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# Accumulation of Heavy Metal Lead (Pb) and Effect of Stomates Number on Green Champa Leaves (*Polyaltia longifolia*) in Industrial Area of Makassar City

**Hardiyanti YM[1], Fahruddin Fahruddin[2]*,Paulina Taba[3]**

[1]Department of Environmental Management, Faculty of Graduate School, Hasanuddin University, Makassar, Indonesia
[2]Department of Biology, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Makassar, Indonesia
[3]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Makassar, IndonesiIndonesia.

## Abstract

Star Heavy metal pollution in the industrial area causes problems in the surrounding vegetation. The study aims to determine the absorption of heavy metals lead (Pb) which accumulates on green champa leaves (*Polyalthia longifolia*) in the industrial area of Makassar city, and its effect on the number of leaf stomata. Leaf samples were taken at three stations, the method used was random sampling. Measurement of the concentration of heavy metals lead (Pb) by the atomic absorption spectrophotometery method (AAS), observation of the number of stomata using a microscope. The results showed the concentration of Pb that accumulated in green champa leaves, such as 1.21–2.42 µg/g. Heavy metals affect stomata on green champa leaves but do not show significant damage (> 0.05). This shows that the green champa plant has benefits in reducing heavy metal pollution in the air, without experiencing damage to the leaf stomata fruit

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## Introduction

Air pollution originates from very large quantitative human activities, which are sourced from transportation, industrial, and burning activities (Aaksu, 2015; Nurhidayah et al., 2019). air pollution emissions by industry are very dependent on the type of industry and its processing, industrial equipment and their use. Various industries use energy and heat from burning gasoline to increase the amount of pollutants in the air (Tauqeer et al., 2013; Fahruddin, 2020). Combustion of coal coming from industries that emerge from the chimney produces various substances - such as CO, $SO^2$, $NO^X$, and pollutants in the form of heavy metal compounds such as cadmium (Cd), and lead (Pb) (Zhao et al. 2013; Fahruddin et al., 2018).

CONTACT : FAHRUDDIN fahruddin_science@unhas.ac.id

Some heavy metals in the environment bioaccumulate in the food chain, so metals will be distributed to human body parts. If this continues for a long period of time, it may endanger human health and the environment (Aksu, 2015). Heavy metals have toxic effects when biochemical reactions occur in living organisms, namely inhibiting growth, lack of oxygen needed, reproductive disorders and tissue repair. One of them is lead metal (Pb) has attracted attention because it is persistent, bioaccumulative, and toxic (Javarabad et al., 2013; Adawiyah et al., 2017).

Makassar Industrial Area or known as PT. KIMA is one of the areas in the city of Makassar in which there are many industries to meet the needs of the people of Makassar city and surrounding areas (Hapsah et al., 2013). The existence of an industrial area in the middle of community settlements can bring benefits and negative impacts, will harm the surrounding community if not managed properly (Shock et al., 2016). If an industrial company does not properly manage its waste disposal, especially waste entering the air containing heavy metals, it will spread to other places in the direction of the wind (Javarabad et al., 2013).

The main road in the industrial area of Makassar city is traversed every day by various vehicles and industrial activities using fossil fuel types, producing heavy metal emissions of cadmium (Cd) and lead (Pb). Then there will be accumulation of heavy metals in the shade plants in the Industrial area of Makassar city (Hapsah et al., 2013; Fahruddin et al., 2019). Overcome air pollution due to the presence of industry and traffic is to plant trees on the roadside and in the corner of the city. This is certainly beneficial, namely the road environment to be shady and comfortable, air pollution and noise pollution can be overcome (Rungruang et al., 2016).

Some plants are metal hyperaccumulators, namely mahogany (*Swetenia macrophylla*), green champa (*Polyalthia longifolia*), sea putat (*Baringtonia asiatica*), and rain tree (*Samanea saman*) have the ability to accumulate heavy metals in the air (Jafarabad et al., 2013). The heavy metal in the form of free particles will partially stick to the plant especially on the leaves. Part of road shading plants that are sensitive to pollutants and are most often exposed to heavy metals are leaves (Popescu, 2011). Therefore leaves can be an indicator of air pollution, marked by physical changes, including changes in leaf tissue, one of which is the amount of leaf stomata (Rungruang et al., 2016).

Most trees used as shade plants in urban areas and in industrial areas are green champa trees. This tree is a type of plant that has roots that can withstand damage, easily grows in hot areas and is resistant to wind, making it suitable for use as a road shade plant that can absorb heavy metal pollution in the air (Tauqeer et al., 2013). Based on this background, an observational study of green champa leaves was carried out in absorbing heavy metals lead (Pb) and its effects on the amount of stomata in the leaves.

## Materials and Methods

### Sampling Stations

The station is determined based on its location in the Industrial area of Makassar city on green champa leaves (*Polyalthia longifolia*) affected by air pollution. The study was conducted based on a distance of about 1 km between. Different locations, namely: Station 1 is the entrance of Jalan Kima 1, Station 2 is the intersection of Jalan Kima 1 and Jalan Kima 2, and Station 3 is Jalan Kima 4. Map of sampling locations in the Industrial Area of Makassar city is seen in Figure 1.

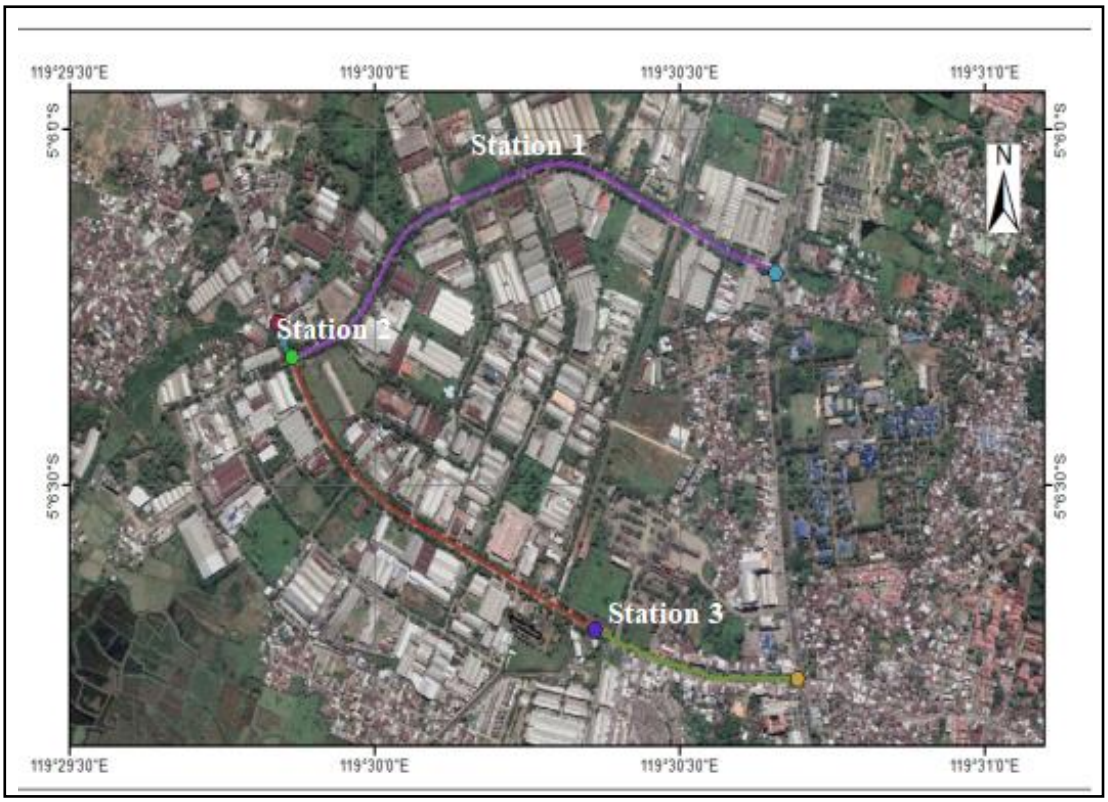


**Figure1. Map of the location of leaf samples of green champa plants (*Polyalthia longifolia*) in the Industrial Area of Makassar**

## Leaf Sampling

Sampling of green champa leaves was carried out by random sampling at each station. Leaflets are stored in plastic container for further analysis. Green champa leaves taken at each station are the leaves in the upper leaf, namely with the code S1A, S2A, S3A as high as 10-25 m and the lower leaf with the codes S1B, S2B, S3B as high as 5-10 m.

## Measurement of Heavy Metal Pb Concentration in Leaves

Measurement of heavy metal Pb concentrations was carried out on green champa leaves using atomic absorption spectrophotometery (AAS). Samples of green champa leaves are heated in an oven at 70 °C until they reach a constant dry weight, then weighed as much as 5 g. The dried leaf samples were grayed in a furnace at 600 °C for 24 hours. Leaf ash was given demineralized water with 100 mL and 5 mL concentrated H2SO4 (65%). The mixture is heated at 20 °C until the sample reaches 10 mL in a beaker, filtered and added aquabides to the 100 mL limit mark. Lead content (Pb) in the solution was measured with an atomic absorption spectrophotometer with the formula:

Cy1= $Cy\ x\ \frac{V}{W}$

where : Cy1 = heavy metal content in leaf tissue (µg/g), Cy = the concentration of heavy metals measured at AAS (µg/mL) V = dilution volume (mL),W= dry weight of the leaf (g).

### Determination of stomata amount in the leaves

The underside of the green champa leaves is given cutex, then isolated to get a transparent stomata print. Then the mold is affixed to the deck glass. This clear layer is then observed under a trinocular microscope with a magnification of 400x, then the number of stomata is calculated. The data obtained are grouped into categories: few (1 - 50), quite a lot (51 - 100), many (101 - 200), very much (201 -> 300), infinite (301 -> 700).

## Results and Discussion

### Vegetation and Industry Conditions of Industrial Areal

Based on observations, there are two highway lanes in the Industrial Area of Makassar city. The most dominant shady tree besides road to grow is green champa (*Polyalthia longifolia*) with a tree height between 10-25 m, has the characteristics of a strong trunk, canopy tree diameter of 5-10 m, and has dense leaves and soars upward which grow in groups and form a barrier along the road and partly in the yard of the factory and warehouse. The distance between the tree and the highway is very close, and the distance between the tree and the industrial factory is 5-10 m.

According to data from the Head Office of Industrial Area in the city of Makassar, there are 265 factories in the form of industrial concrete factories, battery factories, paint factories, textile processing plants, electronic factories, accu factories, paper factories, as well as food factories and others. Fuels used in managing industries in the combustion process are coal, firewood and petroleum. This can be a source of heavy metal pollution in the air (Hapsah et al., 2013; Tauqeer et al., 2013).

### Heavy Metal Pb Concentration on Green Champa Leaves

From the observations of heavy metal concentrations showed the green champa leaves at each station. In the upper leaf and lower leaf that is relatively the same. At S2A and S3B the Pb concentration was 2.42 µg/g, then at S3A the Pb concentration was 1.91 µg/g. Furthermore in S1B and S2B with Pb concentration was 1.81 µg /g, as shown in Figure 2.

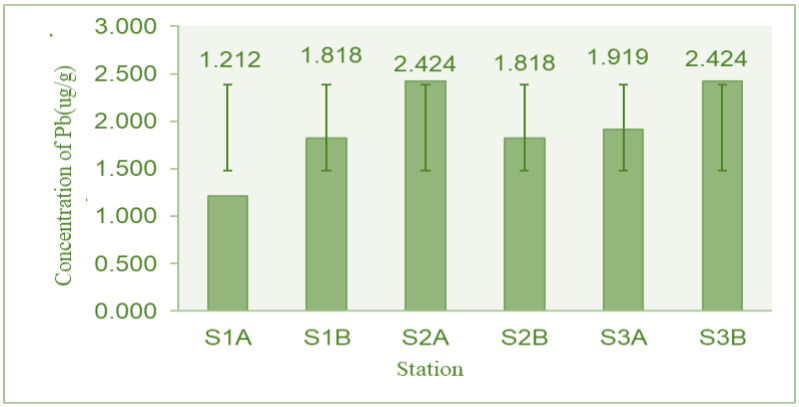


**Figure 2. Heavy metal Pb concentration on green champa leaves in each station, i.e. S1 is station 1, S2 is station 2 and S3 is station 3; A is the upper leaf and B is the lower leaf.**

Differences in plant response to types of heavy metals caused by the characteristics of plants to the way of accumulation, as well as the level of tolerance of plants to the toxic effects of heavy metals Pb, even at low concentrations can affect plant metabolic processes (Fakhry and Migahid 2011). The amount of Pb in the air is affected by the volume or density of traffic, distance from the highway and industrial areas, engine acceleration and wind

direction. While the high content of Pb in plants is also influenced by sedimentation (Al-Hasnawi et al. 2016). Differences in plant response to types of heavy metals caused by the characteristics of plants to the way of accumulation, as well as the level of tolerance of plants to the toxic effects of heavy metals Pb, even at low concentrations can affect plant metabolic processes (Fakhry and Migahid, 2011). The amount of Pb in the air is affected by the volume or density of traffic, distance from the highway and industrial areas, engine acceleration and wind direction. While the high content of Pb in plants is also influenced by sedimentation (Al-Hasnawi et al,. 2016).

Factors that influence the absorption of heavy metals are the high intensity of light and air temperature, as well as low humidity which triggers the number of stomata more, so that more absorption of heavy metals Pb accumulates in the leaves. Another factor that affects the absorption of heavy metals is the size of the opening of the stomata which has a length of 12 - 39 µm. Having mesophyll thickening in the stomata exposed to Pb (Attipalli et al., 2010; Andriany et al., 2018). Heavy metal pollutants can enter through the stomata due to the very small size of heavy metal particulates, which is less than 2µ, while the opening size of the stomata is 10µ x 27µ, so heavy metal particulates can enter easily through the stomata. The thicker mesophyll shows the more metal concentration (Kabir et al., 2010).

## Number of Stomata

The most number of stomata to the concentration of heavy metal Pb was at station 3 in the lower header (S3B) of 130 compared to stations 1 and 2 and control. Compared to Station 1, there were 77 stomata of the upper leaf (S1A) and 73 stomata of the lower leaf (S1B) of 73 stomata, this is quite a number (51 - 100) which is relatively the same as the control, as shown in Figure 3.

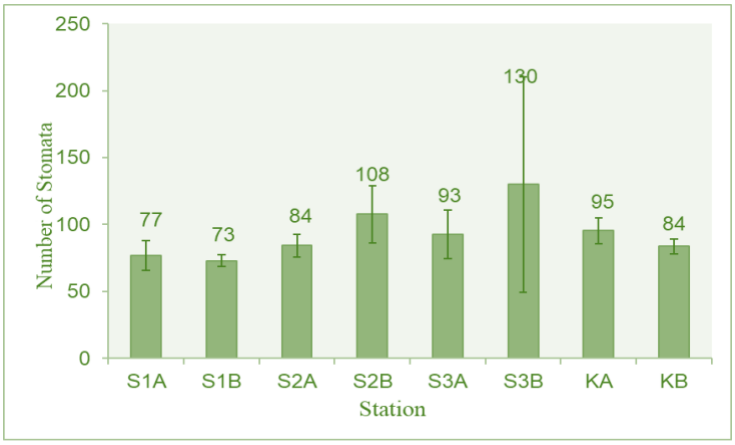


**Figure 3. The number of stomata to the concentration of heavy metals Pb in Green Champa leaves at each station: i.e. S1 is station 1, S2 is station 2 and S3 is station 3; A is the upper leaf and B is the lower leaf; KA is the control on the upper leaf and KB is the control on the lower leaf.**

Based on an analysis of the effect of Pb on the upper green champa leaves on the number of stomata using statistical analysis, namely a simple linear regression test, the square of R2 is 0.271. The effect of Pb heavy metal concentration on the amount of stomata in the leaves is 27%. This means that there is an influence of heavy metal Pb concentration on the amount of stomata in the leaves, and the remaining 73% is influenced by other variables, as shown in Figure 4A. Based on the results of the analysis of variance shows that

although the concentration of heavy metal Pb on the amount of stomata in leaves is 27%, the results do not experience significant damage.

Based on the analysis of the effect of Pb on the bottom green champa leaves on the number of stomata using statistical analysis, namely a simple linear regression test, the results obtained are the square of R2 of 0.629. The effect of heavy metal Pb concentration on the amount of stomata in leaves was 62%. This means that there is an influence of heavy metal Pb concentrations on the amount of stomata in the leaves. The remaining 38% is influenced by other variables as shown in Figure 4B. Based on the analysis of the variance which shows that although the concentration of heavy metals Pb on the amount of stomata in the leaves is 27%, the results do not experience significant damage.

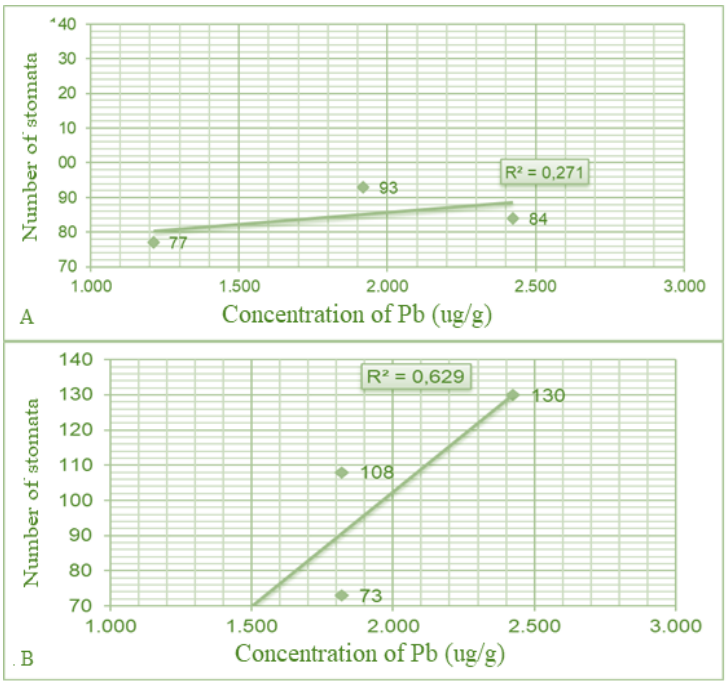


**Figure 4. Analysis of the effect of Pb on the number of stomata in green champa leaves in the upper leaf (A) and green champa leaves in the lower leaf (B).**

More stomata in the lower canopy than the top canopy, because water loss occurs faster through the stomata on the top of a leaf exposed to sunlight, this is in line with previous research (Attipalli et al., 2010; Tanjung et al., 2019), the number of stomata under the tree canopy is higher than above the canopy in road shade plants, so the higher the number of stomata, the higher the potential to absorb heavy metals or particles in the air. When in the lack of light intensity and low temperature at each station, the amount of stomata is reduced so that absorbs $CO_2$ is reduced and the process of photosynthesis is disrupted (Aalto et al. 2017; Fahruddin and Tanjung 2019).

## Conclusions

From research on the absorption of heavy metals Pb in green champa leaves (*Polyaltia longifolia*), shows that the heavy metals Pb concentration is 1,21–2,42 µg/g which accumulates in green champa leaves in the Industrial Area of Makassar city by being categorized as still normal. Heavy metals Pb affect the number of stomata in green champa leaves, but microscopically the leaf stomata do not show any significant damage (>0.05) that occurs at three stations.

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