Ability of Wayside Trees as Pb Absorbent on Jl Jenderal Soedirman Purwokerto

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Abstract. Air pollution can be determined by using plants as a bioindicator. The purposes of this research were 1) to determine the ambient air Pb concentration and Pb concentration in some leaves of wayside trees on Jl Jenderal Soedirman Purwokerto, 2) to find out the stomata characteristics i.e. size and density of stomata related to their ability to absorb Pb. The research method used was the survey method. The wayside tree leaf samples were taken with purposive sampling. The variables used in the research include variables such as aerial Pb and Pb concentrations of leaves, while the dependent variable was anatomical responses. The main parameters observed in the form of air Pb concentrations, Pb in leaf and stomata anatomical characters. The support parameters are traffic density. The results of this study showed that the concentration of Pb in Jl Jenderal Sudirman within 1 hour is 0.0147 μg/m³. Pb concentration was the highest in the leaves of Schima wallichii (0.3524 ppm), and the lowest was in Hibiscus tiliaceus (0.2354 ppm). Pb accumulated in the leaves caused a very significant effect on the density, length, and width of the leaf stomata of shade plant on Purwokerto’s Jenderal Sudirman Road. Pb concentration in leaves positively correlated with the density, length, and width of stomata (p<0.05).

1. Introduction
Purwokerto is a developing city in Banyumas Regency, Central Java. This is indicated by the growing development of the economy, industry, trade, and services. Jl Jenderal Soedirman is one of the roads in Purwokerto City where traffic is always congested. The increasing number of vehicles crossing Jl Jenderal Soedirman cannot be separated from the economic transition and development on the road. This caused the air on Jl Jenderal Soedirman to become polluted.

Lead (Pb) is one of the sources of air pollutants on the highway caused by transportation vehicles. Lead content on the highway can be accumulated due to the influence of traffic density [1]. Pb is a soft blue or silvery gray metal with a melting point at 327.5 ºC and a boiling point 1,740 ºC at atmospheric pressure. Pb has the largest atomic number of all stable elements, which is 82. Pb-organic compounds such as Pb-tetraethyl and Pb-tetramethyl are widely used as additives in premium gasoline to increase octane and make up the largest portion of all Pb emissions into the atmosphere. Pb-tetraethyl and Pb-tetramethyl are in solution with boiling points of 110 ºC and 200 ºC, respectively. The evaporation power of the two compounds is lower compared to the other elements in gasoline, so the evaporation of gasoline will tend to concentrate the levels of Pb-tetraethyl and Pb-tetramethyl. Both of these compounds will decompose at boiling point in the presence of sunlight and other chemical compounds in the air, such as acid halogen compounds or oxidizing agents [2].
Road shade trees found along Jl Jenderal Soedirman are expected to accumulate Pb into leaves through stomata. The result of research [3] reported that increasing the density and size of stomata is one of the responses of plants to air pollution. The purpose of this research was to determine: 1) The level of Pb pollution in Jl Jenderal Soedirman Purokerto; 2) The potential of some wayside trees in absorbing Pb in Jl Jenderal Soedirman Purwokerto based on their anatomical characteristics; 3) Correlation between Pb contained in the leaf of wayside trees and their anatomical characters in Jl. Jenderal Soedirman Purwokerto.

2. Methods
The material used in the study was the leaves of wayside trees on Jl. Jenderal Soedirman Purwokerto. The chemicals used were Pb (NO3) 2, HNO3 1%, H2O2 20%, HNO3, HCl, distilled water, 96% alcohol, ethanol PA, xylol, glycerin, and paraffin. The tools used were a microscope, Middle Air Volume Sampler (MVAS), Total Suspended Particulate (TSP), Atomic Absorption Spectrophotometer (AAS), muffle furnace, destruction flask, measuring cup, 1000 mL cup, hand counter, ocular micrometer, objective micrometer, square micrometer, glass object, analytical balance, oven, measuring pipette, drop pipette, cuvette, furnace cup, membrane filter, funnel, film bottle, Whatman paper no. 42, wrapping, scissors, razor blades, label paper, digital camera.

The research was conducted with a survey method. Plant leaf samples road shading is taken by purposive sampling in Jl Jenderal Soedirman. To observe the anatomical character of leaves, preparation of anatomical used embedding method, staining with 1% safranin in 70% alcohol [4]. Traffic density stated in motor vehicle units per hour, calculated by a hand counter within 1 hour. The location of the calculation is around the point of measurement of air Pb content. The parameters observed were the level of ambient air Pb, the road leaf shade of Pb, and the number of vehicles passing at a time when the air Pb level was measured. Preparation of leaf Pb filtrate was done based on the method [5]. Data obtained from the results of measurements of ambient air Pb and road leaf plant leaf Pb are described by displaying data through a table or histogram.

3. Results
The results of the study on traffic density on Jl Jenderal Soedirman Purwokerto showed that the number of vehicles passing was between 3302 - 5055 pieces per hour (4340 ± 698.09). Vehicle activity on Jl Jenderal Soedirman in the morning is the most crowded time for vehicles because, in the morning, all community activities begin, especially in the schools, offices, and shopping centers. The density of traffic passing through Jl Jenderal Soedirman, is shown in Figure 1.

![Vehicle Density](image-url)  
Figure 1. Traffic density on Jl Jenderal Soedirman Purwokerto
Pb concentration measurements obtained was 0.0147 µg/m³ for 1 hour. Based on the [4] concerning ambient air quality standards in Central Java Province, the Pb threshold value is 2 µg/m³ for 24 hours, so the ambient air Pb on Jl Jenderal Soedirman is still below the specified threshold. The concentration of Pb ambient air on Jl Jenderal Soedirman emitted from motorized vehicles has not significantly impacted changes in ambient air quality.

Based on the results of the research it was reported that there were 10 species on wayside trees along Jl Jenderal Sudirman. The results of the average measurement of leaf Pb concentration obtained showed that the highest Pb concentration was found in *Schima wallichii* leaves which was 0.52 ppm while the lowest leaf Pb concentration was found in *Hibiscus tiliaceus* leaves which was 0.21 ppm. The average leaf Pb content can be seen in table 1. The results of observations on the density of leaf stomata obtained average leaf stomatal density (per mm²) in 10 plant species on Jl. Jenderal Soedirman can be seen in Table 2.

### Table 1. The average leaf Pb concentrations of 10 road plant shade species on the road of Jl Jenderal Soedirman Purwokerto

| Spesies             | Average leaf Pb concentrations (ppm) |
|---------------------|--------------------------------------|
| *Schima wallichii*  | 0.52 ± 0.001                         |
| *Bauhinia tomentosa*| 0.42 ± 0.005                         |
| *Filicium decipiens*| 0.42 ± 0.003                         |
| *Pithecellobium dulce* | 0.35 ± 0.008                     |
| *Tabebuia argentea* | 0.34 ± 0.002                         |
| *Delonix regia*     | 0.29 ± 0.010                         |
| *Polyalthia longifolia* | 0.28 ± 0.003                     |
| *Terminalia catappa*| 0.26 ± 0.002                         |
| *Ficus benjamina*   | 0.25 ± 0.010                         |
| *Hibiscus tiliaceus*| 0.21 ± 0.002                         |

### Table 2. The average density of stomata of 10 road plant shade species on the road of Jl. Jenderal Soedirman Purwokerto

| Spesies              | The average density of stomata per mm² |
|----------------------|---------------------------------------|
| *Filicium decipiens* | 77.00 ± 1.48                         |
| *Terminalia catappa* | 58.00 ± 2.88                         |
| *Pithecellobium dulce* | 27.00 ± 7.75                     |
| *Polyalthia longifolia* | 24.00 ± 2.00                     |
| *Ficus benjamina*    | 20.00 ± 6.47                         |
| *Delonix regia*      | 20.00 ± 1.92                         |
| *Hibiscus tiliaceus* | 19.00 ± 1.92                         |
| *Bauhinia tomentosa* | 19.00 ± 2.70                         |
| *Tabebuia argentea*  | 16.00 ± 4.83                         |
| *Schima wallichii*   | 16.00 ± 3.11                         |

4. Discussion

The low Pb concentration on Jl Jenderal Soedirman can be influenced by several factors, such as high wind speed, an average speed of passing vehicles, and weather. The results of measurements of wind speed obtained when sampling is equal to 5.04 km/h, sunny weather with 70% air humidity, and a temperature of 30.5°C. This is in accordance with the statement of [7], the factors that influence the concentration of lead in the air are a). time, temperature, speed of emissions, size, shape, and density of lead; b). meteorological parameters such as wind speed, degree of turbulence, and humidity; c). the distance of sampling from pollutant sources, local topography such as valleys and valleys.
The number of vehicles that pass through Jl. Jenderal Soedirman certainly affects the average speed of vehicles passing through. Jl. Jenderal Soedirman as a city road with a capacity of 2 lines per lane has a maximum recommended speed limit of 50 km/hour. The speed limit can be seen in traffic signs on Jl. Jenderal Soedirman, Purwokerto. When compared with the results of [9] research conducted on Jagorawi Toll Road, the highest air Pb content in the 2-row line obtained was 0.2939 µg/m³ while the lowest was 0.0852 µg/m³. This value is almost 20 times higher than Jl Jenderal Soedirman, Purwokerto.

Wayside trees absorb Pb through roots or stomata. Pb that is dissolved in water is so small that what is absorbed through the roots is also small, whereas Pb contained in the air enters the stomata through passive absorption. The absorbed Pb will accumulate in the palisade tissue. The effectiveness of the absorption of Pb through the stomata is influenced by the density and size of the stomata. Based on the observation of stomata density on 10 species of road shade plants, the highest average leaf stomatal density on F. decipiens leaves was 77 per mm², while the lowest stomata density on S. wallichii leaves was 16 per mm². Based on the analysis of variance, it is obtained that the accumulation of Pb on the leaves has a very significant effect on the density of stomata. The results of the correlation regression test showed that there was no correlation between the Pb concentration of road shade plant leaves and stomatal density.

Based on the observation of the stomata length of 10 species of road shade plants, the highest stomata length was between 28.8 - 33.6 µm with an average of 30.72 µm owned by P. longifolia leaves while the lowest was between 12.0 - 16.8 µm with an average of 14.40 µm belongs to F. decipiens leaves. Research conducted by [9] on leaves of several species of forest trees in Makassar obtained P. longifolia stomata length between 19.2 - 26.4 µm while the length of F. decipiens stomata was between 12.0 - 19.2 µm.

Based on the observation of stomata width in 10 species of road shade plants, the largest obtained between 19.2 - 26.4 µm with an average of 22.08 µm was the leaf of P. longifolia while the smallest was between 7.2 - 9.6 µm with an average 8.64 µm on F. decipiens leaves. [9] in his study of the leaves of several species of forest trees in Makassar, the results were the width of the P. longifolia stomata between 14.4 - 21.6 µm while the width of the F. decipiens stomata was between 9.6 - 16.8 µm.

![Figure 2](image-url)

**Figure 2.** Stomata on the leaves of S. wallichii (400x) (a) and H. tiliaceus (400x) (b). S arrow was stoma.

Based on the analysis of variance, the concentration of Pb in leaves significantly affected the length of the stomata. Correlation regression test results show that there is a correlation between the concentration of Pb that accumulates on the leaves of wayside trees with stomata length. The analysis of variance, it is obtained that the concentration of Pb in leaves gives a very significant influence on
the width of the stomata. Correlation regression test results show that there is a correlation between the concentration of Pb that accumulates on the leaves of wayside trees with stomata width.

5. Conclusion
The concentration of Pb in Jl. Jenderal Sudirman within 1 hour is 0.0147 μg/m³. Pb concentration was highest in the leaves leaf *Schima wallichii* 0.3524 ppm and lowest *Hibiscus tiliaceus* 0.2354 ppm. Pb accumulated in the leaves significantly affects the density, length, and width of the leaf stomata of shade plants in Jl Jenderal Sudirman. Pb concentration in leaves positively correlated with density, length, and width of stomata (p<0.05).

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