Lead Accummulation Potential By Leaves With Abundant Trichomes (*Muntingia Calabura* L.) And Rare Trichomes (*Mimusops Elengi* L.) In Makassar, Indonesia

Sri Suhadiyah, Djamal Sanusi, Samuel Paembonan, Roland A. Barkey

Abstract: - A study of lead accumulation by leaves with abundant trichomes (*Muntingia calabura* L.) and leaves with rare trichomes (*Mimusop elengi* L.) in Makassar, Indonesia was conducted in August 2011 by using wet ashing method and Atomic Absorption Spectrophotometer. The objective of this study was to find out the influence of trichome abundance on lead accumulation in shade trees. Results from multiple regression analysis with interval level of 95% indicated a significant correlation between lead (Pb) absorption and Pb adsorption, trichome abundance and leave surface area in A.P. Pettarani street (R = 0.851) and Hasanuddin University College (R = 0.731). In AP Pettarani Street, correlation test between Pb absorption and each of the variable indicated a coefficient correlation (R) of 0.280 for Pb adsorption, 0.849 for leave surface area. In Hasanuddin University College, coefficient correlation (R) for Pb adsorption was 0.625, trichome abundance was 0.061 and leaves surface area was 0.243. In conclusion, the trichome abundance had an influence on Pb accumulation in leaves with abundant trichomes (*Muntingia calabura* L.) and leaves with rare trichomes (*Mimusop elengi* L.).

Keywords: Air pollution, Pb absorbtion, Trichome, *Muntingia calabura* L, *Mimusop elengi* L.

1. Introduction

Lead (Pb) is a very dangerous heavy metal to life creatures due to its neurotoxin which attacks the nervous system. This metal has some characteristics such as accumulative, carcinogenic, capable of resulting in gene mutations, degradable in long period, and unchanged toxicity (Brass and Strauss, 1981 in Sembiring and Endah, 2006). Lead (Pb) can pollute the air, soil, water, plants, animals, and human. Considering the huge negative impacts associated to this heavy metal in human, an urgent attempt is needed to reduce the lead level in the air. This can be achieved by using trees as a bioremedy to reduce lead pollution in the air when the trees can absorb Pb without indicating damaging effect on the trees itself (Larcher, 1995).

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Ahluwalia and Goyal (2005) in Liong (2010) reported that there were some mechanisms that can be used to reduce heavy metal pollution such as absorption, precipitation, coagulation, cation exchange, cementation, electrodyalisis, and reverse osmosis. Aiyen (2005) in Liong (2010) suggested several trees with a very high ability to reduce various pollutions. According to Kusminingrum and Gunawan (2008), The Green Openspace concept, in which plants are the primary components as natural filter to reduce air pollution in urban areas. Leaves of the trees reduce the concentration of various pollutants in the air. According to Smith (1981) in Widagdo (2005), the ability of leaves to capture particles is highly influenced by the leaves surface conditions, such as smoothness, slippage, and trichomes (leave hairs). Leaves with wider and coarser surface having trichomes will be more easily in capturing particles compared to leaves with more smooth and narrower surface having no trichome. The objective of this study was to find out the influence of leave trichome abundance on lead accumulation in shade trees.

2. Study Methods and Plants

2.1. Study Plants

Two species of woody plants that are used as road side trees in Andi Pangerang Pettarani street and Hasanuddin University College, Makassar Indonesia, namely *Muntingia calabura* L. and *Mimusop elengi* L.

2.2 Leaves Sampling

Each of the road was divided into three station, in which one *M. Calabura* and *Mimusops elengi* L tree each was taken. Then, the leave sample was collected from lower crown layer near to the vehicle emission and from upper crown layer.

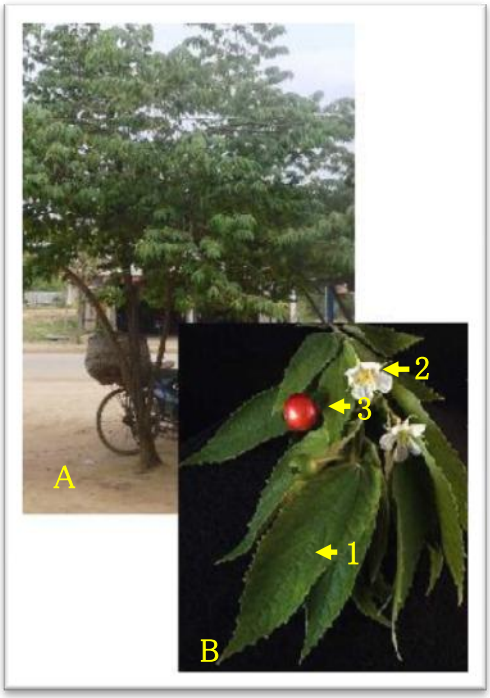

Figure 1. Cherry (*Muntingia calabura* L.), A: Habitus (tree), B: Stalk, 1: Leaf (*Folium*), 2: Flower (*Flos*), 3: Fruit (*Fructus*)

Figure 2. Tanjung (*Mimusops elengi* L.), 1: Habitus (Pohon), 2: Leaf (Folium), 3: Flower (Flos), 4: Fruit (Fructus)

2.3. Measurement of Pb Concentration in Leaves

The leave sample was placed in oven at 105^{o}C and then was ashed in oven at 600^{o}C for 2 hours. The leave ash was then destructed by concentrated HNO_3 (65%) and diluted with distilled water 50 mL each. The solution was then measured for Pb level by using Atomic Absorption Spectrophotometer.

2.4. Environment Parameters Measurement

The measured environmental parameters included the wind speed (km/ha), air temperature (^{o}C), and humidity (%).

2.5. Traffic Density Measurement

The number of motor vehicles was determined by field survey using scanning method with measurement intervals as follow: 06.00-07.00 o'clock, 12.00-13.00 o'clock, and 16.30-17.30, with duration of each was 1 hour from Monday to Sunday.

2.6. Data Analysis

In order to observe the influence of trichome abundance, Pb adsorption, and leaves surface area of *Muntingia calabura* L. and *Mimusops elengei* L. on Pb absorbtion, a multiple regression analysis was performed. Multiple regression test was implemented by using SPSS.

3. Results and Discussion

3.1. Vehicles Density

Motorcycle and car density difference in the two study locations was the main reason to choose the Hasanuddin University College and AP. Pettarani Street. According to chi-square test in Hasanuddin University College, a difference was obtained in motor vehicles number every day ($p < 0.05$). The same occurred in AP. Pettarani street, with $p < 0.05$, indicating significant difference in vehicle number every day. The difference in vehicle density in the two location by t-test also indicated a significant value between Hasanuddin University College and AP. Pettarani Street ($p < 0.05$). Average vehicle density in AP. Pettarani Street was higher compared to Hasanuddin University every day.

3.2. Pb Absorbtion

Multiple regression analysis to determine the relationship between Pb absorbtion and Pb adsorption, trichome abundance, and leave surface area indicated a coefficient correlation of 0.851 in AP. Pettarani Street. This indicated that in AP Pettarani Street, the relationship between Pb absorption and Pb adsorption, trichome abundance, and leave surface area was significant because the coefficient correlation was near 1, meaning that the higher the Pb adsorption concentration, trichome abundance, and leave surface area, the higher the Pb absorbtion concentration. Conversely, the lower the Pb adsorption concentration, trichome abundance, and leave surface area, the lower the Pb absorption concentration. The determination coefficient (R_{square}) of 0.723 indicated that 72.3% of Pb absorption concentration was influenced by Pb adsorption, trichome abundance, and leave surface area.

Table 1. Results of Multiple Regression Analysis for Pb Absorption and Pb adsorption, trichome abundance, and leave surface area.

Location	Variables	R	R_{square}
AP Pettarani Street	Adsorption	0.85	0.72
	Trichome abundance		
	Leave surface area		
Hasanuddin University College	Adsorption	0.73	0.54
	Trichome abundance		
	Leave surface area		

Relationship analysis in Hasanuddin University College indicated that the relationship between Pb absorbing and Pb adsorption, trichome abundance and leave surface area was significant with coefficient correlation of 0.731. The determination coefficient (R_{square}) of 0.535 indicated that 53.5% of Pb absorption concentration was influenced by Pb adsorption, trichome abundance, and leave surface area. Whereas, 47.5% was influenced by environmental factor including temperature, air Pb and wind speed. Pb accumulation in leave tissues was higher than the other parts of the plant. Particles attaching to leave surface were derived from one of the three processes: (1) sedimentation due to gravity force, (2) collision from wind turbulence, and (3) precipitation related to rain. Pb metal is amphoteric (insoluble in water). In basic environment Pb wll change into $Pb(OH)^{4-}$ and in acid environment Pb is soluble to form Pb^{2+} ion and becomes more mobile compared to cuticle that is still in particle form (Dahlan, 1989).

3.3. Pb Adsorption

The relationship between Pb absorption and Pb adsorption (Table 1) for AP Pettarani Street indicated a weak correlation as indicated by coefficient correlation of 0.280. Whereas for Hasanuddin University College, the relationship between Pb absorption and Pb adsorption was strong as indicated by the coefficient correlation of 0.625.

Table 2. Results of Correlation Analysis of Pb Absorption and Pb Adsorption, Pb absorption and trichome abundance, and Pb absorption and leave surface area.

Location	Variables	R
AP Pettarani Street	Adsorption	0.85
	Trichome abundance	
	Leave surface area	
Hasanuddin University College	Adsorption	0.73
	Trichome abundance	
	Leave surface area	

Adelia (2007) in Widjaya (2008) indicated that in high temperature the air humidity is low that the air is drying. This will cause many leads flying in the air and just few are attaching to leave surfaces. In contrast, Hasanuddin University College has a lower temperature and higher air humidity compared to AP Pettarani Street, so many leads are attached to leave surfaces of trees.

3.4. Trichome Abundance

Table 1 indicates the magnitude of relationship between Pb absorption and trichome abundance in AP Pettarani Street, which was calculated by the coefficient correlation of 0.849. This indicated a very strong correlation between Pb absorption and trichome abundance. The higher the trichome number, the higher the Pb absorbtion in plant. In contrast, the lower the trichome number, the lower the Pb absorbtion concentration accumulated by the leave. Whereas in Hasanuddin University College, the relationship between Pb absorbtion and trichome abundance was weak. This is due to the low correlation coefficient (0.061). Little and Wiffer (1977) in Ahmad et al., (1978) suggested that the Pb particle accumulation was higher in leaves with coarser surface and with trichomes. Wedding et. al., (1977) in Flanagan et. al., (1980) stated that $PbCl_2$ particles precipitated in hairy leave surfaces was seven times higher than those precipitated in smooth and waxy leave surfaces.

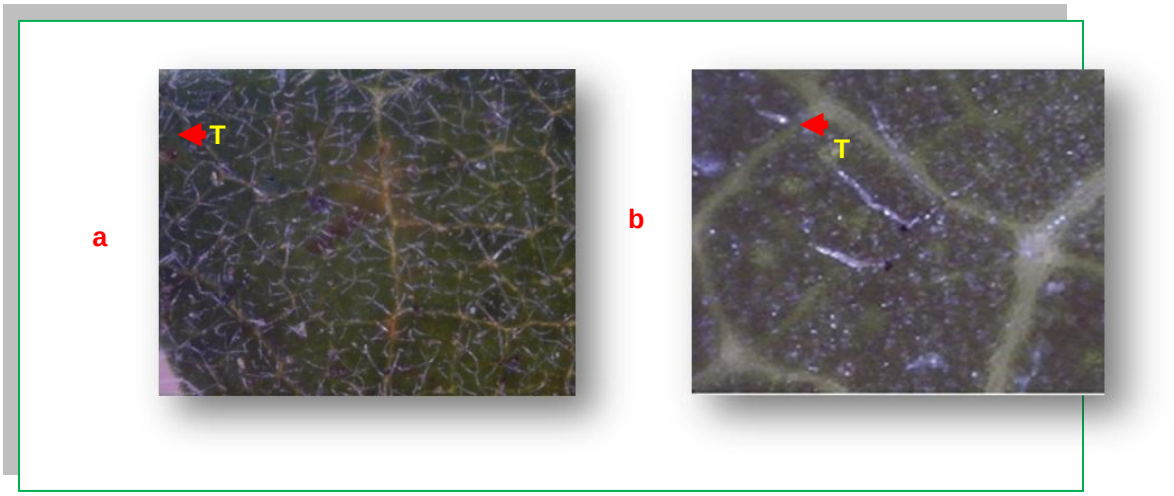

Figure 3. Trichome of Leaf (a) *M. calabura*; type of branching, (b) *M. elengi*, Type a radiant

3.6. Relationship between Pb Absorption and Vehicle Number

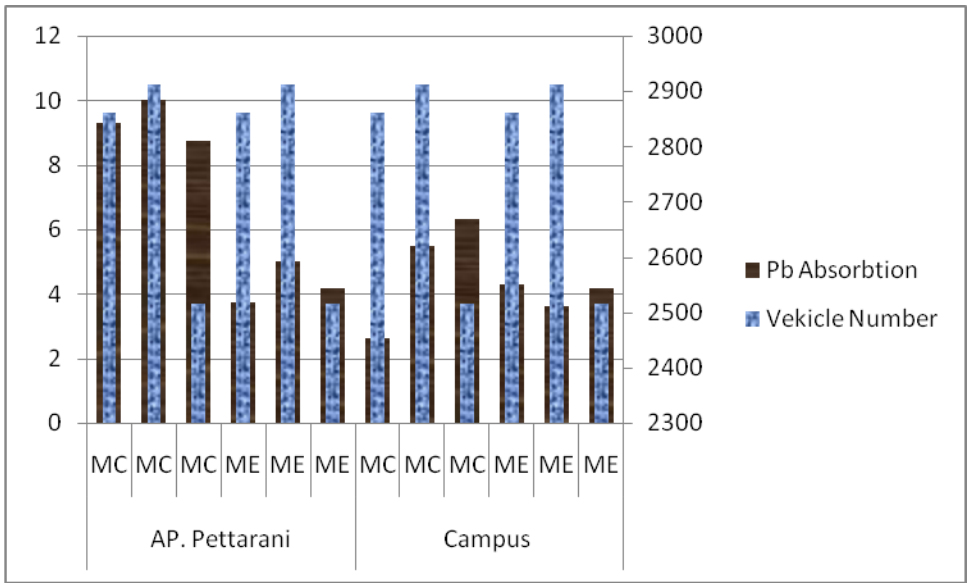

Figure 4. Concentration of absorbed Pb for *Muntingia calabura* L. and *Mimusops elengi* L. with different traffic densities.

Figure 4 indicated that traffic density is higher in AP Pettarani Street with average vehicle density in station I was 2861 units/hour, station II was 2913 units/hour and station III was 2516 units/hour. Concentration of absorbed Pb in the station I was 9.3056 ppm for *M. Calabura* and 3.7500 ppm for *M. Elengi,* in the station II was 8.7500 ppm for *M. Calabura*, 5.000 ppm for *M. Elengi*, and in the station III was 8.7500 ppm for *M. Calabura*, 4.1667 ppm for *M.*

Elengi. Whereas in Hasanuddin University College, the average vehicle density was 629 units/hour in station I, 439 units/hour in station II, and 673 units/hour in station III. Concentration of absorbed Pb in the station I was 2.6389 ppm for *M. Calabura* and 4.3057 ppm for *M. Elengi,* in the station II was 5.4762 ppm for *M. Calabura*, 3.6111 ppm for *M. Elengi*, and in the station III was 6.3095 ppm for *M. Calabura*, and 4.1665 ppm for *M. Elengi*. Previous studies indicated that plants grew in an area with high traffic density will capable of containing more Pb compared to those grew in areas with low traffic density (Dudka, et. al, 1999; Haro and Pujadas, 2000 in Ebadi et. al., 2005). Siregar (2005) in Suhadiyah (2010) also suggested that the number of Pb in the air was influenced by traffic density, distance from the highway and industrial estates, seasonal acceleration, and wind direction, as well as sedimentation. Furthermore, the fluctuation of air pollution level in urban streets in 24 hours indicates the generally increasing trend. Beginning from the busy hours until night at about 19.00, the peak concentration occurs at noon with the increasing solar radiation (Kusminingrum and Gunawan, 2008).

3.7. Temperature, Humidity, and Wind Speed Measurements

Measurements of environmental parameters indicated an average of six repetitions ± standard deviation for air temperature was 30.9000 ± 0.5860 ^{o}C, humidity was 64.3000 ± 1.0408 %, and wind speed was 1.7700 ± 0,0900 m/s. Adelia (2007) suggested that the high air temperature in an area will result in low air humidity that the air is drying. This results in many particulates flying in the air. Furthermore, Adelia suggested that wind speed had a capability of reducing Pb particles. According to Soedomo (2001), the wind speed in an area with many buildings tends to decrease due to increasing friction by air flow. The small air flow causes the higher Pb concentration in an area with many buildings.

4. Conclusion

- Trichome has a significant influence on accumulation of absorbed Pb in leaves.
- The leaves of *Muntingia calabura* has abundant trichome which is potential in accumulating more Pb compared to *Mimusops elengi* leaves which has rare trichomes.
- The concentration of accumulated Pb in *Muntingia calabura* and *Mimusops elengi* leaves doesn't influence tha leaves conditions so these two plants are potentially as bioremedial agent for Pb pollution in the air.

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