Research Article

# Determination of Air Pollutants ($PM_{2.5}$) along Wagah border Lahore, Pakistan

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**Abstract |** Air quality is increasingly becoming a global problem due to intensification in industrial development and urban sprawl. Air quality is not only worsening in megacities but has much deteriorated in villages of Pakistan as well. In the present study, air qualities at 3 sites along the border were evaluated. $PM_{2.5}$ was monitored for four months for the time period of 5 hours at each sampling site by using Mini Vol portable air sampler. A total of 50 samples, from the 3 sites were collected. For the identification of microbial flora (Bacterial and Fungal) LM (light microscopy) and SEM (scanning electron microscopy) were used correspondingly. Filter papers containing particulate matter ($PM_{2.5}$) were placed on prepared petri dishes. Colonies appeared after 24 hours of incubation at appropriate temperature. Generally, the concentration of $PM_{2.5}$ was found to be greater than the permitted range specified by National ambient air quality standard (NAAQS). A higher microbial concentration was detected in the Wagah border and Ganda Singh while lower in Beddiyan. Different bacterial and fungal strains were identified from collected samples. The mean standard deviation of bacterial counts ranged from 320.3±72.1 cfu/$m^3$ to 481.5±286.5 cfu/$m^3$ and the mean fungal counts ranged from 87.10±44.2 cfu/$m^3$ to 158.9±85.7 cfu/$m^3$.

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## Introduction

One of the greatest menaces to human wellbeing is air pollution. As the world is technologically and industrially advancing in a rapidly manner, here is a notable rise in emission sources such as automobile, industries, burning of solid waste, along with the rise in population, development, unsatisfactory air quality administration and emission regulating approaches have become primary reasons for deterioration

of air quality (Ali *et al*., 2015). The levels of air pollution are of grave welfare attention for people, predominantly in developed parts of the World and are linked with a number of illnesses such as lung malignancy, heart disease, and childhood asthma (Shmuel *et al*., 2017). Air pollution related to transportation has emerged as a major benefactor of universal air pollution. Diesel exhaust is the most significant and encompasses more than 40 poisonous air contaminants as well as being the chief contributor to ambient PM (particulate matter) mainly of fine $PM_{2.5}$ (Costa *et al*., 2017). Transportation vehicles cause $PM_{2.5}$ and $PM_{10}$ contamination that have lethal effects on both human health and air quality (Abbas *et al*., 2017). Numerous microorganisms are present in the air (Smets, 2013). Usually bacteria in the air do not disturb health, although greater counts of bacteria designate overloading or reduced ventilation (Qadir *et al*., 2012). Some biological contaminants are capable of triggering allergies such as hypersensitivity pneumonitis, allergic rhinitis and few forms of asthma. These pollutants may also irritate the human skin or cause bodily harms such as headache, weakness, and other irritations (Zweer, 1996; Manisalidis *et al*., 2020). The current research work was designed to evaluate the concentration of $PM_{2.5}$, isolate and characterize airborne bacteria from the culture media.

## 2. Materials and Methods

### *2.1. Sampling site*

The present study was carried out at 3 sites along the trans-boundary area of Indo Pak border between Lahore to Kasur namely Wagah border, Beddiyan and Ganda Singh. From 3 different sites, total 50 samples were collected during the months of January 2021 to May 2021.

#### *2.1.1. Site-I: Wagah Border Lahore*

Wagah is situated 600 meters (2,000 ft) west of the border and lies on the historic Grand Trunk (GT) Road between Lahore in Pakistan and Amritsar in India. The latitude of Wagah is 31.604°N and longitude is 74.572°E. Wagah is a village located in the Wagah Zone of Lahore, Punjab, Pakistan. Wagah town Lahore is an industrial zone boasting traffic hubs, agricultural land and residential zones as well. The town is famous as a transit terminal for goods and a railway station between Pakistan and India.

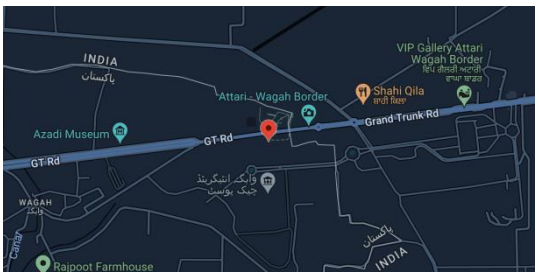


**Figure 1: Wagah Border Lahore**

#### *2.1.2. Site-II: Beddiyan*

Beddiyan is a village in the District Kasur of Punjab, Pakistan, close to the Indo Pak border. Coordinates of the site are 31.3152°N and 74.5028°E. After the British East India Company conquered Punjab, they created the Upper Bari Doab Canal (UBDC) system, bringing waters from the Ravi River to irrigate lands in the Bari doab (the interfluvial regions between the Ravi and Beas-Sutlej rivers). The main branch of the UBDC runs through the village of Beddiyan.

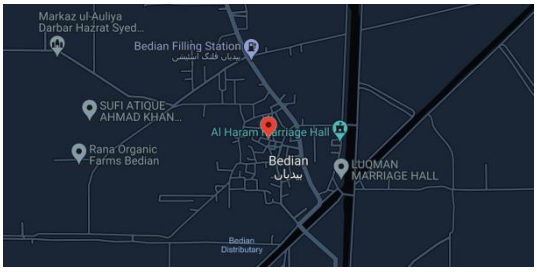


**Figure 2: Beddiyan**

#### *2.1.3. Site-111: Ganda Singh Kasur*

Ganda Singh Kasur is located in the District Kasur Lahore division of the

Punjab Province, Pakistan. It is situated 55 kilometers south of Lahore and adjacent to the border of Ganda Singh between Pakistan and India. The latitude and longitude of this site are 31.0386°N, 74.5178°E respectively. It is bounded on the north by Lahore district, on the east and south east by India. Until 1986, it served as the main border crossing between Pakistan and India. The Sutlej River flows by Ganda Singh and the area is prone to flooding.

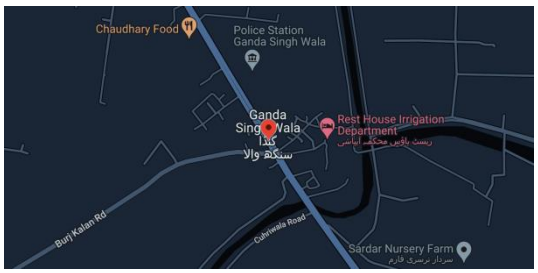


**Figure 3: Ganda Singh Kasur**

### *2.2. Sampling*

Atmospheric $PM_{2.5}$ was detected by means of portable mini volume air sampler (MiniVol SN:3224) on micro fiber filters between 10:00am and 3:00pm from January, 2021 to May, 2021 from 3 locations. At ambient temperature and atmospheric pressure, the aerosol masses for $PM_{2.5}$ were measured by evaluating the filters before and after disclosure (Goudarzi *et al*., 2019; Farsani *et al*., 2018).

### *2.3. Identification of microflora*

#### *2.3.1. Bacterial characterization*

A cross-sectional study was conducted to determine the levels of $PM_{2.5}$ and to assess microbial count in outdoor air at selected sites. The direct air sampling technique was used to obtain air samples on prepared nutrient agar plates. The substantial dirt elements, droplets and humidity to which microbes may be attached and settle upon the upper film of the nutrient agar. Nutrient agar plates were exposed in sampling areas and incubated for 24 hours at 37°C (Fang, 2007). The colonies were morphologically and biochemically identified using Burgey's Manual of systematic bacteriology. The Gram-staining technique was used to distinguish Gram-negative and Gram-positive bacteria. Different biochemical tests were performed for the biochemical characterization of the isolated bacteria including Urease test, Coagulate plasma test, carbohydrate fermentation test, Motility test, Catalase test, and Oxidase test.

#### *2.3.2. Fungal characterization*

Fungal spores were collected through the filters at rates of 2-10L $Min^{-1}$. The microscopic specimen were taken from the medium and inspected with an electron microscope by SEM approach (40 kV). The quantity of bacteria was calculated subject to the spore concentration on the filters. Surfaces having a culture medium were then incubated. For the colony counts, the positive hole correction technique was employed. Different species were identified by SEM analysis after the filter was prepared by pressing a Nucleopore filter slightly onto the culture (Heikkila, 1988).

## 3. Results

In present study the particulate matter concentration was measured from 3 sites along the trans-boundary area of Indo Pak border between Lahore to Kasur namely Wagah border, Beddiyan and Ganda Singh. Among the 3 sites, the $PM_{2.5}$ concentration calculated was maximum at Wagah border i.e. 114.6 µg/m³ and lowest at Beddiyan i.e. 78µg/m³ (Table 1).

The concentration of $PM_{2.5}$ measured for 24 hours in each month at Beddiyan was 65µg/m³, 86µg/m³, 83µg/m³, 78µg/m³ respectively, which is above the NAAQS recommended limits (35µg/m³). For four months the mean value was 78.4µg/m³. The monthly $PM_{2.5}$ mean concentration in Ganda Singh was 121µg/$m^3$, 113µg/$m^3$, 127µg/$m^3$, 52µg/$m^3$ respectively, which is

higher than the NAAQS (35µg/m$^3$ per 24 hours). The collective mean value at Ganda Singh was 103.25 µg/m³ (Figure 1). The average $PM_{2.5}$ concentrations at Wagah were 132µg/m$^3$, 140µg/m$^3$, 86µg/m$^3$, 100µg/m$^3$ respectively, above the NAAQS recommended range. The mean value for 4 months at Wagah was 114.6 µg/m³.

| Sr. No. | Months | Beddiyan | Ganda Singh | Wagah Border |
|---|---|---|---|---|
| 1. | March | 65µg/m³ | 121µg/m³ | 132 µg/m³ |
| 2. | April | 86µg/m³ | 113 µg/m³ | 140 µg/m³ |
| 3. | May | 83µg/m³ | 127 µg/m³ | 86 µg/m³ |
| 4. | June | 78µg/m³ | 52 µg/m³ | 100 µg/m³ |
| Mean Values | | 78µg/m³ | 103.25 µg/m³ | 114.6 µg/m³ |

**Table 1: $PM_{2.5}$ concentrations of 3 sites along trans-boundary area of Indo Pak border**

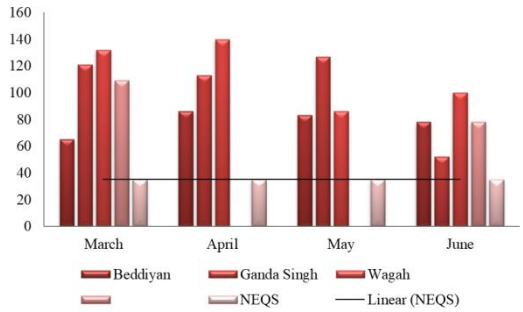


**Figure 4: Average mean values of $PM_{2.5}$ concentrations compared with NEQS of 3 sites along trans-boundary area of Indo Pak border**

The total number of colonies isolated are shown in Table 2. The calculation of bacterial colonies was made by the (Total colonies x 1,000)/100=Total counts (colony forming units/m$^3$ or cfu/m$^3$).

| Sr. No. | Bacteria | Sites | Bacteria colonies identified | | |
|---|---|---|---|---|---|
| | | | W1 | W2 | W3 |
| 1. | *Micrococcus luteus* | Wagah | 30 | 28 | 32 |
| | | Beddiyan | 35 | 30 | 22 |
| | | Ganda Singh | 73 | 57 | 30 |
| 2. | *Staphylococcus aureus* | Wagah | 60 | 18 | 21 |
| | | Beddiyan | Nil | 09 | Nil |
| | | Ganda Singh | 17 | 22 | 10 |
| 3. | *Bacillus subtilis* | Wagah | 45 | 11 | 11 |
| | | Beddiyan | 07 | 08 | 12 |
| | | Ganda Singh | 11 | 18 | 10 |
| 4. | *Streptococcus spp.* | Wagah | 20 | 11 | 07 |
| | | Beddiyan | 14 | 09 | 14 |
| | | Ganda Singh | 08 | 15 | 10 |

**Table 2: Bacterial colonies isolated from 3 sites along trans-boundary area of Indo Pak border**

The concentration (cfu/m$^3$) of airborne bacteria from $PM_{2.5}$ at 3 different trans-boundary area of Indo Pak border are shown in Table 3.

| Sr. No. | Sites | Mean ± Standard deviation (cfu/m³) for bacterial count from PM 2.5 |
|---|---|---|
| 1. | Beddiyan | 320.3 ± 72.1 |
| 2. | Ganda Singh | 470.0 ± 409.5 |
| 3. | Wagah | 481.7 ± 286.5 |

**Table 3: Mean and standard deviation of bacterial count from samples of trans-boundary sites**

Microscopic and Gram staining characteristics of isolated bacteria were used to identified them. A large number of colonies isolated from the sites were of *Micrococcus spp.* and *Staphylococcus spp.* while a few number of colonies isolated were of *Bacillus spp.* and *Streptococcus spp.* For bacterial sum the mean ± standard deviation was 401.7±218.3 cfu/m$^3$ from $PM_{2.5}$. Air samples collected from Wagah and Ganda Singh had the highest mean bacterial count 476.7±151.4 and 493.3±175.0 from $PM_{2.5}$ collected from Beddiyan had lowest mean bacterial count (203.3±61.1) cfu/m$^3$ and (196.7±106.9) cfu/m$^3$ from $PM_{2.5}$. Mean fungal count from samples of different sites are shown in Table 4.

| Sr. No. | Fungal species | Mean (cfu/m³) fungal count from $PM_{2.5}$ |
|---|---|---|
| 1. | *Aspergillus* | 91.01±47.2 |
| 2. | *Penicillium* | 87.10±44.2 |
| 3. | *Cladosporium* | 101.9±81.7 |
| 4. | *Yeast* | 158.9±85.7 |

**Table 4: Mean fungal count from samples of trans-boundary sites**

## 4. Discussion

Major sources of particulate matter are biomass burning and vehicular pollution. However highest concentrations of atmospheric particles tend to occur near roads and are transported over long distances. Present study provides an over view of mean $PM_{2.5}$ vales at three major trans-boundary sites along the Indo Pak border. Challenges related to the air

pollution have become the main global focus post-COVID (Alava and Singh, 2022). The latest statement on ambient air pollution by World Health Organization advocates that in 2008 and 2013 annual mean values of PM have improved further worldwide in more than 5% in 720 cities (WHO, 2016). Air pollution is more conspicuous at certain localities, referred to as hot spots for instance signalized traffic junctions and high contamination. The USEPA outlines the signalized traffic connections as small geographical positions with high concentration of pollutant than the NAAQS (Niaz *et al*., 2016). PM also exaggerates several health difficulties and has been associated with health related disorders due to heart and lungs infections. It can intensify the vulnerability of breathing contagions and exacerbate prevailing respirational diseases, such as asthma and prolonged bronchitis (Penkala *et al*., 2018).

The mean and standard deviation of bacterial totals from samples of different sites in our study shows highest concentration at Wagah and lowest at Beddiyan. Substantial associations have been established between atmospheric factors (particularly, relative moisture component) and bacterial and mycological development. The mycological and bacterial outdoor concentrations were found to high throughout monsoons (Niazi *et al*., 2015). Atmospheric $PM_{2.5}$ can transfer diversities of pathogenic entities such as heavy metals, viruses, and bacteria owing to the adverse health outcomes. Epidemiological research established a resilient association between high toxic ambient air, noxious heavy metal components and morbidities and mortalities (Liu *et al*., 2017). Basic environmental factors like temperature and humidity can significantly affect the levels of microbial development and may spread rapidly. The occurrence of bio aerosols can be linked with definite human illnesses, like pneumonia, cold, measles, asthma, sensitivities, and digestive diseases (Kim *et al*., 2018).

In present study, the studied areas were surrounded by the traffic, trans-boundary biomass burning and dust particles which may cause airborne diseases. Seasonal variations in different microbial clusters verified presence of Gram positive *cocci* and *bacilli*. Current study revealed that both non-pathogenic and pathogenic microflora was predominant in the studied areas. Though, many of the microbes found were chiefly non-infectious nonetheless, inhaling non-infectious microbes and their elements may be responsible for lung infection whereas antigens and allergens may cause allergic and immunotoxic effects by stimulating the immune system (Colbeck *et al*., 2011; Mirkov *et al*., 2021; Falcon and Caoili, 2023).

The present study found the gram-positive cocci (*Micrococcus luteus*, *Streptococcus spp.* and *Staphlococcus aureus*) and rods (*Bacillus subtilis*) from the air in the study areas. These reslts are in agreement with a similar study conducted in the Skyway stations, Bankok which found most bacterial cultures that were gram-positive cocci i.e. *Staphylococcus spp.* (Luksamijarulkul and Kongtip 2010). Similarly, a study conducted in Beijing noticed that in summer and autumn there were high microscopic contaminations in the air when the temperature and moisture components justifed optimal situations for the airborne microbes (Fang *et al*., 2007). A number of studies have showed that atmospheric microbes in outdoor atmospheres regulate the concentration distribution. Several factors regulate the concentration of microorganisms, together with regular and periodic climatological variations, flora, air pollution, agronomic, manufacturing, and other anthropogenic activities (Rogula-Kozłowska *et al*., 2013; Ali *et al*., 2015).

## 5. Conclusion

From current study, it is determined that particulate contamination in air and universal environment affects human health. Exposure to high extent of PM is directly associated with high rates of illness and deaths. PM fractions detected in current work were directly linked with reference to microbial vegetation. The air quality of 3 trans-boundary sites Wagah, Ganda Singh, and Bddiyan were measured. According to outcomes, it was found that trans-boundary pollution means were responsible for high amount of particulate pollution in the study zone. The value of $PM_{2.5}$ was more than the NAAQS in Wagah. It is recommended that further strategic and comprehensive research should be directed and monitoring approaches should be adopted to lessen additional loss on air and human fitness.

## 6. Acknowledgments

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## 7. Author's Contribution

All authors have equal contributions towards the publishing of current manuscript.

## 8. Conflict of Interest

All authors state that there are no conflicts of interests.

## 9. Novelty Statement

The current research was designed to evaluate the concentration of $PM_{2.5}$ at 3 major trans-boundary sites Wagah, Ganda Singh, and Baddiyan and to isolate and characterize airborne bacteria in studied areas. The study further described the frequency and morphology of the identified bacterial and fungal colonies. The highest concentrations of atmospheric particles occurred near roads due to vehicular pollution and trans-boundary biomass burning. Identification of particulate pollution is a vital step towards control and management of air quality.

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