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Research Paper

Cadmium and Lead Retention Efficiency in the Leaves of Ten Local Tree Species in Faisalabad

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Abstract: Pollution has major negative impact on human health. The discharge of gaseous volatile organic and inorganic contaminants from industries, factories, motor cars, aero planes, and ships causes a persistent decline in air quality, accomplished with outbreak of several disease and even mortality. This study estimated the concentration of Cd and Pd concentration in leaves in district Faisalabad which is the 3rd largest city of Pakistan and industrial zone. In the industrial city of Faisalabad, excessive traffic on the highways and industrial trash are seriously polluting the environment. Study revealed clear spatial and species-specific variations in Pb and Cd accumulation, with urban sites showing the highest concentrations, followed by suburban and rural areas, due to intense anthropogenic activities. Among species, *Syzygium cumini* and *Alstonia scholaris* demonstrated the greatest potential for Pb and Cd accumulation. The observed differences strongly reflect the influence of site-specific pollution load and leaf morphological traits on particulate retention.

Keyword: Pollution, Cd and Pb filtration, trees, Faisalabad

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1. Introduction

Atmospheric pollution is a major global health issue. Air contaminants are released into environment by different sources such as industries, factories, motor cars, aero planes, and ships (Gurcam *et al.,* 2021). The discharge of gaseous volatile organic and inorganic contaminants causes a persistent decline in air quality, accomplished with outbreak of several disease and even mortality (Manisalidis *et al.,* 2020). In several urban areas, atmospheric pollution has a major negative impact on human health such as discomfort and smog can have negative economic and societal impacts. According to studies, traffic emissions, which include CO_2, CO, NOx, and other gaseous components as well as dust and soot particulates, are one of the main causes of urban air pollution. Additionally, this pollution has a substantial negative impact on structures, plants, and public health (Dwijendra *et al.,* 2023; Madhav *et al.,* 2019). Globally, the air quality is getting worse due to atmospheric pollution. One of the most major transient sources of inhalable particles is road dust, and especially its smaller particles can be carried to the atmosphere by wind or moving vehicles. Road dust frequently contains particulate matter from a variety of sources, including vehicle exhaust (Singh et al., 2020).

Among the air contaminants, heavy metals and dust particles are major problem because of the development of industrial

sector, the high frequency of immigration, and rapidly increasing urbanization (Roy *et al.,* 2024; Adnan *et al.,* 2022; Nsemo, 2019). Heavy metal contamination is a significant environmental hazard. Anthropogenic activities added these elements into the ecosystem (Farid *et al.,* 2023). Cadmium (Cd) is one of the most hazardous heavy metals for both flora and fauna. Cd is mostly added into the soil-plant ecosystem as a result of anthropogenic activities. Because Cd compounds are more soluble than other toxic substances, they are more readily absorbed by plants, where they can amass in edible plant portions (Farid *et al.,* 2023). Cancer, kidney, lung, hepatic, skeletal, and reproductive problems may result from excessive Cd exposure. The lungs, kidneys, bones, and overexposure suffer the most from heavy metal toxicity. But it is also mentioned that skeletal and reproductive problems could have serious consequences (De Souza *et al*., 2019). A sizeable portion of the Cd that reaches the soil and plants is due to the precipitation of Cd from the air in the form of microscopic dust particles. Near industrial and active areas, the air contributes more than 40% of the accumulated Cd in plants (Nsemo, 2019; Ramesh and Gopalsamy, 2022).

Lead (Pb) is a typical weighty metal tracked down in soils, plants, and water. Pb is released into the climate because of mining, modern, and agrarian exercises (Farid *et al.,* 2023). Evaluating the measures of lead, cadmium, and copper in the climate is clearly vital. For every single human populace, the World Wellbeing Association (WHO) discovered that the OK week by week admissions of Cd and Pb were 0.007 and 0.025 mg kg1 body weight, separately (WHO, 2022). In an end, it tends to be seen that even at very low fixations, these two metals represent a gamble to human wellbeing. It is very much perceived that private warming, significant distance transportation, and traffic are the essential wellsprings of a few weighty metals, (Alshmailawi and Atia, 2021; Bahiru, 2021). It is stated that variations in the lead levels of the vegetation and soil along the sides of highways are closely connected to traffic density (Adnan *et al.,* 2022; Abderrahmane *et al*., 2021).

Plants are important parts of the habitat, and they can help to better the quality of urban environments (Fineschi and Loreto, 2020). Heavy metals can be absorbed and accumulated by plants via their leaves and roots surfaces (Fineschi and Loreto, 2020). Several plant species have potential of absorbing and accumulating significant concentrations of potentially harmful substances (Raj and Maiti, 2020; Fineschi and Loreto, 2020). Plants are important bio-indicators and low-cost alternatives to filter air. They provide a comprehensive exposure throughout a specific timeframe (Angon *et al.,* 2024; Sharma *et al.,* 2020). Present study is particularly directed toward the determination of Cd and Pb concentration in different tree species of Faisalabad district. Faisalabad is the 3rd largest city of Pakistan and experiencing severe environmental issues due to its expanding population, increased number of automobiles, and industrial sectors. The usage of numerous modes of transportation, particularly privately owned vehicles, has intensified the air quality dramatically in a very short period of time, resulting in severe pollution in Faisalabad. Moreover, it is a growing industrial hub of Pakistan. There are 512 large industrial units, including 328 textile units, 92 engineering complexes, and 92 chemical and food processing factories. Additionally, there are over 12,000 national industries, including over 6000 electric weaving mills, which contributes to a significant traffic strain (Khan *et al*., 2020). Therefore, the study was designed to determine the levels of heavy metals (Cd and Pb) using tree leaves as indicators of atmospheric trace metal pollution in Faisalabad and to evaluate the dust load in the leaf dust of different tree species in different sites of city Faisalabad.

2. Materials and Methods

2.1 Study area

Study was conducted in District Faisalabad which is the 3rd largest city of Pakistan and industrial zone. In the industrial city of Faisalabad, excessive traffic on the highways and industrial trash are seriously polluting the environment. Particularly in its metropolitan regions, automobile operations contribute a variety of harmful metals to the environment. The city is connected to the districts of Lahore, Rawalpindi, and Sheikhupura via metallic roadways. The leaves samples were collected from different sites (Manawala, Khurrianwala, Maqbool road, Sargodha Road, Botanical garden (UAF) and Madina town) of Faisalabad district. The tree leaf samples were collected from these sites. Decision regarding proposed sample zones was made after a detailed examination of traffic density and industry distribution patterns throughout the study area.

2.2. Tree species

The following ten tree species were selected for study based on their availability and frequency along the roads in the selected areas:

Bombax cieba (BC), *Terminalia arjuna (TA)*, *Dalbergia sissoo (DS)*, *Morus alba (MA)*, *Ficus benghalensis (FB)*, *Ficus religiosa (FB)*, *Alstonia scholaris (AS)*, *Conocarpus lensifolius (CL)*, *Eucalyptus camaldulensis (EC)* and *Syzygium cumini (SC).*

Leaf collection and Determination of Cd and Pd concentration in leaves

Leaves were collected from three trees per species. Care was taken while collecting the leaves that they were collected from road facing side. Collected leaves were placed in paper bags and brought to department lab. To decide the Cd and Pb fixation, tests were taken to the lab. Collected leaves from the road side trees were washed with faucet water. To eliminate outer pollution, the leaves were washed with distillated water. After that leaves were washed with weakened hydrochloric acid and again washed with refined water. leaves were air dried and afterward positioned in a heat oven at 70˚C for 18 hours. The dried examples were grounded to make fine powder. The acid combination was ready by blending of $HClO_4$ and HNO_3 with a proportion of 1:3. One gram of leaf powder tests was taken and added into jar containing 12 ml of diacid combination and left over night. The next day, the samples were processed on a hot plate until the plant material was totally digested. After digested, the example was cooled and were left over night. Later on, samples were sent to Hi-Tech Lab, university of Agriculture for Cd and Pb analysis using Spectrophotometer.

2.3. Data analysis

We All collected data was compiled and tabulated in a Microsoft Excel spreadsheet. The experiment was performed in a completely randomized design. Statistictica version 8.1 or any other statistical program was used to analyze the data. One way ANOVA was performed and Tukey's HSD test at probability level 5% was used to compare the means.

3. Results and Discussion

3.1. Concentration of Pb and Cd in the leaf wash

The results showed that the concentration of Pb and Cd varied among the three sites (Figure 1 and 2). Highest concentration of Pb and Cd was found in the urban site (34.9 and 8.10 ppm) followed by suburban (17.4 and 5.26 ppm) and least was found in rural site (7.1 and 5.03 ppm) as (Zereg et al., 2022) found that particulate deposition and surface absorption are highly site specific. Similar findings were observed have been reported by (Cui et al., 2022) Who illustrated that elevated Pb levels in urban vegetation compared to suburban and rural

areas. Rural site had the lowest concentrations, which is consistent with the reduced human activities and pollution load in these areas. Another study demonstrated the similar findings in which (Zhang et al., 2019) confirmed that urban areas are hotspot

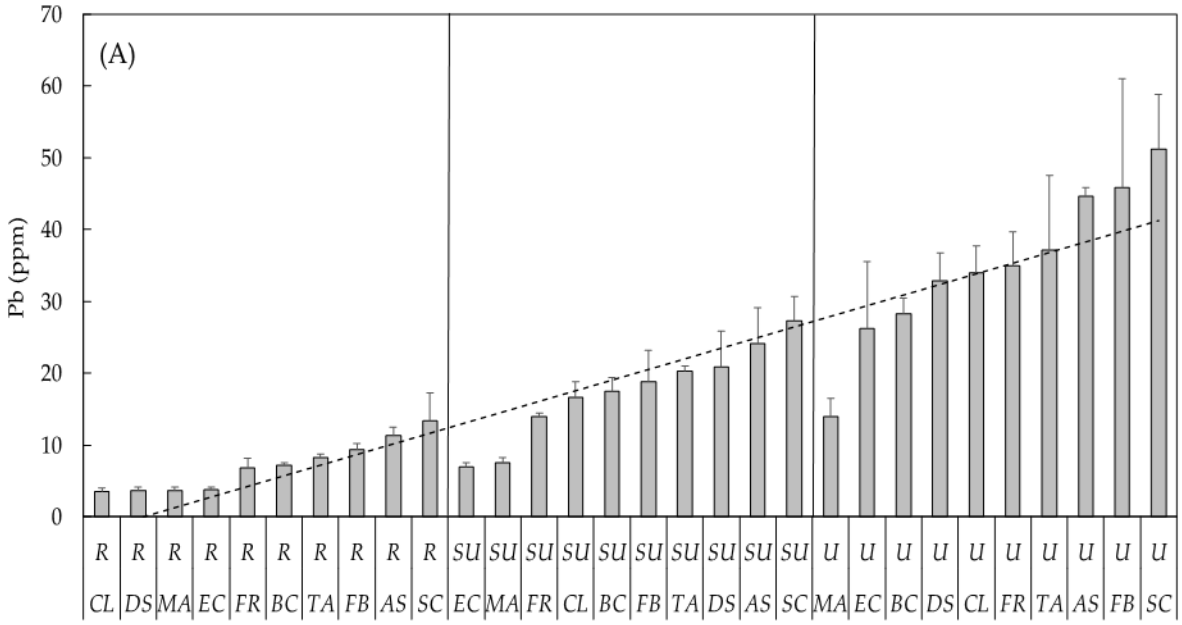

Figure 1: Concentration of Pb varied significantly among the species where highest concentration of Pb was found in the leaf wash of *Alstonia scholaris* (7.61 ppm) and least was found in the leaf wash of *Morus alba* (4.05 ppm) in all three locations.

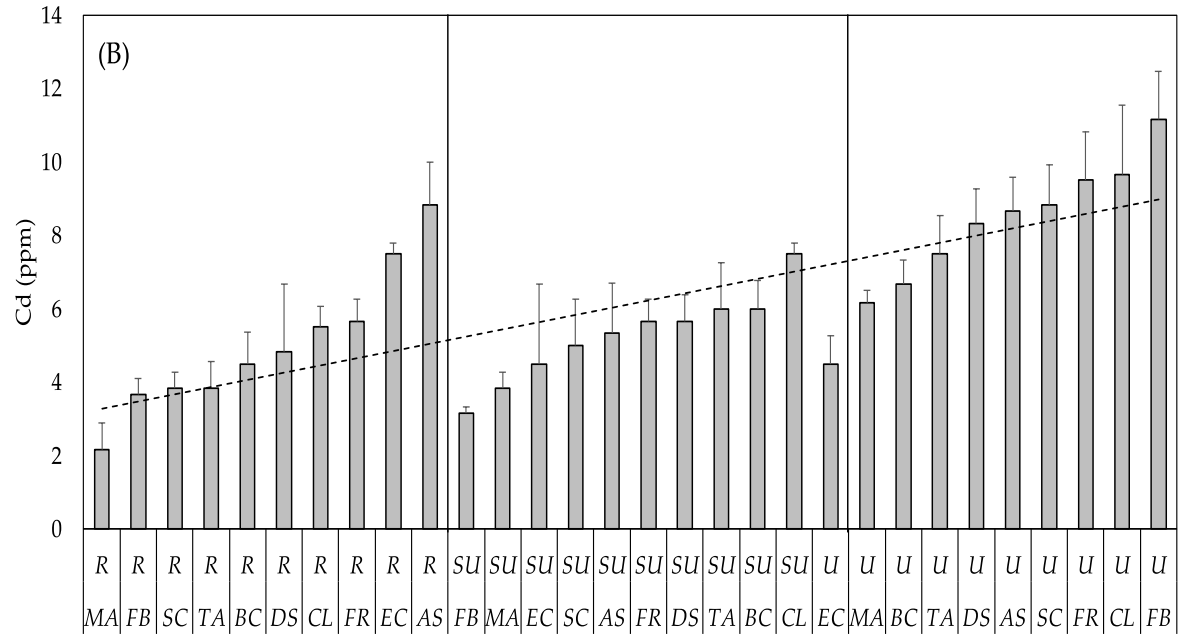

Figure 2: Concentration of Cd varied significantly among the species where highest concentration of Pb was found in the leaf wash of *Alstonia scholaris* (7.61 ppm) and least was found in the leaf wash of *Morus alba* (4.05 ppm) in all three locations.

for heavy metal deposition on vegetation. (Khan et al., 2020) also found significantly higher Pb and Cd in leaves from urban (traffic-impacted sites) than from suburban

and rural sites, attributed this to vehicle emissions, industrial discharges and greater particulate matter load in cities. Concentration of Pb also varied significantly among the species (Figure 1 and 2) where highest concentration of Pb was found in the leaf wash of Syzygium *cumini* (30.6 ppm) and least was found in the leaf wash of *Morus alba* (8.38 ppm), respectively. This aligns with the findings of (Ramesh and Gopalsamy, 2022), who reported *Syzygium cumini* as effective bio-monitors of airborne metals. Also, in line with the findings of (Jiang el at., 2019) who conducted an experiment and found that mulberry tree species were all not hyperaccumulators for Cd and Pb. Concentration of Cd also varied significantly among the species where highest concentration of Pb was found in the leaf wash of *Alstonia scholaris* (7.61 ppm) and least was found in the leaf wash of *Morus alba* (4.05 ppm), respectively. These findings are consistent with the (Singh, 2023), who found that *Alstonia scholaris* showed noticeable air pollution tolerance index and leaves captured high number of heavy metals. Another study demonstrated similar findings in which (Jia et al., 2021) compared common topical species for dust capture and metal accumulation; species with rough, hairy or waxy leaves capture more particulate matter and show higher surface-bound metals. The differential accumulation across species highlighted the potential of *Syzygium cumini* and *Alstonia scholaris* as effective biomonitors for Pb and Cd, respectively. These findings emphasize the importance of selecting appropriate plant species for monitoring and mitigating urban air pollution. Study strongly emphasized that leaf morphological traits (surface roughness and waxiness) influence leaf metal loads and particulate capture. The outcomes of the study is that the tree species growing in the urban centers endure more heavy metal pollutants as in this study meatal contamination was highest in tree leaves collected in urban center, followed by suburban and rural areas. Secondly, the highest concentration was found in *Syzygium cumini* and least was found in *Conocarpus lansifolius*.

Conflict of Interest:

The Authors declare that there is no conflict of interest.

Authors' Contribution statements:

Fahad Rasheed and Asif Iqbal executed the experiment and prepared the draft after lab analysis.

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