Stomata Characteristics of Ketapang Leaves (*Terminalia catappa* L.) Based on Environmental Differences

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Abstract. Ketapang (*Terminalia catappa* L.) is a type of plant that is widely planted on the roadside of urban areas that functions as a green plant. The response from green plants exposed to pollutants originating from motorized vehicles can be seen from the leaf stomata. This study aimed to determine the characteristics of the stomata of Ketapang leaves in areas with different environmental conditions. The parameters observed were density and stomata distribution. The sample was taken in Bung Hatta Forest Park and on the edge of Prof. Dr. Hamka streets. Observation of stomata using preparations with replica or mold method. The results showed that there were significant differences in the stomata density of Ketapang leaves in both locations. Stomata density on Prof. Dr. Hamka street is higher than the Bung Hatta Forest Park. The average density of the stomata of Ketapang leaves in Bung Hatta Forest Park is 132738.09/mm² while at the edge of Prof. Dr. Hamka street is 232142.85/mm². The distribution of stomata of Ketapang leaves in both locations showed no difference, i.e. they were of the hypostomatic type (stomata were only found on the lower surface of leaves).

1. Introduction
Air pollution or we often hear the term air pollution is defined as the presence of foreign materials or substances in the air that causes changes to the composition or composition of the air from its normal state [1]. Air pollution occurs when the air contains one or more types of pollutants obtained from chemical processes such as CO, O₃, CO₂, SO, H₂O, SO₂, NOX, C₂H₄, and Pb gases as well as the presence of dust particulates, all of which exceed the threshold [2]. According to Faradiaz [3], in addition to these gases, there are dust particles that are generated from the friction in the engine, tire friction with the road, and the remaining friction of vehicle brake components. Gases and dust particles from vehicles will float in the air and give changes to the air composition in both the short and long term.

One of the big cities that has an increasing number of vehicles every year is Padang City. The increase in the number of vehicles cannot be separated from the increase in population every year. The total population of Padang city in 2017 reached 927,168 people. Also, the people of Padang city prefer to use private vehicles instead of using public transportation to carry out their activities [4]. This has resulted in fairly high growth in the population of vehicles on the highway. Prof. Dr. Hamka street is one of the roads that is crowded with vehicles passing by in the city of Padang because there are various activities such as shopping and education centers, which cause high travel mobility on the
road, which increases CO emissions which reduce air quality. Wijaya’s [5] research results show the air pollution index on Prof. Dr. Hamka street of 56.67 which is included in the unhealthy air category. Contaminated air needs to be monitored and controlled. Meanwhile, Kovacs [6] states that one way of monitoring air pollution is to use plants as bioindicators. The part of the plant that functions as an absorber of pollutants is part of the plant canopy, especially the leaves. Thus, leaves are a plant organ as a bioindicator that is most sensitive to the environment by looking at the macroscopic or microscopic damage to the plant organs. A similar thing was stated by Karliansyah [7], plants that are sensitive to air pollutants will show changes in morphology, anatomy, physiology, and biochemistry. To determine the effect of air pollution on leaves, it can be seen from the damage either macroscopically such as chlorosis, necrosis, or microscopically such as cell structure or changes in physiology and chemistry of the plant.

The process of reducing pollutants can be done in two ways, namely absorbed (absorb) or absorbed (adsorb). Absorbed means that it enters the leaf structure through the stomata, whereas being absorbed means that it only sticks to the leaf surface and allows it to be released and becomes a pollutant again [8]. Plants have a big reaction in receiving the effects of changes or disturbances due to air pollution and environmental changes. The level or level of air pollution in an environment will affect the structure and function of the stomata [9]. The level of sensitivity of plants is related to their ability to absorb and accumulate pollutants. Pollutants will diffuse into the leaves through the stomata which are also influenced by the surrounding air conditions. This is because stomata function as a gateway for gas and water vapor exchange between plants and the surrounding environment [10]. According to Hidayati [8] the ability of plants to absorb pollutants in the air also depends on the morphology of these plants, the types of plants that have stomata on both sides of the leaves are relatively more potential in absorbing the surrounding gases, including pollutants in the air.

Greening activities are carried out to make the city environment into an environmentally friendly area with a beautiful, harmonious, and cool atmosphere. It can be done in many ways. Methods or forms of urban greening, including urban forest development, green lines, greening with potted plants. Urban greening becomes a form of the biological environment with various functions in environmental management. Dahlan [11] states that urban greening functions as the lungs of the city because plants produce oxygen gas needed by all living things, absorbing gases or toxic particles to reduce air pollution and as a noise damper from transportation means. Raharjo et al. [12] also argue that reforestation can be done by planting plants which in addition to adding aesthetics also functions to reduce air pollution. Protective plants that can be used for reforestation include Ketapang, glodokan, tamarind, mahogany, and others.

Green plants that are often found along the streets of Padang include Ketapang (Terminalia catappa L.). The exposure of these green plants to pollutants will certainly affect the stomata of the leaves. Based on this, it is necessary to know about the stomata characteristics of Ketapang (T. catappa) leaves based on environmental differences.

2. Materials and Methods

2.1 Materials

The tools used in this study were scissors, plastic bags, tissue, transparent tape, label paper, glass objects and covers, Zeiss Primo Starlight microscope, and a digital microscope. The materials used in this study were transparent nail polish and Ketapang leaves (T. catappa).

2.2 Research procedure

2.2.1 Sampling. Leaf samples were taken at Prof. Dr. Hamka street and Bung Hatta Forest Park. In order for a representative leaf sample, as many as ten sheets were taken at each location. The leaves taken are the third leaf from the end of the tree branch. Leaf samples were taken at 09:00-12:00 WIB. Samples that have been taken are labelled according to the location of collection, then put in a plastic bag so that the plants do not wither when doing research at the Botanical Laboratory of the Department of Biology, Faculty of Mathematics and Natural Sciences, State University of Padang.
2.2.2. Preparation of Stomata Preparations. The method used is the replica method by rubbing a clear nail polish on the lower and top surfaces of the leaves in the middle and leaving it to dry. Then the part covered with nail polish is affixed with clear insulation and pulled slowly and then placed on the glass object, and cut approximately 0.5 cm. Then observed under a Zeiss Primo Starlight microscope at a magnification of 10x40 and the results were photographed with a digital microscope.

2.2.3. Calculation of Stomata Density. To determine the density of the stomata, first know the area of the field of view, the field of view in this study is 168 µm\(^2\) which is then entered into the formula of Willmer [13]:

\[
\text{Density} = \frac{\text{number of stomata}}{\text{field of view}}.
\]

2.2.4. Determination of Stomata Distribution. The distribution of stomata is classified according to whether they are amphistomatic (stomata are present on both leaf surfaces), epistomatic (stomata are only present on the upper surface of the leaf only), and hypostomatic (stomata are only found on the lower surface of the leaf) [14].

2.2.5. Data Analysis. The research data were analyzed using the T-test with a significant level of 5%.

3. Results and Discussion

The results of the comparative analysis of the T-test for stomata density of Ketapang leaves (T. catappa) at the Bung Hatta Forest Park and Prof. Dr. Hamka street can be seen in Table 1 below:

| Location                  | Stomata Density (／mm\(^2\)) |
|---------------------------|-------------------------------|
| Bung Hatta Forest Park    | 132738.09\( ^a \)            |
| Jl. Prof. Dr. Hamka       | 232142.85\( ^b \)            |

Note: The same letter in the same column is not significantly different at the 5% significance level.

The results showed that the stomata density of the Ketapang plant on Prof. Dr. Hamka street is taller than Bung Hatta Forest Park. The average density of Ketapang leaf stomata in Bung Hatta Forest Park was 132738.09 / mm\(^2\) while on the side of Prof. Dr. Hamka street amounting to 232142.85 / mm\(^2\). This is because the location of Prof. Dr. Hamka often experiences congestion, resulting in high growth in the vehicle population on the highway. The effect of this growth is high road density and increased CO emissions which reduce air quality so that the stomata at the location respond by increasing the number of stomata. The results of research by Mutaqin et al. [15] also showed that the density and damage to the stomata of mango leaves (Mangifera indica) that grow on roadsides where motorized vehicles are high are higher than in Nature Reserves. The same thing was stated by Vauzia et al. [16] the density of the stomata of Mallotus leucodermis seed regeneration and shoot regeneration at the burnt location was higher than the unburned location.

The number of stomata in polluted areas is higher than in non-polluted areas. This is a form of physiological adaptation due to air pollution. Pollutants that stick to the stomata will accumulate and if in large numbers it can damage the stomata cells. Damaged stomata cells will stimulate the production of stomata in greater numbers so that the photosynthesis process runs normally as a form of adaptation [15]. Prawiranata [17] states that in addition to pollutants, the frequency of stomata is also influenced by environmental conditions. Plant leaves that grow in dry environments and under high-intensity light tend to have a lot of stomata. Thus, the density of stomata is not only influenced by pollutants but also by light intensity. Light intensity is influenced by vegetation cover. The light intensity at the two sampling locations was different, the light intensity in Bung Hatta Forest Park was lower because
many large trees were covering the vegetation while on Prof. Dr. Hamka street has high light intensity because there are few shade trees planted by the side of the road.

![Image of Ketapang leaves](image.jpg)

**Figure 1.** Longitudinal cross section of Ketapang leaves (A) Adaxial Bung Hatta Forest Park (B) Abaxial Bung Hatta Forest Park (C) Adaxial Jalan Prof. Dr. Hamka (D) Abaxial Jalan Prof. Dr. Hamka.

The stomata distribution of Ketapang leaves in the two locations did not show any difference, namely with the hypostomatic type (stomata only on the lower leaf surface) as seen in Figure 1. Haryanti’s research results showed that both monocot and dicot plants that grow on land have many stomata on the lower surface of the leaves except for onclang, pineapple, cantel and palms which are found on the upper surface of the leaves. This is confirmed by Campbell who stated that in general the number of stomata is more located on the lower surface of the leaves, which is a mechanism for adapting trees to the environment to reduce transpiration.

4. Conclusion
From the research results, it can be concluded that the stomata density of Ketapang leaves (*Terminalia cattapa* L.) on the side of Prof. Dr. Hamka street, which has many motorized vehicles, is bigger than in Bung Hatta Forest Park. The average density of Ketapang leaf stomata in Bung Hatta Forest Park was 132738.09/mm² while on the side of Prof. Dr. Hamka street amounting to 232142.85/mm². The distribution of Ketapang leaf stomata is only found on the lower surface or is of a hypostomatic type.

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