Nagmani A, Kumar IK, Manoharachary C (2006) *Handbook of Soil Fungi*. I.K. International Pvt. Ltd., New Delhi and Bangalore.

Naruka K and Gaur J (2019) Distribution pattern of airborne bacteria and fungi at market area. *American –Eurasian J. Sci. Res.* 9 (6): 186-192.

Noorimotlagh Z, Jaafarzadeh N, Martínez SS and Mirzaee SA (2020) A Systematic Review of Possible Airborne Transmission of the COVID-19 Virus (SARS-CoV-2) in the Indoor Air Environment. *Environ. Res*. 193:110612. https://www.doi.com10.1016/j.envres.2020.110612

Samake A , Uzu G, Martins JMF, Calas A, Vince E, Parat S *et al*. (2017) The Unexpected Role of Bioaerosols in the Oxidative Potential of PM. *Sci. Rep*., 7 (1): 10978. https://doi:10.1038/s41598-017-11178-0.

Shammi M, Rahman MM and Areq SM (2021) Distribution of bioaerosols in association with particulate matter: a review on emerging public health threat in Asian megacities. *Frontiers in Environmental Sci.,* 9: 698215. https://doi.org/10.3389/fenvs.2021.698215.

Thaware J (2019) Atmospheric concentration of airborne pollen grains at Kamptee Dist-Nagpur *International Research Journal of Natural and Applied Sciences*, 6(6):102-106

Thaware J (2023) Aeromycoflora associated with museum and herbarium of a degree college at Kamptee (Nagpur), Maharashtra. *Indian Journal of Aerobiology,* 36 (1): 19-28.

Publisher's Note
IJLSCI remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.