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AIRBORNE POLLEN SURVEYS IN INDIA DURING LAST FIFTEEN YEARS (2006-2020): A REVIEW

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ABSTRACT

Pollen grains are important bioparticles produced by the angiospermic plants. They are the carriers of male gametes that fertilize egg to form embryo. Being microscopic they are not visible but these airborne bioparticles contain some proteins in their composition that elicit allergenic response on coming in contact with human body. Most pollen in air are produced from anemophilous plants, while some belong to entomophilous and amphiphilous species. Wind pollinated taxa are the major source of inhalant pollen allergens. The knowledge of the pollen types in different times of the year provides help to allergists in identifying the suspected pollen type causing allergic reactions. Besides this being an atmospheric bioaerosol their role are also been analysed as carrier of pathogens like bacteria, virus and fungi. Thus the knowledge of their seasonal concentration in air is of prime importance as they form allergenic composition as well as pathogen carriers. Keeping this in view aeropalynological surveys were conducted in different cities in India and abroad to identify the hypersensitivity time for susceptible persons so that precautions can be taken by patients or appropriate treatment can be done by doctors. The present review compiles the aeropalynological surveys in different cities of India for the last fifteen years from 2006 to 2020.

Key Words: airborne pollen, allergenic, surveys, seasonal variations.

INTRODUCTION

India is blessed with wide variation in ecological diversity. It has snow-capped Himalayas in the north to coastal areas in the south and the desert in the west to fertile Brahmaputra valley in the east. The difference in natural vegetation in various regions is due to variation in amount of rainfall, temperature, soil type, humidity and altitude. The variation in vegetation influences the aerobiological characters of the atmosphere in different geographical regions. Among various aerobiological components pollen are one of the significant bioparticles in air. It affects the human health in form of respiratory allergies (Waisel et al., 2004; Roubelat et al., 2020). The knowledge in seasonal variation of pollen types in air helps the allergists in deciphering the pollen allergens of a particular time in the atmosphere and treating the patients suffering with various hypersensitive allergic disorders (Mir and Albaradie, 2013). This also provides help in planning of recreational or occupational travel of pollinosis suffering patients (Subiza, 2001). Pollen grains are also being recently examined as bioaerosols carrying COVID 19 infection (Ravindra et al., 2021; Damialis et al., 2021). The present review reports the results of palynological surveys conducted in the atmosphere of different cities in India during the last fifteen years from 2006 to 2020.

MATERIALS AND METHODS

The present review is based on analysis of papers published in different journals related to aeropalynological surveys in India during the last fifteen years. The surveys taken from different regions were performed using Burkard Sampler, Vertical cylinder trap sampler, Durham's gravity slide sampler, Rotorod Sampler and Tilak Air Sampler. Moss polsters and spider webs were also used as natural traps for studying modern pollen rain. In most studies seasonal variations were correlated with meteorological parameters. Pollen grains were identified with the help of reference slides and available literature. The studies notified the allergenic airborne pollen concentrations of that region in different times of the year. The survey results were divided in to Northern, Southern, Eastern, Western and Central Regions of India.

RESULTS

Northern Region

Aeropalynological survey of Banda district (Uttar Pradesh) was conducted with the help of modified Durham's gravity slide sampler. They reported *Vernonia cinerea, Euphorbia microphylla, Boerhaavia diffusa, Cassia fistula, Acacia nilotica* and *Parthenium hysterophorus* as the dominant pollen types (Pandey et al., 2006). Sahney and Chaurasia (2008) studied seasonal variation of airborne pollen in George Town locality of Allahabad district (Uttar Pradesh) using a Burkard 7-day volumetric sampler. Highest pollen count was of *Holoptelia integrifolia* followed by Poaceae, *Azadirachta indica, Ailanthus excelsa, Putranjiva roxburghii, Parthenium hysterophorus* and *Ricinus communis*. They also studied variations in the airborne pollen in two adjacent urban localities of University of Allahabad and Katra market (Allahabad, Uttar Pradesh) using vertical cylinder spore traps. At both the sites allergenic pollen of *Holoptelia integrifolia* ranked first in dominance followed by Poaceae. They prepared pollen calendar for the two sites (Sahney and Chaurasia, 2013). The study of Govindpur localty in Allahabad district (Uttar Pradesh) using vertical cylinder spore trap also showed dominance of allergenic pollen of *Holoptelea integrifolia,* Poaceae, *Parthenium hysterophorus, Typha angustifolia*, Amaranthaceae/Chenopodiaceae and *Azadirachta indica* (Chaurasia, 2017). Two year airborne pollen survey conducted in Lucknow district (Uttar Pradesh) depicted the intra- and interannual, diurnal and vertical variation of airborne pollen using a Burkard volumetric portable air sampler. The study concluded that both phenology and meteorological factors play an important role in qualitative and quantitative concentration of aerospora (Datta et. al., 2012). With the help of Durham Gravitational Settling Sampler, Paliwal and Balki (2017) identified 119 pollen types from the atmosphere of Firozabad district of Uttar Pradesh. Out of these 66 pollen types were well known allergens. They found Poaceae pollen to be the most abundant type, followed by Asteraceae and Amaranthaceae/Chenopodiaceae. Mir and Albaradie (2013) installed vertical cylinder rod at three different sites in North Kashmir. At these sites allergenic pollen types of *Plantago lanceolata, Morus* sp., *Rumex acetosa, Salix* sp., *Ulmus* sp., *Pinus, Chenopodium album, Cedrus deodara, Brassica* sp., *Cupressus*, *Poa* and *Prumus* sp. were recorded in different concentrations. They studied allergic aspects in collaboration with department of immunology SKIMS Soura, Sriangar. Moss polsters were analysed in Udhampur district of Jammu and Kashmir to study the pollen rain. It was dominated by *Pinus* sp. followed by *Cedrus* sp. and *Podocarpus* sp. (Quamar et al., 2018). *Cannabis sativa*, Poaceae, Chenopodiaceae/Amaranthaceae and *Parthenium hysterophorus* were the dominant allergenic pollen types reported from the aeropalynological survey in Rohtak city of Haryana using a volumetric spore trap (Ahlawat et al., 2013; Ahlawat and Dahiya, 2014). 24-hour Burkard volumetric air sampler was installed at University of Delhi (North Campus) to

quantify and identify the pollen grains in the atmosphere. *Juniper* sp, *Cannabis sativa*, Pooideae grasses, *Cynodon dactylon, Amaranthus* sp., *Artemisia* sp., *Cassia* sp., *Chenopodium album, Helenium autumnale* and *Parthenium* were classified as the most dominant pollen types (Kumar et al., 2018).

Southern Region

A two year aerobiological survey was conducted in outdoor and indoor environment of a coir spinning factory in Thiruvananthapuram district of Kerala to know the prevalence of airborne pollen and fungal spores using Burkard Personal Sampler and Anderson Sampler. Reportedly allergenic grass and *Cocos nucifera* pollen were found dominant in coir factory environment. The study suggested the use of dust mask to reduce the risk of a worker from becoming sensitized to allergenic pollen and spores (Nayar et al., 2007). Nayar and Jothish (2013) chose four working environments of market, saw mill, poultry and cow sheds for qualitative and quantitative analysis of airborne pollen and fungal spores in Thiruvananthapuram, Kerala using Burkard Personal Slide Sampler and Anderson Two-Stage Sampler. They reported high prevalence of allergenic pollen and fungal spores at all the four studied sites. Poaceae, *Cocos*, *Artocarpus*, Amaranthaceae/Chenopodiaceae and *Tridax* were the common and dominant pollen types at all the four sites. The analysis of airborne pollen found in the atmosphere of Bangalore city (Karnataka) was done with vertical cylinder trap sampler. Among the identified pollen types the most predominant atmospheric pollen was of *Parthenium hysterophorus.* It was followed by Poaceae, *Mimosa pudica*, *Delonix regia* and *Eucalyptus* spp. Maximum pollen concentration was observed in the month of May and minimum in June. The basic information about the pollen allergy has been collected with the help of questionnaire which showed that atmospheric pollen caused nasobronchial allergies in the people of Bangalore (Roopashree et al., 2014). Seetharam et al. (2017) identified 31 pollen types and 8 fungal spores from the nine spider web samples from Osmania University, Hyderabad (Andhra Pradesh). Their study concluded that spider webs act as natural pollen traps. In this study the predominant pollen grains were those *of Peltophorum pterocarpum, Ageratum conyzoides, Tridax procumbens, Prosopis juliflora, Cocos nucifera* and *Pithecolobium dulce*.

Eastern Region

Mandal et al. (2006) did 24 hour sampling using Burkard volumetric sampler in Southern part of Kolkata. The most abundant pollen types were *Trema orientalis*, Poaceae and *Casuarina equisetifolia*. They performed skin prick tests and reported high allergenicity for *Azadirachta indica, Cocos nucifera, Phoenix sylvestris, Borassus flabellifer, Carica papaya and Peltophorum pterocarpum* pollen. In Konnagar city of Calcutta biomonitoring of pollen grains using Burkard Volumetric Sampler was done by Ghosal *et al.* (2015). They established the role of pollen as a biopollutant causing allergic disorders. They also correlated the pollen count with meteorological parameters, hospitalization rate data and health survey data. Monitoring of airborne pollen flora done with the help of Rotorod Sampler in Central Guwahati found dominance of pollen belonging to Poaceae followed by Amaranthus-Chenopod and Asteraceae. *Acacia auriculiformis, Ailanthus excelsa, Azadirachta indica, Callistemon citrinus, Carica papaya, Casuarina equisetifolia, Cassia fistula, Cassia siamea, Cocos nucifera* and *Drypetes roxburghii* were some of the significantly allergenic pollen present in the air of Guwahati (Devi and Sarma, 2007). Aeropalynological survey of Assam was done by Sharma et al. (2010) using Burkard Personal slide sampler. Poaceae pollen was found to be the dominant pollen type followed by *Cassia*, Asteraceae, Mimosaceae etc. Several known allergenic pollen types like *Acacia, Cocos, Cassia* and *Ricinis* were common in the atmosphere of Assam during the survey period. Modern pollen rain study by analysing

pollen from surface sediments and moss cushions was carried out to study the present state of vegetation distribution in Tripura. The most commonly occurring taxa in the studied surface samples were of *Shorea robusta, Palmae, Salix, Symplocos,* Elaeocarpaceae, Solanaceae, Malvaceae, Rosaceae, Poaceae, Amaranthaceae along with marshy and/or aquatic species and fern spores (Mehrotra and Shah, 2018). Nohro et al. (2019) did modern pollen rain study for the Pala Wetland Reserve Forest, Siaha District, Southern Mizoram from moss polsters, surface soils and spider webs to evaluate relationship between modern pollen rain and extant vegetation.

Western Region

Multiple allergenic pollen types were identified by aeropalynological study conducted on the terrace of the Asthma Bhawan, Vidhyadhar Nagar in Jaipur city (Rajasthan) through Burkard 24hr. Spore trap system. The major airborne pollen contributors were of Poaceae, Cheno-Amaranthus, Asteraceae, *Holoptelea, Cassia* spp., *Brassica, Azadirachta* and *Parthenium.* Highest pollen count occurred in August and lowest in the month of June (Singh et al., 2013). At similar site aeropalynological sampling was repeated by Singh et al. (2017). They prepared pollen calendar for two years and established correlation of pollen count with SPT positivity. Gravity slide method and Volumetric method (Tilak air sampler) were the two sampling methods used to sample airborne pollen grains and fungal spores at six sites in Amravati (Maharashtra). Pollen grains of *Moringa oleifera*, *Delonix regia*, *Tecoma stans* and *Parthenium hysterophorus* were most abundantly recorded from study sites (Narkhedkar et al., 2013). *Phaseolus* crop field was selected for aeropalynological sampling in Pune (Maharashtra). Survey was done using Tilak Air Sampler. Airborne pollen count was correlated with meteorological parameters during rabi and kharif season. This study reported allergenic pollen grains of *Hibiscus, Ricinus*, *Alternanthera*, *Holoptelea*, *Xanthium* and *Cassia* in the atmosphere (Thakur et al., 2019). Pohekar and Kalkar (2016) conducted a daily survey of airborne pollen using Rotorod Air Sampler in Nagpur (Maharashtra). Pollen grains of Poaceae, Cyperaceae, *Achyranthes aspera, Brassica campestris, Lantana camara, Xanthium strumarium and Alternathera sessilis* dominated the atmosphere. The effect of meteorological parameters on pollen count was reported.

Central Region

In Korba (Chattisgarh), an industrial town, the samples of pollen were taken fortnightly using Rotorod air sampler. The study provided information on quantitative composition of atmospheric pollen grains. Out of total 40 identified pollen types during the study *Ailanthus, Carica, Datura* and *Parthenium* were reported as human allergens. Maximum pollen coint was of *Cynodon dactylon*, followed by *Parthenium hysterophorus*, *Ocimum sanctum* and *Cassia siamea* (Shukla and Shukla, 2010). Quamar and Chauhan (2011) made pollen analysis of spider webs from Khedla village (Betul District, Madhya Pradesh). They found dominance of pollen belonging to *Madhuca indica, Holoptelea integrifolia, Lannea coromandelica, Emblica officinalis* and *Aegle marmelos.* Their observation concluded that spider webs have been an efficient natural trap of airborne pollen grains and spores which reflects most of the local vegetation of the study area. Gupta (2017) identified 33 pollen grains from the atmosphere of Kampoo (Gwalior, Madhya Pradesh) using Burkard Portable Spore Trap Sampler. They found Poaceae pollen grain in maximum number followed by Asteraceae, Mimosaceae and *Cassia*.

DISCUSSION

In all the surveys atmospheric pollen coincided with the flowering season of local flora. Thus aerospora of any region is the depiction of surrounding vegetation showing annual variations

due to changes in various biotic and abiotic factors in subsequent years (Kalkar and Patil, 1994). The studies focussed on updating of pollen calendar in each geographical region at regular intervals as it gives an idea of any seasonal change of pollen count, introduction of any new pollen type or disappearance of any existing pollen type in the atmosphere (Agashe et al., 1999).

The studies focussed on higher concentration of anemophilous pollen in air. Anemophilous pollen being small, smooth, light weight and non-sticky are buoyant and transported to longer distance. The amount of pollen production is also greater in such taxa. They are the chief source of inhalant pollen allergens (Singh and Malik, 1992; Singh and Kumar, 2002).

Weather conditions like temperature, rainfall, relative humidity, wind speed and wind direction play an important role in the discharge, dispersal, prevalence and deposition of air-borne pollen grains (Singh and Babu, 1980; Kumar et al., 2015). The studies that correated the pollen count with meteorological parameters showed that rain free days, high wind, high temperature and low humidity generally favours pollen dispersal.

Some families like Poaceae, Chenopodiaceae, Amaranthaceae and Cyperaceae being stenopalynous could not be identified up to genus level.

Different sampling devices were used by different workers. Studies suggested that Burkard spore trap is the most widely used superior air sampling instrument for sampling particles smaller than 10um in size (Frenz, 1999). It is a volumetric pollen and spore trap with consistent flow and provides time discrimination of collected particles (Portnoy, 2000). Moreover the site and height of the sampling device has an effective role in trapping the pollen from air. Ogden et al. (1974) had provided guidelines for siting of the samplers. Pollen and spores from natural pollen trap like spider webs also provides interesting new frontiers to understand the aerospora, their dispersal and deposition in a particular region (Bera et al., 2002).

The extent of pollen allergenicity is variable at different sites as it depend upon various factors like, pollution level (Ruffin et al., 1986; Behrendt et al., 1992; Knox et al., 1997), rural and urban environment (Bosch-Cano et al., 2011), particle sizes (Agarwal et al., 1984) and genetic and environmental factors (Ahlholm et al., 1998). The aeropalynological studies are also important as pollen act as transmitter of various pathogens (Card et al., 2007). Various bacteria, virus and fungi are pollen transmitted (Pathak, 1980; Bhat and Rao, 2020). A research team from PGIMER and Panjab University, Chandigarh (India) examined the possibility of linkage between the pollen bioaerosols, COVID-19, meteorological parameters and anticipated risk in the severity of allergic rhinitis and asthma (Ravindra et al., 2021). Damialis et al. (2021) correlated the higher airborne pollen concentrations with increased SARS-CoV-2 infection rates.

These results focussed the importance of aerobiological results as a prerequisite in the allergy evaluation studies.

CONCLUSION

The studies taken in review suggest that knowledge of pollen season is helpful to both allergy practitioners and susceptible patients for managing pollen allergy. Creating awareness among people will help them to take preventive measures before the onset of allergic season to avoid any health hazard. Wearing a particle filtering mask for reducing the inhalation of allergenic

pollen and avoiding unwanted visits when pollen concentrations are high can keep both the virus and pollen out of the respiratory airways.

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