

# Microbiological Pollution of Air in Lal Bagh Botanical Gardens, Bangalore, Karnataka, India

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**Abstract:** *Bioaerosols significantly influence indoor and outdoor air quality and may cause numerous allergies and diseases. Intensity of habitual birds within the park and recreational garden exposes the visitors to elevated concentrations of bioaerosols that is mainly emitted by birds. Our study presents results of an evaluation of air quality in the Lal Bagh Botanical Garden in Bangalore. Air tests were conducted by using of impaction method at different sites of the garden and compared with Outdoor Air quality standards prescribed by Polish- European Environmental protection agency PN-89/Z-0411/02 and PN-89/Z-0411/03. The analysis indicates that bacterial pollution were the most abundant at Pigeon feeding/sheltering site and the bacterial number increased with distance of downwind. Negative rods dominated making up 45% and positive Cocci were 36% of the airborne bacterial community. Negative coccus was recorded as 13% and positive rod was recorded as 6%. Eight species of bacteria detected are Aeromonas sp., Enterococcus faecalis, Mycobacterium sp., Citrobacter sp., Pseudomonas sp., E.coli, Micrococcus, Staphylococcus sp. These pathogens may get aerosolized from Pigeon faecal matter and drops. The most abundant microorganisms in this region were fungi, the concentration of fungal number varied from 2,805 to 3,451 CFU/m<sup>3</sup>, predominating genera were Aspergillus, Fusarium and Alternaria contributed over 17%,15%,15% of all fungal genera. These fungal genera are strongly associated with asthma and other respiratory diseases which may get aerosolized from trees and thick vegetation in the garden. The overall microbial study revealed that Lal Bagh garden is moderately polluted according to the norms of the Polish- European Environmental protection agency. The high intensity of Pigeon population in the garden contributing bacterial and fungal pollution in the air and drives risk of health impacts on visitors.*

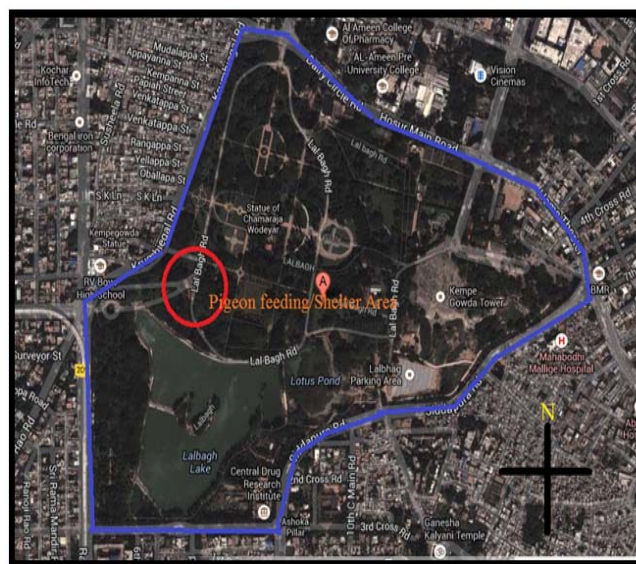
**Keywords:** Outdoor air, Pigeon, Air borne Bacteria, air borne fungi, health risk

## 1. Introduction

The measurement of airborne microorganisms in public parks and gardens has gained continuing interests for that many bioaerosols found in outdoor environments cause adverse effects to visitors. Biological particles such as bacteria, fungus, pollen, viruses, insect eggs, yeast and protozoan suspended in the air can be present in viable (culturable and nonculturable) as well as nonviable forms[1]. They can either exist as individual entities or create aggregates of biological structures. They can be also attached to dust particles formed from inorganic matter or to water or saliva droplets. The range of aerodynamic diameters of particulates in biological aerosols varies from submicron values up to ~200  $\mu\text{m}$ . Their aerodynamic sizes determine the depth of penetration and subsequent deposition in the human respiratory system, which in turn determines possible health effects[2][3]. The lifespan of air microbes is directly connected with their resistance to desiccation and ultraviolet radiation, which is different for various species. The longest lifespan is typical of bacterial spores, actinobacterial conidia and fungal spores adapted for surviving for extended periods of time even in unfavorable conditions. The microbial cells that produce a mucous halo or pigments protecting them from harmful UV radiation can also live longer in the air[4].

The present study was carried out to estimate the concentration of airborne bacteria and mould fungi in the air in the Lal Bag Botanical garden in Bangalore, where the people across India and residents of Bangalore spend their leisure time.

## 2. Study Area



Lal Bagh is a 240 acre garden coordinates 12.95°N 77.59°E located in south Bangalore, Karnataka, India. The garden has over 1,000 species of flora. The garden also has trees that are over 100 years old. Lal Bagh remains open daily from 6:00 a.m. to 7:00 p.m. throughout the year for the benefit of joggers, tourists and fitness enthusiasts.

## 3. Materials and Methods

### 3.1 Sampling

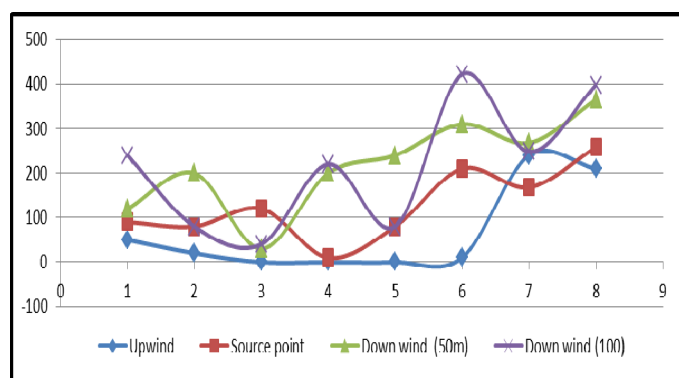
Air samples were collected from five different sites of the Lal Bagh garden as follows. 1. Pigeon feeding/shelter site

(Source point), 2. Upwind distance of 50 meters, 3. A downwind distance of 50 meters and 100meters, 4. Center of the garden. The air samples were taken at a height of 1.5 m, the breathing zone, above ground level between 8 AM and 3 PM during the normal working hours. Air samples were collected by impaction method using Anderson Microbial partial impactor (Hi Media, Model: 0526) at a flow rate of 6 L min<sup>-1</sup> for 5 min. Nutrient agar (Hi Media M022, India) were used to determine the total number of bacteria; Modified Martin rose Bengal agar (MRBA) and Potato Dextrose agar (PDA) used for quantification of fungi; Czapek-Doxa Agar (Hi Media, India) for filamentous fungi identification.

Petri dishes were incubated for 24–48 hours at 37°C (to determine the total number of bacteria) and for 5 days at 25°C to enumerate fungi. The results were shown by colony forming units in 1m<sup>3</sup> of air (cfu/m3). Bacteria were identified by macroscopic estimation followed by biochemical tests according to bacterial classification Bergey’s manual [5]. During air sampling, temperature, relative humidity, wind direction and speed were measured. The temperature (expressed in Celsius) and the relative humidity (expressed in %) was measured with a portable instrument (Envirotech, India). The wind direction and the wind speed (expressed in m/s) were determined by a portable anemometer (Enviro Tech, India).

**4. Result and Discussion**

The investigation results of microbial pollution in Lal Bagh Botanical garden are presented in Figs.1. There is evidence that the highest counts of heterotrophic bacteria were detected at Pigeon feeding/sheltering site and microbial number increased with distance of downwind. Pigeon feeding site is located besides the walking corridor, the bacterial pollution was recorded around 1,016 CFU/m3 and the fungal pollution was recorded as 3,040 CFU/m3. The total number of bacterial pollution at 50m downwind was recorded as 1,615 CFU/m3 and the fungus of 2,862 CFU/m3. At 100m downwind, the total bacterial pollution was 1,943 CFU/m3 and the fungus was 4,132 CFU/m3.



**Figure 1:** Microbial population of Different sites of Lalbagh botanical Garden

The bacterial pollution in air crossed the permissible limit prescribed by Polish- European Environmental protection agency PN-89/Z-04111/02 and PN-89/Z-04111/03 (Table: 1).The permissible limit is less than 1000 CFU/m3 for unpolluted area. Fungal pollution in Lal Bagh garden is

within the permissible limit of 3000 - 5000 CFU/m3. Less number of microbial pollution were observed at upwind distance of 50m. The total number of bacterial pollution was found to be 536 CFU/m3 and the fungal pollution was found to be 2,812 CFU/m3. The meteorological parameters like Temperature, Relative Humidity, Wind speed in Lal Bagh garden may favor the dispersion of mould fungi and bacteria from point source (Table 2).

**4.1. Tables**

**Table 1:** Microbial air pollution standard (Polish-European Protection Agency-89/Z-04111/02 and PN-89/Z-04111/03)

Air pollution levels (Polish standard PN 89/Z-04111/02)	Permissible concentration of mesophilic heterotrophic bacteria (CFU/m <sup>3</sup> )	Staphylococci (CFU/m <sup>3</sup> )	Permissible concentration of mesophilic fungi (CFU/m <sup>3</sup> )
Not polluted	<1000	0	3000 – 5000
Moderately Polluted	1000 - 3000	<25	5000 – 10000
Highly Polluted	>3000	>25	>10000

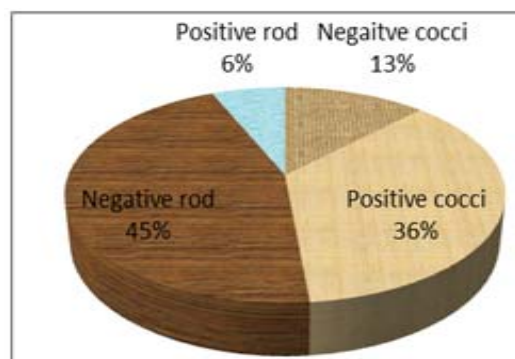
CFU

**Table 2:** Meteorological parameters of Lal Bagh Garden

Parameters	Minimum	Maximum
Temperature (°C)	24	26
Relative Humidity (%)	73	78
Wind speed (Km/h)	15	19
Wind direction	SSW	

**4.2 Bacterial Composition of Microbial Air Contamination**

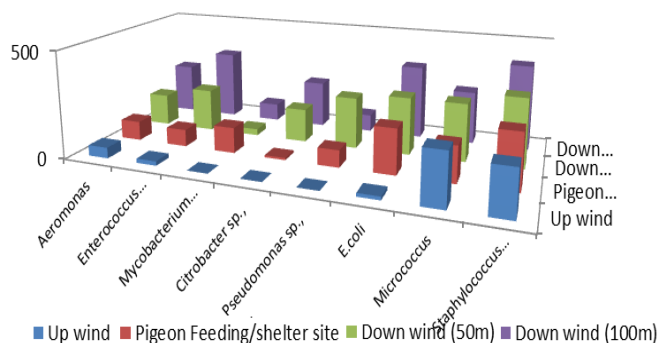
The microbial population at different sites reveals that the highest count of heterotrophic bacteria and fungi were observed in the air. Negative rods were dominated making up 45% and positive Cocci were 36% of the airborne bacterial community. Negative cocci were 13% and positive rod was 6%. (Fig.1). Eight species of bacterial organisms detected were *Aeromonas sp.*, *Enterococcus faecalis*, *Mycobacterium sp.*, *Citrobacter sp.*, *Pseudomonas sp.*, *E.coli*, *Micrococcus sp.*, *Staphylococcus sp.*



**Figure 2:** Percentage fractions of morphological forms of Bacterial pollution in Lal Bagh Botanical Garden.

The Bacterial pollution data suggest that *Staphylococcus* and *Enterobacter* genus were the most numerous at Pigeon feeding/sheltering site and the population number increased with distance of downwind. The estimated *Staphylococcus sp.*, pollution at Pigeon feeding site was found to be 258

CFU/m<sup>3</sup> and the population number increased to 322 CFU/m<sup>3</sup> and 398 CFU/m<sup>3</sup> at 50m and 100m distance of downwind (Figure.3). Similar findings expressed by Schulz *et al.*, state that *Staphylococci sp.*, are used as air quality indicators as they usually point out the pathogenic microbes present in the air [6]. Although this group of bacteria does not produce spores, they have the ability to survive in the air for a long time, which means spreading infections through the air. In the pigeon feeding/shelter site it was observed that high numbers of potentially pathogenic *staphylococci sp.*, exceeded the permissible limit, i.e. 25 CFU/m<sup>3</sup> which is risk to human health. The higher levels of *staphylococci sp.*, may be due to large number of animals and a large number of visitors as well [7].



**Figure 3:** Distribution of Bacterial Pollution in Lal Bagh Botanical Garden

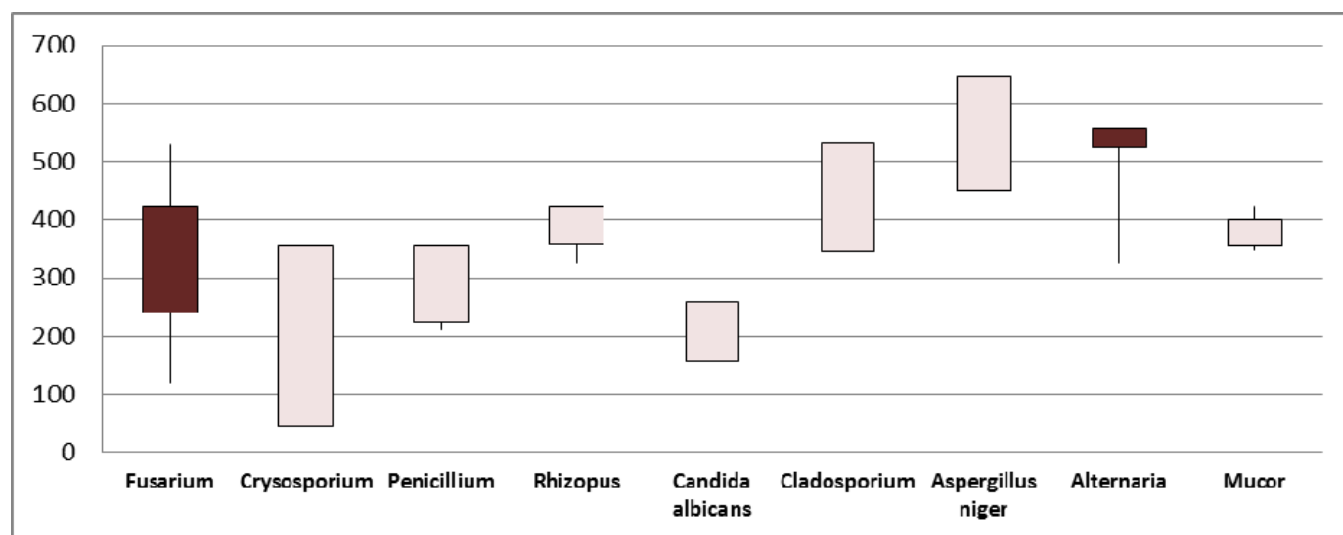
Similarly, *Enterococcus faecalis* and *E.coli*, were recorded around 80 CFU/m<sup>3</sup> and 210 CFU/m<sup>3</sup> at pigeon feeding/shelter site and the population number increased to 200 CFU/m<sup>3</sup> and 268 CFU/m<sup>3</sup> at 50m downwind distance, 328 CFU/m<sup>3</sup> and 347 CFU/m<sup>3</sup> at 100m downwind distance (Figure.4). According to Lues *et al.*, [8] *E. coli* and the other members of the coliforms bacteria could be a good indicators

of air contamination. These pathogens might have got aerosolized from Pigeon faecal matter and drops. Bacteria commonly found in the poultry industry include *Campylobacter spp.*, *Staphylococcus spp.*, *Salmonella spp.*, *Clostridium perfringens type*, *Enterococcus faecalis* and *Escherichia coli* [9][10].

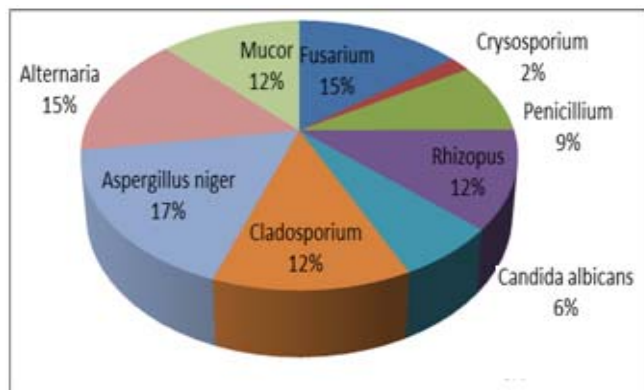
The species recorded include *Mycobacterium sp.*, *Citrobacter sp.*, *Pseudomonas sp.*, at Pigeon feeding/shelter site and downwind distance, where these organisms were not identified from upwind distance. This result reveals that these organisms might have got originated from Pigeon feeding site. Many studies reveal that *Mycobacterium sp.*, were highly prevalent in poultry farms [8][9][10]. *Mycobacterium* bioaerosols from metalworking fluids, swimming pools, hot tubs and water-damaged buildings are reported to cause respiratory diseases, including hypersensitivity pneumonitis. It is possible that *Mycobacterium sp.*, may play a role in the respiratory problem for visitors.

#### 4.3 Fungal Composition of Microbial Air Contamination

Nine species of fungul genera detected were *Fusarium*, *Crysosporium*, *Penicillium*, *Rhizopus*, *Candida albicans*, *Cladosporium*, *Aspergillus niger*, *Alternaria*, *Mucor* (Figure.5). The most abundant microorganisms in this region were fungi, the concentration of fungi number varied from 2805 to 3451 CFU/m<sup>3</sup> and predominating species of the genera were *Aspergillus*, *Fusarium* and *Alternaria* contributed over 17%, 15%, 15% of all fungal genera. Eventually, *Cladosporium* (12%), *Mucor* (12%) and *Rhizopus* (12%) contributed to the pollution of the air (Figure.6).



**Figure 4:** Upwind and Downwind Fungal pollution in Lal Bagh Garden (Include *sp.*, in the graphs)



**Figure 6:** Fungal composition found in the outdoor air in the Lal Bagh garden

A similar pattern was observed by Marta et al., [7] who found that Mould fungi made the highest percentage (66-75%) of studied airborne microorganisms in the air in the recreation park. Allergies develop mostly in organisms attacked by mould fungal species of genera *Cladosporium*, *Alternaria*, *Penicillium* and *Aspergillus* genera; *Cladosporium* and *Alternaria* are typical outdoor microflora. The population of species of *Cladosporium* and *Alternaria* is a important parameter of microbiological quality of air and both fungi are objects of interest all over the world because of their negative influence on human health. *Cladosporium sp.*, and *Alternaria sp.*, live as saprophytes or as parasites in many kinds of plants. *Cladosporium* is the most common airborne fungus in the temperate zones. *Alternaria* is the predominant fungus demonstrated in warm and humid climate [11][12]. Both are strongly associated with asthma and other respiratory diseases.

A considerable number of *Fusarium sp.*, and *Alternaria sp.*, were found in the air in Lal Bagh Garden which may be health risk to visitors. *Fusarium sp.*, is cosmopolitan and distributed worldwide, is considered good secondary metabolite producers [13] and some of them could be human pathogens or at least opportunistic fungi [14][15]. It is common and widespread on many different substrata, able to be isolated from air, painted wood, soil, and many different plants and cereal cultures in tropical and subtropical climates [16].

A large number of mould fungi are confirmed by the fact that these microorganisms are well adjusted to spreading in the air and to survive in unfavorable conditions owing to the production of spores resistant to the following atmospheric factors: UV radiation and low humidity [17]. As they can also easily develop on the soil surface and on the shrubs and trees, their high count in the park is justifiable [18].

## 5. Conclusion

The detailed study of microbial pollution revealed that the occurrence of bacterial pollution were higher near the Pigeon feeding /shelter site and it wide spread in the air of the Lal Bagh garden. High intensity of Pigeon population in the garden contributing bacterial pollution in the air and drives health impacts on visitors.

## 6. Acknowledgement

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