

COMPARISON OF LEAVES MORPHOLOGY AND STOMATAL CHARACTERISTICS OF FRANGIPANI (*Plumeria acuminata*) IN POLLUTED AND NOT POLLUTED PLACE

Imam Mudakir¹⁾, Pujiastuti¹⁾, Iis Nur Asyiah¹⁾, Siti Murdiyah¹⁾, Ika Lia Novenda¹⁾
Pendidikan Biologi, Fakultas Keguruan dan Ilmu Pendidikan
Universitas Jember
email: mudakir.fkip@unej.ac.id

Abstract

*Leaves are an important organ for plants. One part of leaf is stomata which function as a place for gas exchange. The method used in this research is the observation of the morphology and anatomy of frangipani leaves (*Plumeria acuminata*) which are exposed to pollution and not exposed to pollution. The purpose of this study was to determine environmental conditions or as a bioindicator by observing damage to plants. Macroscopic damage to plants in leaf morphology and microscopic damage to changes in leaf stomata conditions. Observations show that the morphology of frangipani leaves (*Plumeria acuminata*) which are not exposed to pollution is larger than frangipani leaves (*Plumeria acuminata*) which are exposed to pollution. The number of stomata in the abaxial part is more than the adaxial part. Meanwhile, the number of stomata on frangipani leaves (*Plumeria acuminata*) that were not exposed to pollution was more than those exposed to pollution. The stomata type on frangipani leaves (*Plumeria acuminata*) is anomocytic type with kidney-shaped covering cells.*

Keywords: *Stomata, pollution, leaf, morphology.*

1. INTRODUCTION

Leaves are an important part of the plant. The leaves usually have a thin, widened shape and are rich in a green dye called chlorophyll. The leaves are usually green and have a limited lifespan. Young leaves are light green whitish, purplish or reddish. Mature leaves are usually dark green. Similarly, frangipani leaves (*Plumeria acuminata*) are dark green when they mature [5].

Leaves have gaps that serve as a place for gas exchange called stomata. Stomata are modifications of leaf epidermal cells, either upper or lower epidermis. The number of stomata in the abaxial layer (bottom) is more than in the adaxial layer (top). The stomata on the lower leaves have a function to reduce excessive evaporation. The level of stomata density is influenced by environmental factors such as temperature, light intensity, and humidity. If the light intensity is high, the stomata density increases. Stomata density and number are a process of adaptation to environmental conditions [2].

Morphologically, according to Melcalfe and Chalk (1950) there are five

types of stomata, namely the anomocytic type of the cover cell surrounded by neighboring cells that cannot be distinguished in shape and size, the anisocytic type of the cover cell is surrounded by three neighboring cells of different sizes, the parasitic type of the closing cells is located parallel to the neighboring cells, the diacytic type of the cover cell is located perpendicular to its neighbor, and the actinocytic type of the guard cell is surrounded by neighboring cells arranged in a row [6]. Guard cells or cover cells function to help the photosynthesis process that occurs in the leaves. Its main function is to regulate gas exchange between the interior of the leaf and the evaporation process [7].

One of the factors affecting leaf morphology and the number of stomata is environmental pollution. This is because plants have the ability to absorb air pollution along with CO₂ absorption by stomata in the photosynthesis process. Air pollution absorbed by the leaves through the stomata can cause damage such as reduced number of stomata, damage to guard cells, increased number of closed stomata, damage to leaf

blade, reduced leaf area, decreased chlorophyll content and death of leaves [4].

Frangipani (*Plumeira acuminata*), in the University of Jember are widely planted in garden parks in areas that are protected from exposure to air pollution, including the FKIP University of Jember garden where samples of frangipani leaf leaves are not exposed to pollutants, but frangipani plants are also one of them. types of plants that are also planted in places that are exposed to a lot of pollutants, because they are on the side of the road which is busy with motorized vehicle traffic, such as Jalan Mastrip, which is the place for sampling of frangipani leaves exposed to pollutants produced by motorized vehicles. The number of motorized vehicles causes air pollution which is the main source of lead (Pb) [1]. Plants are bioindicators of the environment [3]. One of the responses of plants to the presence of pollutants is the macroscopic and microscopic damage to plant organs. Macroscopically, plant damage can be seen in leaf morphology. Microscopically damage to plants can be seen as changes in leaf stomata.

Based on the differences in morphology and characteristics of plant stomata based on its living condition, it is necessary to conduct research on frangipani (*Plumeria acuminata*) in non-polluting and polluting places.

2. RESEARCH METHOD

The research was conducted at the Botany Laboratory of Biology Education, University of Jember in the span of 2 weeks. Leaf samples were taken from FKIP Unej Park and along Mastrip Street in Summersari Jember. The samples were taken in morning time when generally the stomata are open. The leaf parameter being observed are morphology and stomata.

The procedures of morphological observation are as follows; 1) cut the ends of the frangipani branches, put the cut base into a bottle or glass filled with water so that frangipani leaves do not wither, 2) observe the leaf morphology (length, width, thickness, and color.

The procedures of stomatal observation are as follow; 1) apply a clear

nail polish to the lower and upper surface of the leaf epidermis in the designated areas and wait for it to dry, 2) cover the nail polish using clear tape and spread, 3) remove the insulation carefully using tweezers, 4) affixing insulation to glass objects, 5) stick a label on the object glass according to the leaf sample observed, 6) observe stomata with a monocular microscope at a magnification of 10x10, 7) calculate the microscope area with a magnification of 10x10, 8) count the number of stomata observed in the field of view and their density, 9) count the number of opened stomata and closed stomata both in adaxial and abaxial.

The formula of stomatal density is as follow:

$$\text{Stomatal density} = \frac{\text{the number of stomata}}{\text{the width of observation area}}$$

3. RESULT AND DISCUSSION

Leaves are one of the organs that are in plants and generally grow on twigs, the leaves are generally green because the leaves are organs that contain chlorophyll. Leaves generally have the main function as a place for photosynthesis to take place in plants, as a regulator of the transpiration or evaporation process when the plant body lacks or has excess water. And the leaves are also a place for O₂ and CO₂ in and out.

Stomata are cavities or gaps in the epidermis, and are one of the derivatives of the epidermis. Stomata are slits lined by specialized cells, that is, cell cover. The function of stomata is as a cavity for gas exchange and evaporation in plants, as a regulator of gas exchange between CO₂ and O₂ in leaves because this is needed in regulating metabolism such as photosynthesis and anaerobic respiration in plant cells.

Environmental conditions have an influence on the morphological structure of a plant. Leaves are one of the plant organs that are important in metabolic processes. Leaves that grow under conditions exposed to pollution and not exposed to pollution have different morphological structures, including leaf size, leaf color, and stomata conditions. The leaves that are in environmental conditions exposed to

pollution have a smaller size, are light green with a small number of stomata, including closed stomata and are tightly arranged, while in conditions that are not exposed to pollution, the leaf size is larger, dark green with a higher number of stomata, including open stomata, while closed stomata, were not found in the observation. Tabel 1. Leaf morphology of Frangipani (*Plumeria acuminata*)

	Lengt h*	Widt h*	Thickne ss*	color
Leaf from polluted area	24	9	4,6	greenish
Leaf from non-polluted area	24,5	10,3	4,8	Dark green

*all measurements are in cm.

On average, frangipani from non-polluted area have longer, wider, and thicker leaves than those from polluted area. This proves that air pollution in addition to affecting metabolism, it also affects leaf morphology.

Tabel 2. Result of stomatal observation

	Density		# of opened stomata	# of closed stomata		
	Ab*	Ad*		Ab	A	A
	*	*	d	b	d	d
Leaf from polluted area	35,9 9	0,95	645	3	10	3
Leaf from non-polluted area	91,3 5	1,41	101 5	10	0	0

*ab; abaxial

**ad; adaxial

The result shows that there are more adaxial stomata than abaxial. Frangipani is a terrestrial plant which generally has denser stomata in the abaxial part to prevent greater water evaporation. The opening and closing of stomata is also affected by the presence of

pollutants. The large number of opened stomata were only found in leaves which are not exposed to pollution. On exposed leaves, there are pollutants in the form of black spots that block or cover the stomatal openings which disrupts the photosynthesis process and affects the mesophyll tissue.

Density can be obtained if the area of the field of view with the number of stomata is known. In this way, frangipani leaves are exposed to pollution, the number of stomata is 645 parts (abaxial) divided by the area of the area so that the density is 35.99 in the abaxial part and 0.95 in the adaxial part. While the leaves that were not exposed to pollution were obtained on average, with a total number of stomata of 1015 in the field of view, the stomatal density was 91.35 in the abaxial part and 1.41 in the adaxial part. The higher the density of a plant the higher the plant's ability to exchange air. Thus, metabolism runs better.

The number of stomata and density of stomata on leaves exposed to pollutants in this study were smaller. The presence of pollutant particles is predicted to be the cause of not fully opening the stomata and also to be one of the causes of damage to the stomata, causing the less number and less dense of stomata.

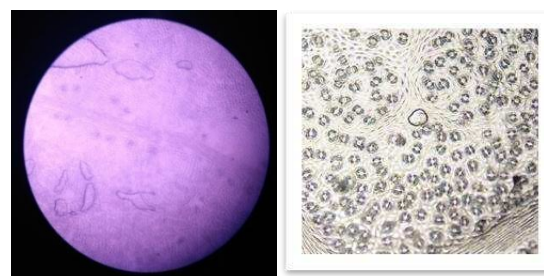


Figure 1. Anatomy of stomata from non-polluted area. The purple one is abaxial.

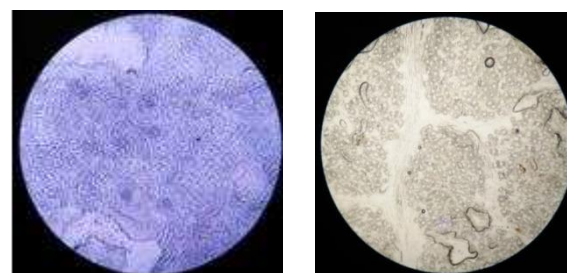


Figure 2. Anatomy of stomata from polluted area. The blue one is abaxial.

The results of microscopy observations showed that in addition to the smaller number of leaves exposed to pollution, the stomata were also tenuous and more irregular. Some of the stomatas even showed damage, and an incomplete opening. The presence of pollutants in the form of black particles can be seen in the epidermis of the leaves that are exposed to pollution.

In general, the factors that affect the growth and development of plants consist of external and internal factors. External factors include soil, humidity, air, temperature, light and water. Internal factors can include genes, hormones, chlorophyll content as well as plant morphological and anatomical structures [8]. The main source comes from air polluted by pollution in the form of motor vehicle fumes that use fuels containing polluting substances, 60% of pollutants. The resulting product consists of CO₂ and 15% consisting of hydrocarbons [8]. This contamination will affect leaves with any type of stomata.

According to Melcafe and Chalk (1950), there are five types of stomata in dicots, namely: the first type is anomocyt, this type of cell covering is surrounded by a certain number of cells that cannot be distinguished in shape and size from other epidermal cells. Second, anisocytic type, which is the cover cell is surrounded by three neighboring cells that are not of the same size. Third, the parasitic type, where each cell is accompanied by one or more neighboring cells which are parallel to the stomata. Fourth, diacytic type, where each stomata is surrounded by two neighboring cells which are located across the stomata. Fifth, the actinocytic type, is a variation of the diacytic type. Its stomata are surrounded by neighboring cells that are regular fingers [5]. The stomata type in frangipani leaves (*Plumeria acuminata*) which was the sample of this study was anomocytic type, it is surrounded by a certain number of cells that can't be distinguished in shape and size from other cells.

4. CONCLUSION

There are morphological differences in frangipani leaves (*Plumeria acuminata*) in places that are not exposed to pollution from

places that are exposed to pollution. The morphological differences are the length, width, thickness, and color of the leaves. Leaf morphology in places that were not exposed to pollution had a higher average value than places exposed to pollution. Differences in the characteristics of frangipani leaf stomata (*Plumeria acuminata*) in places that are not exposed to pollution from places that are exposed to pollution. This difference is in the form of the total number of stomata, the density of the stomata, the number of open stomata, the number of closed stomata. The results showed that the number of stomata, density of stomata, and open stomata was higher in leaves that were not exposed to pollution, only closed stomata were more numerous in leaves exposed to pollution.

5. REFERENCES

- [1] Aini, F., S. Mardiyah, F. Wahyuni, A. U. Millah, dan M. Ihsan. 2017. Kajian Tanaman Penyerap Timbal (Pb) dan Pengikat Karbon di Lingkungan Kampus Universitas Jambi. 3(2): 47-70.
- [2] Akib, M. A., K. Mustari, N. Ilmi, dan R. Rosalina. 2017. Aplikasi Teknologi Pemangkasan dan Dinamika Pertumbuhan Daun Kacang Koro Pedang (*Canavalia ensiformis* L) yang Diberi Mulsa. Jurnal Galung Tropika. 6(2): 146-153.
- [3] Mutaqin, A. Z., R. Budiono, T. Setiawati, M. Nurzaman, dan R. S. Fauzia. 2016. Studi Anatomi Stomata Daun Mangga (*Mangifera indica*) Berdasarkan Perbedaan Lingkungan. Jurnal Biodjati. 1(1): 13-18.
- [4] Raharjo, H. P., S. Haryanti, dan R. Budihastuti. 2015. Pengaruh Tingkat Kepadatan Lalu Lintas dan Waktu Pengamatan yang Berbeda Terhadap Ukuran dan Jumlah Stomata Daun Glodokan (*Polyalthia longifolia* .Sonn). Jurnal Biologi. 4(1): 73-84.
- [5] Mulyani, Sri. 2015. *Anatomi Tumbuhan*. Depok: PT Kanisius.
- [6] Tjitosoepomo, Gembong. 2009. *Morfologi Tumbuhan*. Yogyakarta: Gadjah Mada University Press.
- [7] Stern, K. R., J. E. Bidlack, dan S. H. Jansky. 2008. *Introductory Plant*

- Biology. America: McGraw-Hill.
- [8] Yuningsih, D. A. 2017. Pengaruh Faktor Lingkungan Terhadap Perubahan Struktur Anatomi Daun. *Jurnal Pengaruh Faktor Lingkungan*. 2(1): 103-110.