The Potential of Tabebuya as Phytoremediator of Lead (Pb) in Atmosphere

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Abstract Lead (Pb) is one of the heavy metals that causes pollution in ecosystems, heavy metal Pb can cause disturbances to humans, including plants and animals. In Indonesia, especially in Surabaya, Tabebuya grows on main roads as a shade tree as well as an ornamental plant; This plant can be exposed to Pb metal, among others, from motor vehicle exhaust. This study aimed to determine the levels of Pb in Tabebuya and to study chlorophyll in the leaves. Pb levels in plant leaves were measured using an atomic absorption spectrophotometer (AAS), and chlorophyll levels using a spectrophotometer. Data in the form of Pb and chlorophyll levels at various locations were analyzed by analysis of variance (Anova). The results showed that the location of plant species affected the content of Pb metal and there is no effect of chlorophyll content in the leaves. The results also showed that the absorption of lead (Pb) content by the tabebuia 0.25-0.44 ppm and content of chlorophyll 12.89-14, 94. Lead (Pb) content do not affect the amount of leave chlorophyll produced and the plant had capabilities in absorbing lead like pollutants (Pb).

Keywords : Tabebuya**,** atomic absorption spectrophotometer, ANOVA

1 Introduction

Heavy metals (Pb, Cd, Zn, Fe) are the main pollutants released into the atmosphere [1]. Pb is one of three heavy metals (Pb, Hg, Cd) which are dangerous when contaminating organisms, whether it be plants, animals, as well as humans. Sources of these pollutants, among others, come from the fumes of motorized vehicles that use gasoline. Research [2] in Indonesia showed that Pb levels in PM-2,5 and PM-10 in several cities were still relatively high. Pb concentrations in the sampling locations of Tangerang, Jakarta, and Surabaya were higher than other cities. Pb levels according to quality standards, namely 2µg/Nm3 per 24 hours [3]. Therefore, it is necessary to make efforts to reduce Pb levels in the air. *Syzigium oleina, Wedelia trilobata* is able to absorb Pb [4]. One way to improve air quality is by utilizing plants through a phytoremediation process. Phytoremediation can be interpreted as controlling air pollution with technology that is cost-effective, energy-efficient, and environmentally friendly. In phytoremediation, plant organs and microbes present in the phyllosphere and rhizosphere interact with each other to overcome polluted air [5]. [6] reported that leaves associated with microbes that can reduce air pollutants, example Azalea leaves associated with *Pseudomonas putida* that can reduce volatile organic compounds [7], yellow lupine plant leaves together with endophytic *Burkholderia cepacia* for reduce toluene [8], and poplar leaf associated with *Methylobacterium* sp. that can reduce xenobiotic compounds [9].

Leaf and stem surfaces are known to absorb pollutants. Hence, microbe especially bacteria that live on this surface, called phyllospheric bacteria, have an important role. Part of the adsorbed pollutant also finds its way into the plant, creating (mainly) high-flowering leaf endophytes. Phylospheric and endophytic bacteria are known to be able to detoxify some pollutants through three steps i.e., degradation, transformation, and sequestration processes. Furthermore, rainfall can cause the flow of pollutants into the soil just below the plants. Pollutants contaminate soil and bacteria around plant roots (rhizosphere). This is the main role of plants in reducing air pollutants. This ability will also affect the chlorophyll content and growth.

Plants that can be used for this function, including the Tabebuya genus Handroanthus. *Handroanthus chrysotrichus* is a species of the family Bignoniaceae [10]. HabitusTabebuyain the form of shrubs or trees with a height ranging from 5-50 m depending on the species. The leaves are in pairs crossed or complex with the number of leaf sheets between 3-7 sheets.

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Taking into account the importance of the role of Pb in polluting the air and the prediction that Tabebuya can reduce Pb levels in the air, it is necessary to investigate the potential of this plant, so the objectives of this study were 1) to analyze the Pb levels in Tabebuya leaves, 2) to analyze the chlorophyll content in Tabebuya leaves. it is not known that. Tabebuya is not only a shade plant and ornamental plant, it also maintains an ecological function, namely absorbing Pb in the air. In addition, research related to this phytoremediator has not been widely disclosed.

2 Materials and Methods

2.1 Stage 1: Tabebuya Sampling

The focus of this study is passive biomonitoring using plants in the study area, in the city of Surabaya. Tabebuya samples were collected from three different places, namely Jalan Diponegoro, Jalan Darmo, and Jalan Ir Soekarno. This selection is based on the presence of vegetation and traffic density. At each station, Tabebuya leaves were taken from three trees. On each tree, leaves are taken from the third branch from the base, then leaves are made for various purposes.

2.2 Stage 2: Sample Analysis

2.2.1 Pb Analysis

Lead level in leaves was measured using PerkinElmer Atomic Absorption Spectrophotometry (AAS) by Medtech, Waltham, Massachusetts, United State. Each sample leaf was weighed 2 g, then placed in 800°C furnace for 3 hours. The sample was then added 2 mL HNO3 and 10 mL demineralized aqua. Solution was then filtered and analyzed its absorbance using AAS. Lead content was measured using the standardized Pb Level Test Method SNI No. 06-698945 of 2005. The following was the formula was used to calculate Pb level:

$$Cy' = (Cy \times V/W) \times 1000$$

In which:
Cy' = lead (Pb) content in leaves (µg/g)
Cy = measured concentration (mg/L)
V = dilution volume (L)
W = leaf dry weight (g)
1000 = base conversion of mg to g

2.2.2 Chlorphyll Analysis

Leaf chlorophyll level was examined using MAPADA V-1100D visible spectrophotometers by Shanghai Mapada Instruments Co., Ltd, Shanghai, China at wavelengths of 665 and 649 nm. Extract was made of each sample leaf. From each sample, 0.5 g of leaf was macerated with 50 ml 96% alcohol until leaf color dissolved. Solution was filtered with filter paper and chlorophyll level was examined from filtrate based on level of optical density (OD). Calculation level betwen chlorophyll a, chlorophyll b, and total chlorophyll are using the formula of Wintermans and de Mots [8].

2.3 Data Analysis

Data from the research in the form of Pb levels in leaves, and chlorophyll levels in leaves at various locations were analyzed by Anova.

3 Results and Discussion

Table 1 shows the Pb content in Tabebuya leaves at various sampling locations. Meanwhile, Table 2 shows the chlorophyll content in Tabebuya leaves at various sampling locations.

Table 1. Pb content in the leaves Tabebuya. (n=3)

Area	Mean of Pb (ppm)	Standard Deviation
Diponegoro Street	0.25	0.05a
Darmo Street	0.26	0.08a
Soekarno Street	0.44	0.04b

Table 2. ANOVA result of location Tabebuya with Pb content in the leaves.

Source	Dependent variable	Sign
Location	Pb Content	0.02

Table 3. Chlorophyll content in the leaves Tabebuya. (n=3)

Area	Mean of Chlorophyll	Standard Deviation
Diponegoro Street	13.18	1.89
Darmo Street	12.89	2.96
Ir Soekarno Street	14.94	4.99

Table 4. ANOVA result of location Tabebuya with chlorophyll content in the leaves.

Source	Dependent variable	Sign
Location	Chlorophyll Content	0.75

Table 5. Abiotic Factor

Area	Air Humidity	Air Temperature	Light Intensity (lux)
Diponegoro Street	58.33± 1.154701	32.3±0.01	8266.67±1212.32
Darmo Street	54.66±1.154701	34.5±0.01	7313.33 704.65
Ir Soekarno Street	48.66± 2.886751	36.00±0.0	6762.33± 3004.78

Table 2, the results of ANOVA analysis for Pb content in leaves from various locations, showed that the location affected the Pb metal content in the leaves

($p<0.05$). The results of Duncan's test show that the Pb content in Tabebuya leaves on Diponegoro Street and Darmo Street was not much different. However, the Pb content in these two locations was different from the Pb content in Tabebuya leaves on Ir. Soekarno street (Table 1). Meanwhile, the ANOVA results for Tabebuya leaf chlorophyll showed no difference at various locations ($p>0.05$), namely the chlorophyll content of Tabebuya leaves on Diponegoro street, Darmo street and Jl Ir. Soekarno was no different (Tables 3 and 4).

From this data on Pb content, it can be explained in general that Tabebuya has the ability to absorb Pb in the air up to 0.244 (ppm). Yellow Tabebuya Plant (Handroanthus chrysotrichus) is a shade tree at the same time ornamental plant belonging to the Bignoniacea family, morphologically has a ribbon leaf shape to be precise lanceolate, green leaves, elongated leaves with a width of approximately cm, trunk with a height ranging from 5-10 cm. The leaves are thick and the surface is slightly rough so that it can potentially be one of the plants that is tolerant and has the potential for phytoremediation of air pollutants [11}. Plants that have the potential as absorbents of lead (Pb) have several characteristics, namely ribbon-shaped leaves, large stem, and on the leaf surface there are fine reeds or commonly called trichomes [12].

The content of Pb in the leaves at three different locations was not followed by the chlorophyll content. The chlorophyll content in the leaves at three different places showed no difference. This strengthens the statement that plants have the potential to absorb lead (Pb) in leaves but the presence of lead (Pb) which accumulates in leaves does not have an impact on decreasing leaf chlorophyll levels. This happens because of many influencing factors such as physiological factors, morphological factors and plant structures [13].

From a physiological point of view, chlorophyll is a photosynthetic catalyst contained in plant tissues, especially in leaves that have green pigments. Physiologically lead (Pb) toxicity causes a mechanism involving chlorophyll. The mechanism is the event of inhibition of chlorophyll biosynthesis located in the chloroplast due to the entry of lead (Pb) so that it can block the performance of several enzymes needed in the chlorophyll biosynthesis process

[14]. The enzymes involved in chlorophyll biosynthesis include porphobilonogen deaminase, aminolevulinic acid (ALA) dehydratase, and protochlorophyllide. In terms of morphology, that leaf thickness affects the absorption rate of lead (Pb), the thicker the leaf, the lower the absorption ability, on the contrary, the thinner the leaf, the better the absorption ability. This is because thin leaves have a very thin cuticle layer and there are no trichomes on the leaf surface which causes pollutants (Pb) to be easily absorbed by the leaves, while thicker leaves have a thick cuticle layer and there are trichomes that have maximum defense. Lead particles from the air will fall and stick to the leaf surface and then enter the tissue. The mechanism of the entry of Pb particles into the leaf through passive diffusion is influenced by the size and number of stomata. Pb particles enter the leaf through the stomata gap and settle in it, and accumulate between the gaps in the palisade tissue. Based on the National Ambient Air Quality Standards (NAAQS), the standard of Pb content in the air was equal to 0. 15 g/m3 while the Pb content in Surabaya for particular matter (PM2.5-10) was 0.27 g/m3. However, the quality standard established by the Indonesian Government Regulation 41 in 1999 for Pb was 2 g/m3 (24 hours) or 1 g/m3 (12 hours). This is also related with physical and chemical environmental factors. Table 5 show that air humidity of 48.66-58.33% is included in the humid air category, air temperature ranges between 32.01-36.00ºC including optimum temperature to maximum. This is also supported by environmental physical and chemical factors. According to Dewanti (2012) The optimum temperature value ranges from 30°C while the maximum temperature is 40°C. The light intensity value obtained is 6762,33-8266,67 Lux which is classified as low intensity, this is because the optimum value of light intensity ranges from ±32,000 Lux according [15], the higher the light intensity and temperature, the higher the photosynthesis process. So it can be said that the physical and chemical factors of the environment are still in good condition so they can support the Tabebuya plant growth process. Judging from the potential of plants to absorb lead (Pb) and leaf chlorophyll content. And it is expected to be more effectively used as an absorbent of lead (Pb) in the air, so that it can be used to reduce pollution

Conclusion for this research show that the location of plants affected the level of Pb heavy metal in leaves, but the the location of plants did not affect the chlorophyll level in of leaves

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