Heavy Metals Analysis of Particulate Matter Removed by Trees

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Introduction

Particulate matter (PM) is a complex mixture of extremely small particles and liquid droplets suspended in air. Trees can remove particles from the atmosphere through their leaves, therefore improving air quality. Recent studies suggest the capacity of trees to remove PM from the air is controlled by the chemistry and morphology of their leaves.[1,2]

The goal of this project is to analyze the composition of PM for three species of trees commonly grown in St George, Utah: Pyrus Calleryana Bradford, Prunus x Cistena, and Chilopsis Linearis.

Materials and Methods

Materials

Samples were collected from same location in Fall 2018. Each tree was located near a major road and in a remote location in St. George, UT. The leaf sample from each tree accounted for 300 cm^2 surface area.

PM extraction

Surface PM were extracted with 100 mL water and wax PM were extracted with 100 mL chloroform by shaking the samples in each solution for 90 seconds. Various sizes of PM were separated by filtration[1] using Whatman filtration papers.

Characterization

Filters were analyzed using an Elan 6000 DRC-ICP-MS with specific methods created for the elements being analyzed.

Results

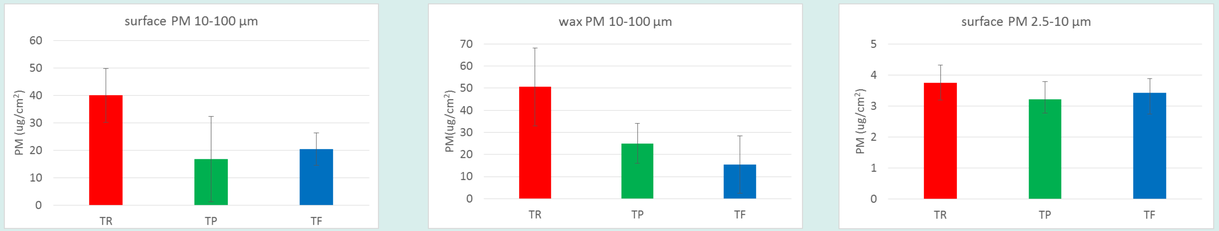

Figure 1. PM accumulated on *Prunus x Cistena (TR)* , *Pyrus Calleryana Bradford (TP)*, and *Chilopsis Linearis* (TF) leaves.

Prunus x Cistena | *Pyrus Calleryana Bradford* | *Chilopsis Linearis*

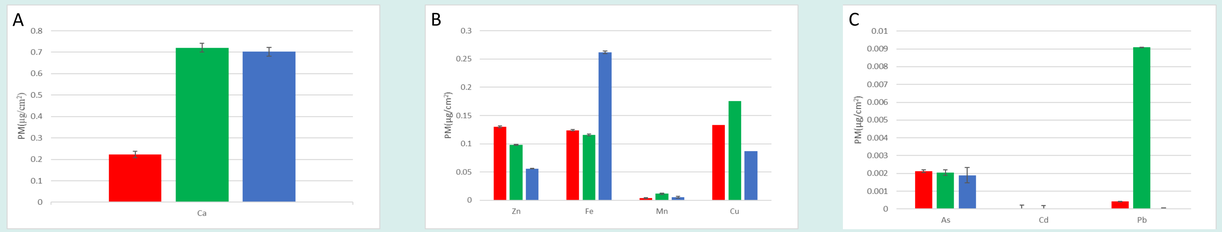

Figure 2. Metal content of surface PM from (A) natural sources, (B & C) anthropogenic sources, C having trace amounts.

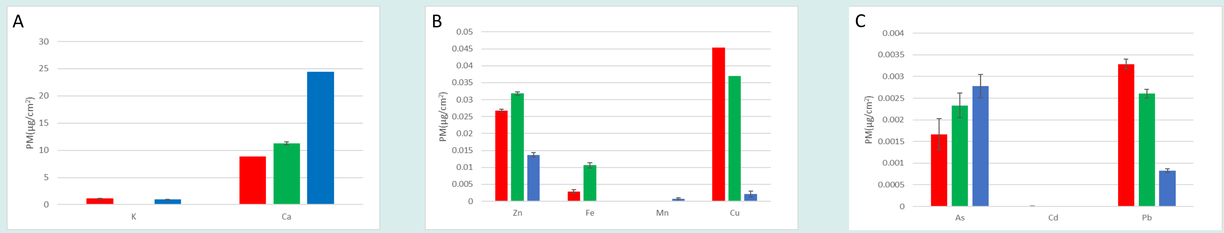

Figure 3. Metal content of wax PM from (A) natural sources, (B & C) anthropogenic sources, C having trace amounts.

Table 1. Anthropogenic sources of various heavy metals

Element	Anthropogenic source	Trace Elements	Anthropogenic source[3]
Zn	Smelting	As	Pesticides
Fe	Mining/Natural erosion	Cd	Fertilizers
Cu	Car Brakes	Mn/Pb	Automobile Exhaust

Summary

Prunus x Cistena (TR) accumulated more PM of 10-100 µm, both surface and wax embedded particles. The PM of 2.5-10 µm (fig.1) removed was similar for all trees.

The surface and wax PM were both dominated by metals from natural sources like calcium (figures 2 and 3). The concentration of metals in the wax PM was 30 x higher than in the surface PM.

The concentration of metals from anthropogenic sources (Zn, Fe, Mn, Cu) is up to 10 x greater in the surface PM than in the wax ones. These contaminants are more likely to be washed by rain.

The concentration of trace elements of anthropogenic origin (As, Cd, Pb) is similar for both surface and wax PM.

The concentration of metals from trees located in remote locations (data not shown) was characterized using ICP-MS and served as a blank. It was found that trees located in remote locations collected significantly less anthropogenic PM compared to the samples collected from trees near a road (area of pollution).

Metal composition of PM from anthropogenic sources suggests that the main source of pollution in the area is the vehicular traffic. (Table 1)

References

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