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Absorption of lead (Pb) by *Codiaeum variegatum* plants in different Surabaya protocol roads: a preliminary research

R E Agustin and Hamidah^a

Department of Biology, Faculty of Science and Technology Universitas Airlangga, Jl. Mulyorejo, Surabaya, Indonesia

^ahamidah@fst.unair.ac.id

Abstract. Increasing the number of motor vehicles in urban areas raises its own problems for the environmental. One of them is the increasing air pollution caused by Pb emission. Puring (*Codiaeum variegatum*), is a plant that serves as an ornamental plant along the Surabaya major arterial road. This study aims to determine the ability of purging (*Codiaeum variegatum*) in absorbing Pb in Surabaya protocol road. The sample of the research was taken from two different places on Jl. A. Yani and area of Campus C Unair. The samples were collected up to 10 gram using randomize sampling. Sample collected from leaf of purging (*Codiaeum variegatum*) used as research material. The content of Pb in purging (*Codiaeum variegatum*) was tested using Atomic Absorption Spectrophotometry (AAS) method. The result of the study is content Pb differences in protocol road solid vehicle with a quiet street. The conclusion that purging (*Codiaeum variegatum*) has potential as Pb emission reduction plant in Surabaya city protocol road.

1. Background

The environment is inseparable from human and human life cannot be separated from the elements that exist around it. Elements in the environment include biological elements (biotic), physical elements (abiotic), and socio-cultural elements. Biotic components are a living component that has many roles in life. Physical element is everything that is around us, in the form of inanimate objects such as land, water, and air and not man-made. While the element of culture is everything that comes from the results of human thought and reason.

Air is part of the physical element and is important to life, so its quality must be maintained. The earth is protected by the atmosphere which is the air layers. Air is inhaled at the time of human breathing, about 90% consists of Nitrogen and Oxygen gas. Inhaled air should be clean air, and contains no other components affecting human health [1]. If the air has been entered into a substance or other component of human and natural activity, it can cause air quality to decrease, causing disturbed human health, resulting in polluted air [2].

The city of Surabaya is made a business center, trade and industry. Currently urban air pollution is a serious problem. Air pollution comes from exhaust emissions, more than 70% of air pollution caused by motor vehicles, while 30% of industrial activities, households, burning garbage and others. This can be seen from the development of the number of vehicles that exceeds the increase in road capacity, the growth rate of vehicles reaches 7% while the increase in area, width and length of road is still below 4% [3].



The composition of motor vehicle emissions in the form of carbon monoxide (CO), sulfur (SO_x), nitrogen oxide (NO_x), hydrocarbon (HC) and dust particulates, including lead can interfere with human health and the surrounding natural environment. Once in the air, some compounds contained in the vehicle exhaust gas may change due to the occurrence of a reaction, for example by sunlight and moisture, or also between the compounds to each other. The process of such reactions takes place rapidly and occurs right there in the highway environment, and those that take place slowly.

The formation of this smog sometimes does not occur in the source place (city), but can form on the outskirts of the city. The distance of this smog formation depends on the reaction conditions and wind speed. For more stable stabilizers such as waste (Pb), some halogen hydrocarbons and polyaromatic hydrocarbons, can fall to the ground with rainwater or settle with dust, and contaminate soil and water. These compounds can then also enter the food chain which eventually enters the human body through vegetables, dairy, and other products from animal animals. Because many food industries today will be able to have an undesirable impact on urban and rural communities. Motor vehicle exhaust emissions also tend to make soil and water conditions acidic.

One effort to reduce the impact of lead pollutants emitted by motor vehicles is to build greenways along the highways. The purpose of the construction of green pathways along the highway is to absorb and absorb pollutants and airborne dust produced by motor vehicles. Trees are often referred to as the lungs of the city.

Broad-leaf trees are believed to absorb air pollutants. Leaf cells function to capture carbon dioxide and lead to be processed in the photosynthesis system. The process of photosynthesis is capable of altering carbon dioxide (CO₂) released from the respiratory system into the oxygen that the lungs require.

Puring plants are capable of absorbing lead of about 2.05 mg L⁻¹ in air compared to other plants. In addition, puring plants have several advantages when used as one of the road shade plants, among others, the appearance of beautiful and colorful leaves. Therefore, puring can have multiple roles as absorber pollutants and city decorators.

Lead (Pb) is a type of heavy metal commonly referred to as lead. Lead has a low overtime point, is easily shaped, and has active chemical properties. Pb can contaminate air, water, soil, plants, animals, even humans.

In addition to pollutants, the environmental feasibility of becoming a residence is also influenced by several physical and chemical factors of air. Such as temperature, humidity, wind speed, and light intensity.

Temperature is a parameter that is very influential on the existence and activity of the organism, because generally the organism has a certain temperature range in order to perform an activity optimally. The maximum range of living things is called the tolerance limit. Temperature cannot be preserved so it must be measured in the field.

Humidity shows the amount of moisture or water in the air (atmosphere). The atmospheric air is a mixture of dry air and water vapor. The humidity of the air is determined by the amount of moisture in the air.

Wind speed is the speed of air that moves horizontally at a height of two meters above the ground. The intensity of light has an effect on an environment and its components.

2. Methods

2.1. Physical and chemical parameters test of air

Before testing the lead content on the leaf, first to test the physical and chemical parameters of air at the point of sampling. The first point in the area of Campus C Unair and the second point on Jl. A. Yani Surabaya. Data collection was conducted in April 2018. At both points measured dry temperature, wet temperature, humidity, light intensity, and wind speed.

Dry temperature, wet temperature, and humidity are measured using a psychrometer sling, which consists of dry thermometers, wet thermometers, fabrics, and aquades. Based on the result of dry temperature and wet temperature can be obtained air humidity.

Air humidity is obtained by wetting the wet thermometer by using aquades, then the sling psychrometer is swung by twisting it in air like a propeller for 2 minutes. Air humidity readings are carried out by squeezing the results of wet and dry thermometer readings on the scale found on the psychrometer sling.

The intensity of light is measured using a lux meter. How to use it is by exposing the light sensor to the light but not directly under the sun then the measurement results are viewed on the scale of the screen designated by the scalp pointer.

Wind speed is measured using anemometer. How to use it is by holding an anemometer around the top of the head for 2 minutes. Then read the scale on the screen.

2.2. Test of lead (Pb) content on puring (*Codiaeum variegatum*) leaf

2.2.1. Leaf sampling. Leaf sampling was done at two points in the area of Campus C Unair and Jl. A. Yani Surabaya. Sampling was done in April 2018. The selected of puring is a that grows in the middle or between the two streets. Selection of sampling place because the middle is considered as the place that has the highest pollution. Leaves taken are leaves located on the bottom, middle, and top layer of the canopy to represent lead metal content throughout the plant using scissors. Newly extracted samples are isolated by inserting into plastic bags separately to prevent mixing of samples and the reduction or replenishment of lead metal in plant leaves.

2.2.2. Lead (Pb) test using atomic absorption spectrophotometry (AAS). The leaf sample that has been obtained is taken to Research Center and Standardization of Industry and Trade Surabaya (Baristand Indag Surabaya) to be tested Atomic Absorption Spectrophotometry (AAS). This test runs from April to May 2018. The leaf samples obtained were weighed by each sample 10 grams after small cuts. The leaves are cut to small in order to fast in the process drying and does not require a large area. Leaf samples were dried at 70 ° C. Samples of dried oven leaves are consumed in a furnace of 600 ° C until they are white ash. The leaves of leaves are given concentrated HNO₃ (65%) and the aquades are 5 ml each and water is added to the 50 ml mark. then the lead is measured in lead with Atomic Absorption Spectrophotometry (AAS). The concentration of Pb is determined by Atomic Absorption Spectrophotometry (AAS). The operation technique of the tool is by measuring the change of the energy of the analyte in atomic form. The sample is evaporated and converted to an element in a gas state. The atoms will experience excitation because of the radiation from the cathode sunlight (Hallow Cathode Lamp / HCL) from the ground state to an excited state by absorbing the higher energy. The wavelength for the radiation is at 283.3 nm. Determination of the content or concentration of Pb metal is carried out by making a calibration curve or readings directly from the AAS tool. In order to make the calibration curve carried out by measuring the absorbance of the standard solution made from CRM-categorized substances in various concentration variations, so that from the calibration curve linear regression equation

$$y = ax + b \quad (1)$$

Note:

y , absorbance.

a , slope.

x , concentration.

b , intercept.

The extracted sample is then measured in absorbance, and the value of the absorbance is converted into a linear regression equation to obtain the concentration of Pb metal present in the leaf. The result of measurement from AAS then analyzed descriptively qualitative.

3. Results

The following is the result of the research that has been done.

Table 1. The result of physical and chemical parameters of air.

Physical and chemical parameters	Area of Campus C Unair	Jl. A. Yani
Dry Temperature	33 °C	32 °C
Wet Temperature	27 °C	27 °C
Humidity	62 %	66 %
Light Intensity	1650 Candella	2800 Candella
Wind Speed	1 m/s	1 m/s

Table 2. The result of lead (Pb) test.

The Name of Plant	Area of Campus C Unair	Jl. A. Yani
<i>Codiaeum variegatum</i> / Puring	0,46 mg/kg	0,74 mg/kg

4. Discussion

The growing number of motor vehicles with various brands and types will increase consumption of fuel oil and cause air pollution effects. Seeing this problem, it is imperative for the government and the motor vehicle industry and the public in Indonesia to be aware of as early as possible the effects of hazards posed by exhaust emissions pollutants and to jointly strive for an act of how to breathe in air from the resulting pollution by exhaust emissions pollutants and environmentally friendly.

The combustion process of a gasoline motor consisting of gasoline elements (Heptane C_7H_{16} and Iso Oktana C_8H_{18}) with air (O_2 , N_2 , and other elements) will produce exhaust emissions which include Hydrocarbons (HC), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Nitrogen Oxide (NOx) Tetra Ethyl Lead (Pb), and Sulfur / sulfur (SO_2) as well as other particulate materials.

The Pb-organic compound is widely used as an additive in gasoline fuels. Pb-tetramethyl and Pb-tetraethyl are solvent-shaped. Both of these compounds will decompose at their boiling point in the presence of sunlight and other chemical compounds in the air such as acid halogen compounds or oxidizers.

Pb emissions into the atmosphere layer. These emissions are by-products of combustion that occur in motor vehicles that function as antiknocks in vehicle engines. The loss of lead during the combustion process causes the amount of Pb discharged into the air through vehicle exhaust fumes to be very high.

In addition to the consequences of burning gasoline on motor vehicles, one source of lead pollution is the use of lead in various industries. As in the battery recycling process or wire-producing industry, and metal casting industry.

Lead (Pb) is one of the heavy metals that are harmful to living things because they are carcinogenic. Lead is a soft-colored, bluish-gray metal and has a +2 oxidation number [4]. Lead has a number 82 with atomic weight of 207.20. The melting point of lead is 1740 ° C and has a density of 11.34 g / cm³ [5]. Palar [6] reveals that the Pb metal at a temperature of 500-600 ° C can evaporate and form oxygen in the air in the form of lead oxide (PbO).

Pb contained in gasoline is very dangerous, because burning gas will emit 0.09 grams of lead per 1 km. One of them is the decline of IQ and brain damage caused by this lead emission. In adults generally the characteristics of lead poisoning are dizziness, loss of appetite, headache, sleepless anemia, weakness, and miscarriage of the womb. In addition, lead is dangerous because it can lead to changes in the shape and size of red blood cells that result in high blood pressure [7].

In Surabaya there has been a lot of greening activities as an effort to reduce air pollution. Besides being held by the government is also the initiative of the citizens. Reforestation activities have many benefits such as reducing air pollution, reducing dust particles, natural fertilizer suppliers, learning facilities, and tourism facilities. The most important thing is to make the environment better.

Reforestation in Surabaya in the form of city parks, seedlings, mangrove gardens, and the existence of shade plants in the vicinity of the streets - protocol roads. City park is an area in the city that can be a place to get pleasure and comfort. Park city makes sense of security, comfort, cheerfulness, fatigue release, familiarity, and freshness in the middle of the city life [8].

Comfort in the city park due to the cool and fresh air. The air is cool and fresh due to the many plants that are deliberately planted in the park area. The selected plants are plants capable of absorbing various substances that pollute the air and have a beauty in certain parts of the plant.

Shade plants are plants grown as greening crops. This plant is also an absorbent plant of air pollution and noise. Plants can be shaped trees or shrubs that have dense leaves and can absorb air pollution from vehicle fumes and noise. The shade plants are also the oxygen-producing plants, so the shade plants serve as one of the largest oxygen-producing trees and as a source of human life. Shade plants can also fight global warming, and fight air pollution.

In addition to green leaf, the choice of reforestation plants should also consider its function as a shade that can improve the microclimate, and can also serve as a barrier against the spread of air pollution from vehicles. The shade plants grown on the side of the highway in addition to functioning as a chemical pollutant absorber, also serves as a silencer both qualitative and quantitative.

The general character of plants that have a high ability to absorb indoor and outdoor pollutants, are generally similar. Plants have dense canopy, do not fall leaves, and the plants are tall. Specific crop characters that have a high ability to reduce particle pollutants, have characteristics of leaves, have fine hair, leafy surface, scaly leaves, jagged leaf edge, needle leaf, sticky surface leaves, it is effective to absorb pollutants

Examples of plants used as shade plants include Puring, dracaena, trembesi, palm, beads flower, and many others. Of the many types of plants used as ornamental plants, this time research chose to use Puring plants. Selection of puring plant as a sample of lead (Pb) content because the puring has a shrub habitus so it is easy in sampling.

Upright erect stem growth soars up with many branches. Gum puring stems indicate the growing age of the plant. Puring flowers including naked flowers, male flowers are a collection of stamens.

Puring including plant protandri male flowers will appear and adult first of the female flowers. The puring fruit is round, the green fruit is shiny green, after the old turns into a dull dark green. Puring seeds are also round in the fruit.

The use of the AAS test is because AAS can measure certain elements well even in the presence of other elements based on the absorption of radiation by the free atoms of the element [9]. Punch leaf samples measured their lead content after being cleared of organic matter. The exemption of metal is done by destruction and then atomized. Atomization is carried out with a flame system. Flame atomization using air acetylene gas or nitrous oxide air [10].

Based on the test results of Pb content, between leaves taken from the area of Campus C Unair and on Jl. A. Yani has a very far difference. In the area of Campus C Unair Pb content of 0.46 mg / kg and on Jl. A. Yani 0.74 mg / kg. These results prove that the environmental conditions of the two points are different. When viewed from environmental factors, the content of Pb in this leaf is directly proportional to the content of Pb air based on Martuti [11] research results and the traffic density calculated from both points.

Based on the AAS test results, Pb content is absorbed on the puring leaves at two different points. The content of Pb on the leaf is quite high. The content does not exceed the normal threshold of Pb content in plants ranging from 0.5 to 3.0 ppm [12].

The results showed that there were differences of Pb content in leaves of puring plant in the area of Campus C Unair and Jl. A. Yani. Plant spacing with pollutant sources, the number of cover crops, and

the surrounding plant species and environmental factors (air temperature, air humidity, light intensity, wind speed, and airborne Pb) are factors that affect the Pb content in the leaves.

The ability of purring plants to absorb Pb is supported by anatomical structure. The density of stomata is to increase the absorption of Pb content with a considerable contribution of influence ($R^2 = 25.2\%$). This means the absorption of high Pb content for leaves with high stomatal density [13].

Santoso, Lestari, and Samiyarsih [14] stated that Pb absorbed by leaves of purring plants will accumulate in the palisade tissue and the effectiveness of Pb through stomata is influenced by stomata density and stomata size.

The physical and chemical parameters of the air show different results. In the area of Campus C Unair has a dry temperature of 33°C , wet temperatures 27°C so that the humidity of the air reaches 62%, the light intensity of 1650 Candella, and the wind speed of 1 m / s. Based on this result, the area of Campus C can be regarded as a place that has a hot dry temperature with bright sunlight and rarely there is wind.

In Jl. A. Yani has a dry temperature of 32°C , wet temperature of 27°C so that air humidity reaches 66%, light intensity 2800 Candella, and wind speed 1 m / s. Based on this result Jl. A. Yani can be said as a place that has a temperature hot and dry enough with sunlight is more blistering than the area of Campus C Unair and rarely there is wind.

Differences in temperature and light intensity are caused by slightly different sampling times although not reaching 1 hour. Moreover, it is caused by environmental conditions around the picking point that are filled by large trees. So it gives a different effect on the condition of temperature, air humidity, and light intensity.

5. Conclusions

Based on the results of research that has been done, the content of Pb in the leaves of purring plants in the area of Campus C Unair and Jl. A. Yani there is a difference. In area of Campus C Unair is 0.46 mg / kg and on Jl. A. Yani of 0.74 mg / kg and from both places are below the normal range of 0.5 to 3.0 ppm. The difference is caused by various environmental factors and the volume of vehicles that cross the road. The higher volume of vehicles crossing the road causes the higher Pb pollutants present in the air and is complete in the leaves of the Purring plant.

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