**Florea: Jurnal Biologi dan Pembelajarannya**
Vol. 11, No. 1, May 2024, pp. 16~25
ISSN 2355-6102; e-ISSN 2502-0404 DOI: 10.25273/florea.v11i1.21146


# Morphoanatomy and Phytochemical Content of Sente Leaves (*Alocasia macrorrhizos* (L.)G.Don) under Different Light Intensity in Arboretum Universitas Padjadjaran

**Nadhira Zaachrany Rachma[1], Asep Zainal Mutaqin[2], Tia Setiawati[3], Mohamad Nurzaman[4], Rusdi Hasan[5]**
[1,2,3,4,5] Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran.

**Article Info**

***Article history:***

Received February 15, 2024
Revised March 29, 2024
Accepted May 31,2024

***Keywords:***

*A. macrorrhizos*
chlorophyll
light intensity
morpho-anatomy
phytochemical

**ABSTRACT**

*Light intensity in plants influences their growth potential as well as their morphological, anatomical, and physiological structures. This study aimed aims to see the comparison of morphology, anatomy, chlorophyll content and phytochemical content in Sente leaves (Alocasia macrorrhizos) in two places under different light intensities. This exploratory research employed a survey method to select the research location, with environmental parameter measurements serving as supporting data. Morphological and anatomical parameters and chlorophyll content were assessed using a quantitative approach, while phytochemical content was determined qualitatively and analyzed descriptively. The results showed differences in the morphology, anatomy, chlorophyll content, and phytochemicals of Sente leaves under different light intensities. Morphologically, the leaves of Sente plants in shaded locations had larger surface areas, thinner, and greener compared to those in unshaded locations. The stomatal density of leaves in unshaded areas was higher (76.43 cells/mm²) compared to shaded areas (56.05 cells/mm²). The chlorophyll content in shaded locations was higher (82.03 CCI) than in unshaded locations (41.7 CCI). Phytochemical tests for flavonoids and saponins showed higher compound levels in leaves from unshaded locations, while tannin tests revealed higher levels in shaded locations compared to unshaded ones. Meanwhile, tests for alkaloids and quinones yielded negative results.*

*This is an open access article under the CC BY-SA license.*

***Corresponding Author:***

Nadhira Zaachrany Rachma
Department of Biology, Universitas Padjadjaran, West Java, Indonesia
Email: nadhirazaachranyr@gmail.com

## 1. INTRODUCTION

The taro family or Araceae family is a plant that is often found in Indonesia. The main characteristic of this family is the inflorescence arranged in the form of a cob (spadix) surrounded by a sheath (spathe). The diversity of Araceae in Indonesia is quite high, as many as 31 genera of Araceae or around 25% of the total genera in the world are in Indonesia which is spread across Sumatra, Java, Kalimantan, and Papua (Asih et al., 2015). One species of the Araceae family is the Sente plant (*Alocasia macrorrhizos*). This plant is a tropical plant that is widely cultivated by the community. Sente is used for its leaves and tubers for consumption, used as animal feed and used as an ornamental plant (Arbain et al., 2022). In addition, this plant is used as a medicine for stomach aches, headaches, and wound treatment because it contains various secondary metabolite compounds such as flavonoids, alkaloids, saponins, tannins, quinones, and triterpenoids (Müller & Guzzon, 2024).

Sente plants can be found in the Arboretum of Universitas Padjadjaran, Jatinangor Campus in various environmental conditions. Arboretum Universitas Padjadjaran is part of campus forest located at 107°46’14.13”-107°46’28.80”E and 6°55’34.41”- 6°55’54.92” S with a total area of 12.5 ha. This campus forest is divided into several zones, namely the fruit plant zone, industrial plant zone, medicinal zone, rare plant zone and the regional symbol plant zone (identity plant) of West Java Regency. This place provides a heterogeneous environment, one of which is an environment with various light intensities. The light intensity in this place ranges from 3300 to 43200 lux (Kusmoro et al., 2019).

Light is an abiotic factor in an ecosystem. In plants, light can affect plant growth and productivity (Fan et al., 2022). Light is used by plants as an energy source for CO2 fixation during photosynthesis, activating and regulating various physiological processes related to plant development and growth (Paradiso & Proietti, 2022; Yang et al., 2022). During plant growth, light regulates photomorphogenesis such as affecting seedling growth, leaf expansion, and plant development which ultimately forms plant architecture (Seyedi et al., 2024). The need for light in plants is influenced by the quality, duration of lighting, and light intensity (Paradiso & Proietti, 2022). Light intensity plays an important role in plant growth because each plant requires optimal light intensity depending on its type (Lee et al., 2019). When the intensity is too low, it will inhibit plant growth due to the photosynthesis process not running optimally. Likewise, when the light intensity is too high, it can reduce phytochemical efficiency due to photooxidative damage which can affect plant growth and development (Zhang et al., 2022).

The form of plant response to light intensity can be seen based on observations of plant architecture (Gao et al., 2019; Febrianto et al., 2024). Leaves are organs that are sensitive to light intensity because they are the organs responsible for the transfer of energy between plants and the environment (Yang et al., 2023). Several studies have shown that differences in light intensity result in differences in morphological characteristics, anatomy, and phytochemical content in leaves. Research by Rezai et al. (2018) on the effect of light intensity on sage plants (*Salvia officinalis* L.) resulted in differences in leaf morphological characteristics, photosynthetic capacity, and chlorophyll content with 30% irradiation being the optimal irradiation for sage cultivation. Research by Setiawati et al. (2018) showed that light intensity in shaded locations (low light intensity) and shaded locations (high light intensity) resulted in differences in leaf thickness, leaf area, stomatal density, and alkaloid phytochemical content in kiasahan plants (*Tetracera scandens L.).*

Therefore, a study was conducted on the morpho-anatomical characteristics and phytochemical content of sente leaves (*Alocasia Macrorrhizos* (L.) G.Don) in places with different light intensities in Arboretum Universitas which aims to see the comparison of morphology, anatomy, chlorophyll content and phytochemical content in Sente leaves (*Alocasia macrorrhizos*) in two places with different light intensities.

## 2. METHOD

The research was conducted in the Arboretum of Universitas Padjadjaran and the Structure and Function Laboratory of the Department of Biology, Universitas Padjadjaran, Jatinangor District, Sumedang Regency, West Java (Figure 1.) The research was conducted from November 2023 to December 2023. The research conducted was exploratory using quantitative and qualitative methods that were analyzed descriptively. The parameters observed included morphology, anatomy, chlorophyll content, and phytochemical content in leaves.

### 2.1 Tools and Materials

The tools used in this study include stationery, Chlorophyll meter Opti Science CCM-200, object glass, cover glass, camera, compound microscope, screw micrometer, analytical balance, knife/cutter, dropper, tape, soil tester, lux meter, multichecker parameter, label paper, stirring rod, plastic bag, parchment paper, mortar, drip plate, test tube rack, spatula, and test tube. The materials used in this study were Sente plant leaves (*Alocasia macrorrhiza*), aquades, clear nail polish, millimeter block paper, comparison paper, alcohol, dilute sulfuric acid, concentrated acetic acid, chloroform, iron (III) reagent, chloride, Dragendroff reagent**.**

### 2.2 Research Location Survey

The survey was conducted to determine the location of Sente leaf (*Alocasia macrorrhizos*). The Arboretum of Universitas Padjadjaran was chosen as the research location because there are Sente plants (*A. macrorrhizos*) at different light intensities. Location 1 is the location where Sente plants (*A. macrorrhizos*) were found in shaded conditions and location 2 is the location where Sente plants (*A. macrorrhizos*) were found in unshaded conditions.

**2.3 Leaf Sampling and Environmental Parameter Measurement**

Leaf samples were taken from mature leaves that had fully opened as many as 1 leaf from the middle position (second or third uppermost part) as many as 3 individuals in different place treatments. (Asih et al. 2022). The leaves taken were then put into different plastic bags and labeled. Furthermore, environmental parameters were measured using GPS essential, multichecker, lux meter, and soil tester.

**2.4 Observation of Leaf Morphology**

Observation of leaf morphology includes morphological observation, leaf thickness measurement using a screw micrometer, and leaf area measurement using the gravimetric method using millimeter block paper. The gravimetric method is carried out by making a leaf pattern on millimeter block paper, cutting the leaf pattern on the paper then comparing it with the following equation:

Leaf Area (cm$^2$) = $\frac{\text{Weight of leaf replica paper (grams)}}{\text{Weight of standard paper (grams}} \times$ Area of standard paper

(Leviastuti & Setiawati, 2020)

**2.5 Observation of Leaf Stomata**

Observation of stomata was made from leaf preparations that had been cleaned and then coated with clear nail polish. Observations included stomata types and stomata density with the replica method, using the following equation:

Stomatal density = (Number of stomata/field of view)

Wide field of view at 400x magnification

= ¼ 1/4$\pi d^2$

= ¼ x 3,14 x $(0,5)^2$

= 0,19625 mm$^2$

(Leviastuti & Setiawati, 2020)

**2.6 Measurement of Chlorophyll Content**

Chlorophyll content were measured using a Chlorophyll meter by clipping the tip, middle, right side, left side, and base of the leaf with three repetitions, then averaged (Nasution et al., 2019).

**2.7 Phytochemical Content Testing**

Phytochemical testing on sente leaves includes testing for the presence of alkaloids, flavonoids, saponins, tannins, and quinones. The procedure is as follows:

2.7.1 Alkaloid

The phytochemical testing for alkaloids was conducted using 4 grams of finely ground leaf extract. Chloroform was added until the extract dissolved, followed by 10 mL of ammonia. The solution was filtered, and the filtrate was transferred into an Erlenmeyer flask. Ten drops of $H_2SO_4$ were added, and the mixture was shaken to form two layers. The upper layer was then transferred to a test tube. The solution was tested using Dragendorff's reagent. A positive result for alkaloids was indicated by the formation of a precipitate, with Dragendorff's reagent producing an orange-colored precipitate (Makalalag et al., 2019).

2.7.2 Flavonoid

Ethanol was added to 1 gram of ground leaf extract, and then the mixture was heated until forming two layers. Separate the upper layer and add magnesium powder with 1 mL of 2N HCl. A positive result is indicated by the appearance of a red color in the solution (Makalalag et al., 2019).

2.7.3 Saponin

Distilled water was added to 2 gram ground leaf extract until fully submerged, followed by heating for 2-3 minutes and then cooling. Once cooled, the mixture was shaken vigorously. A positive result of saponin was indicated by the formation of stable foam (Makalalag et al., 2019)

2.7.4 Tannin

20 mg of ground leaf extract was added with distilled water until fully submerged. 2 mL of this solution was transferred to a new test tube, then 2-3 drops of 1% $FeCl_3$ were added. A positive result for tannin was indicated by the formation of of a blue-black or green coloration in the solution upon the addition of 1% $FeCl_3$ (Makalalag et al., 2019).

2.7.5 Quinone

5 mL of leaf extract dissolved in distilled water. Then, a few drops of NaOh solution were added to the sample. A positive result for quinones was indicated by the formation of a yellowish-red or orange color (Lestari & Andriani, 2021).

## 3. RESULTS AND DISCUSSION

### 3.1 Research Location

The research was conducted in Arboretum Universitas Padjadjaran. The research locations were at coordinates 6°55'43"S 107°46′23″E for the shaded area and 6°55'45"S 107°46'23"E for the unshaded area, as determined using GPS Essentials.

### 3.2 Environmental Parameters

The results of measuring the environmental parameters at the shaded and unshaded leaf sampling locations can be seen in Table 1.

Table 1. Environmental Parameters

| Location | Light Intensitiy (Lux) | Air Humidity (%) | Air Temperatur (°C) | Soil Moisture (%) | Soil pH | Air Pressure (hPa) | Nutrient Content (mg) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | N | P | K |
| Shaded | 2600 | 38 | 29,6 | 80 | 4 | 910,5 | 6 | 6 | 16 |
| Unshaded | 60400 | 23 | 36,2 | 50 | 5,5 | 922,7 | 6 | 3 | 1 |

### 3.3 Morphological Characteristics of Sente Leaves (*Alocasia macrorrhizos* (L.) G.Don) Under Different Light Intensities

The morphological characteristics of sente leaves according to Tjitrosoepomo (2020) are shown in Table 2. There are no significant morphological differences in sente leaves between shaded and unshaded locations. This is because light does not affect the morphology of a single leaf but rather influences the morphology of the plant as a whole (Li et al., 2016). Changes in leaf morphology are more influenced by genetic factors, resulting in similar morphological characteristics across the two locations (Leviastuti & Setiawati, 2020).

Table 2. Morphological Character of Sente Leaves (*Alocasia macrorrhizos* (L.) G.Don)

| Character | Description |
|---|---|
| Color | Green |
| Shape | Sagittate |
| Tip | Blunt |
| Base | Concave |
| Edges | Wavy |
| Venation | Pinnate |

Based on Figure 1, the sente leaves have similar characteristics, but there are differences in leaf color. Leaves from the shaded location (low light intensity) have a darker green color compared to leaves from the unshaded location (high light intensity). According to Yue et al. (2021), when light is reduced by shading, the leaves become greener due to a higher accumulation of chlorophyll b compared to chlorophyll a, while shading inhibits the synthesis of carotenoids.

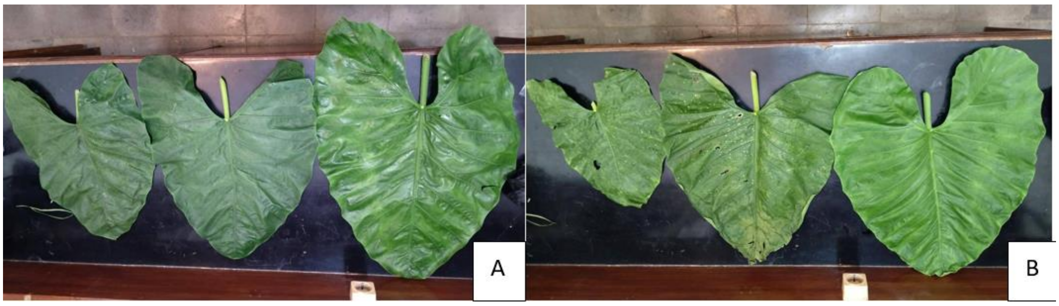


Figure 1. Morphology of Sente Leaves (*Alocasia macrorrhizos* (L.) G.Don)

Based on the research results, there are differences in leaf thickness and area between the two research locations (Table 3). Plants growing under direct sunlight have thicker leaves due to the provision of more chloroplast space per unit leaf area. The increase in leaf thickness is primarily attributed to the formation of longer palisade cells in the mesophyll and the development of multiple palisade layers in leaves exposed to direct sunlight. Plants naturally growing in high-light environments possess palisade parenchyma on both sides of the leaf, allowing them to absorb more sunlight, which results in thicker leaves (Gotoh et al., 2018).

Table 3. Comparison of Leaf Thickness and Leaf Area of Sente

| No. | Location | Leaf Thickness (mm) | Leaf Area ($cm^2$) |
|---|---|---|---|
| 1. | Shaded | 0, 39 | 248, 89 |
| 2. | Unshaded | 0,44 | 246,67 |

Based on Table 3, there are differences in the leaf area of sente between the shaded and unshaded locations. The average leaf area in the shaded location is 248.89 $cm^2$, which is larger than the leaf area in the unshaded location, 246.67 $cm^2$. This occurs because leaves growing under direct sunlight have adaptations to minimize limitations in carbon fixation, whereas leaves in shaded areas have adaptations to address light scarcity. Plants in shaded environments tend to have larger leaves to create a greater surface area for absorbing light energy for photosynthesis. In contrast, plants exposed to direct sunlight have smaller leaves to reduce the surface area, thereby minimizing water loss through transpiration (Martin et al., 2020).

### 3.4 Anatomical Characteristics of Sente Leaves (*Alocasia macrorrhizos* (L.) G. Don) Under Different Light Intensities

Based on the research findings, the anatomical observation of Sente leaves includes the observation of stomata type, stomatal count, and stomatal density as shown in Table 4. The results indicate that the type of stomata in Sente leaves is paratetracytic (Figure 2). This observation aligns with the research conducted by Vaidya (2016). The paratetracytic stomata type refers to stomata that have an additional elongated cell parallel to the two guard cells, along with a narrow cell present at each pole (Mitra et al., 2015).

Table 4. Comparison of Stomatal Characteristics in Sente (*Alocasia macrorrhizos* (L.) G.Don

| No. | Stomatal Type | Stomatal Type | Stomatal Count | Stomatal Density (sel/$mm^2$) |
|---|---|---|---|---|
| 1. | Shaded | Paratetracytic | 11 | 56.05 |
| 2. | Unshaded | Paratetracytic | 15 | 76.43 |

The higher stomatal density in the unshaded location (76.43 cells/$mm^2$) compared to the shaded area (56.05 cells/$mm^2$). This number is higher than the average stomatal density of Sente reported by Suratman et al. (2016), which is 20.48 cells/$mm^2$. This difference occurs because plants exposed to direct sunlight adapt to higher light intensity. In contrast, plants in shaded areas exhibit a lower stomatal density as an adaptation to lower light intensity. A higher stomatal density can enhance the rate of assimilation (Idris et al., 2019).

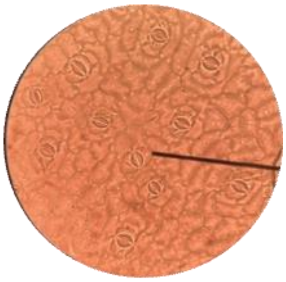

Figure 2. Paratetracytic Stomata Type in Sente Leaves (*Alocasia macrorrhizos* (L.) G.Don)

### 3.5 Chlorophyll Content in Sente Leaves (*Alocasia macrorrhizos* (L.) G.Don) Under Different Light Intensities

Based on Table 5, it is observed that the average chlorophyll content in shaded leaves is higher than the chlorophyll content in unshaded leaves. This finding aligns with research conducted by Zhao et al. (2015) on the impact of light intensity on chlorophyll content in *Paeonia lactiflora*. Zhao et al. (2015) explained that the levels of chlorophyll content serve as indicators of environmental adaptation. Plants growing in shaded areas have higher chlorophyll content to absorb more light, ensuring optimal photosynthesis and the synthesis of organic compounds.

Table 5. Comparison of Chlorohyll Content in Sente (*Alocasia macrorrhizos* (L.) G.Don)

| No. | Location | Average Chlorophyll Content (CCI) |
|---|---|---|
| 1. | Shaded | 82.03 |
| 2. | Unshaded | 41.70 |

### 3.6 Phytochemical Content in Sente Leaves (*Alocasia macrorrhizos* (L.) G.Don) Under Different Light Intensities

The tests conducted in this research were qualitative analyses aimed at determining the presence and quantity (high or low levels) of active compounds in the leaves. The phytochemical test results for the sente leaves are presented in Table 6.

Table 6. Phytochemical Content of Sente (*Alocasia macrorrhizos* (L.) G.Don) Leaves at Different Light Intensities

| No. | Phytochemical Compound | Shaded Location | Unshaded Location |
|---|---|---|---|
| 1. | alkaloid | (-) | (-) |
| 2. | flavonoid | (+) | (++) |
| 3. | saponin | (+) | **(++)** |
| 4. | tanin | (++) | (++) |
| 5. | kuinon | (-) | (-) |

3.6.1 Alkaloid Content

The test for alkaloid content in sente leaves resulted in a negative outcome (Table 6). A negative result for the alkaloid test is indicated by the absence of an orange precipitate when reacted with the Dragendroff reagent (Makalalag et al., 2019). However, research by Singh et al. (2019) reported the presence of alkaloids in sente leaves. In their study, they employed various tests and solvents to determine the alkaloid content. Positive results were obtained in the Hager test using ethanol as a solvent and in the Dragendroff test using water as a solvent. The difference in test outcomes is likely due to the use of different solvents.

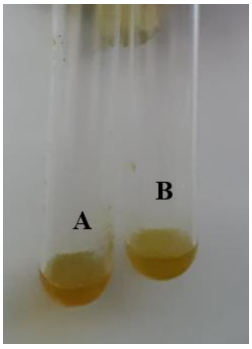


Figure 3. Phytochemical Test for Alkaloid A) Unshades B) Shaded

3.6.2 Flavonoid Content

The phytochemical test for flavonoid content in sente leaves (Table 6) showed that leaves from the unshaded location contain a higher concentration of flavonoids, as indicated by a darker orange color. In contrast, the flavonoid concentration is lower in leaves from the shaded location. This difference is related to the protective role of flavonoids against ultraviolet (UV) radiation. As light intensity increases, UV radiation intensity also rises. As a result, plants require a greater accumulation of flavonoids to provide strong protection against UV damage (Li et al., 2016).

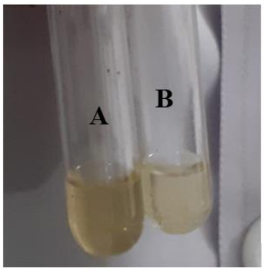


Figure 4. Phytochemical Test for Flavonoid A) Unshades B) Shaded

3.6.3 Saponin Content

The phytochemical test for saponin content yielded a positive result. Based on Table 6, the leaves of sente from the unshaded location formed more foam compared to the leaves from the shaded location. This indicates that in the unshaded environment, where the plants are exposed to higher light intensity, there is an increased concentration of saponin compounds in the leaves. The higher saponin content in leaves from unshaded areas is related to the plant's stress response, where under high light stress, leaves activate a protective mechanism by increasing saponin synthesis to mitigate damage caused by intense light exposure (Wen et al., 2023).

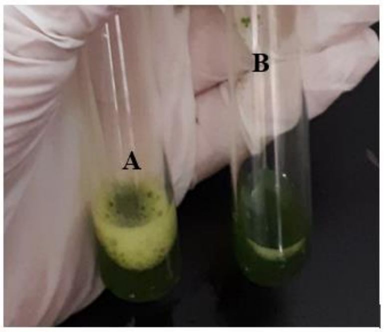


*Figure 5. Phytochemical Test for Saponin A) Unshades B) Shaded*

3.6.4 Tannin Content

The phytochemical test for tannin content yielded a positive result. The study showed that sente leaves from shaded locations (low light intensity) exhibited a darker brown color compared to leaves from unshaded locations (high light intensity).A high concentration of tannins indicates stress conditions, as many secondary metabolites are produced in response to high stress. However, this response is not the same across all species, as each species has its own optimal light intensity. When light intensity exceeds or falls below this optimal point, the concentration of secondary metabolites decreases (Li et al., 2016).In the case of sente, the research suggests that low light intensity represents the optimal condition for tannin production.

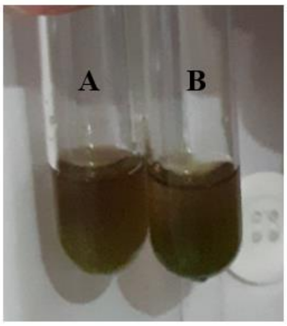


Figure 6. Phytochemical Test for Tannin A) Unshades B) Shaded

3.6.5 Quinone Content

Based on the experiment testing quinone content in sente leaves from shaded and unshaded locations in the UNPAD arboretum, the results showed a negative presence of quinone compounds (Table 6). The negative result for quinone compounds was observed in both shaded and unshaded locations, as indicated by the absence of an orange color change in the solution (Makalalag et al., 2019).

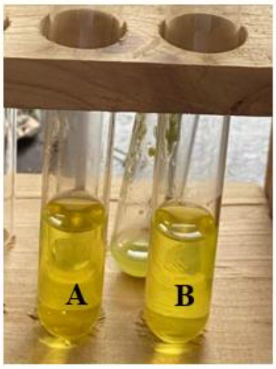


Figure 7. Phytochemical Test for Alkaloids A) Shaded B) Unshaded

## 4. CONCLUSION

Sente plants (Alocasia macrorrhizos) have different morpho-anatomical characteristics in shaded and unshaded locations. In shaded locations, the leaf color is darker, the leaves are thinner, and the leaf size is wider than in unshaded locations which are related to the adaptation mechanism to limited light. The density of stomata in sente leaves in unshaded locations (76.43 cells/mm2) has a higher value than in sente leaves from shaded locations (56.05 cells/mm2) related to the adaptation mechanism to high light intensity causing an increase in the number of stomata to increase the level of photosynthetic assimilation. The chlorophyll content of sente leaves in unshaded locations has a higher value (82.03 CCl) than in unshaded locations (41.7 CCl) for adaptation to limited light absorption. The phytochemical content of sente leaves in unshaded locations has high saponin and flavonoid content, due to the results of adaptation to the light stress mechanism. On the other hand, in the tannin test, leaves from shaded locations had higher values related to the optimum work of secondary metabolites at a certain light intensity. The results of the quinone and alkaloid tests produced negative tests.

## REFERENCES

[1] Arbain, D., Sinaga, L. M. R., Taher, M., Susanti, D., Zakaria, Z. A., & Khotib, J. (2022). Traditional Uses, Phytochemistry and Biological Activities of Alocasia Species: A Systematic Review. *Frontiers in Pharmacology*, 13, 849704.

[2] Asih, N P S, Warseno, T., & Kurniawan, A. (2015). Studi Inventarisasi Araceae di Gunung Seraya (Lempuyang), Karangasem, Bali. *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia*, 1(3) : 521–527.

[3] Asih, Ni Putu Sri, Hendriyani, E., & Tihurua, E. F. (2022). Morphological and Anatomical Variations Among *Alocasia alba* Schott Accessions In Bali Botanic Garden. *Journal of Tropical Biodiversity and Biotechnology*, 7(1) : 66823.

[4] Fan, L., Tarin, M. W. K., Hu, W., Han, Y., Rong, J., Chen, L., He, T., & Zheng, Y. (2022). Changes In Light Intensity Affect Leaf Gas Exchange, Chlorophyll Fluorescence, and Nonstructural Carbohydrates of Ma Bamboo (*Dendrocalamus latiflorus* Munro). *Applied Ecology & Environmental Research*, *20*(2).

[5] Febrianto, M. R. H., Santosa, E., Susila, A. D., Zaman, S., Widodo, W. D., & Hapsari, D. P. (2024). Light Intensities Affect Canopy Architecture and Fruit Characteristics of Cayenne Pepper (*Capsicum frutescens* L.). *Jurnal Hortikultura Indonesia*, *15*(1) : 23–32. https://doi.org/10.29244/jhi.15.1.23-32

[6] Gao, Z., Khalid, M., Jan, F., Jiang, X., & Yu, X. (2019). Effects of Light-Regulation and Intensity on The Growth, Physiological and Biochemical Properties of *Aralia elata* (Miq.) Seedlings. *South African Journal of Botany*, 121 : 456–462.

[7] Gotoh, E., Suetsugu, N., Higa, T., Matsushita, T., Tsukaya, H., & Wada, M. (2018). Palisade Cell Shape Affects the Light-Induced Chloroplast Movements and Leaf Photosynthesis. *Scientific Reports*, 8(1) : 1472. https://doi.org/10.1038/s41598-018-19896-9

[8] Idris, A., Linatoc, A. C., & Bakar, M. F. B. I. N. A. B. U. (2019). Effect of Light Intensity on the Photosynthesis and Stomatal Density of Selected Plant Species of Gunung Ledang, Johor. *Malaysian Applied Biology*, 48(3) :133–140.

[9] Kusmoro, J., Mayawatie, B., Budiono, R., Noer, I. I. N. S., Permatasari, R. E., Nurwahidah, A., Satriawati, R., Arum, D., Saragih, D. E., Widya, R., Jatnika, M.F., Makarim, A., & Partasasmita, R. (2019). Species diversity of corticolous lichens in the arboretum of Padjadjaran University, Jatinangor, Indonesia. *Biodiversitas Journal of Biological Diversity*, 20(6): 1606-1616.

[10] Lee, R. J., Bhandari, S. R., Lee, G., & Lee, J. G. (2019). Optimization of Temperature and Light, and Cultivar Selection for the Production of High-Quality Head Lettuce in a Closed-Type Plant Factory. *Horticulture, Environment, and Biotechnology*, 60 : 207–216.

[11] Lestari, F., & Andriani, S. (2021). Fitokimia Tumbuhan Berkhasiat Obat Tradisional di Kalimantan Selatan dan Kalimantan Tengah. *Jurnal Galam*, 1(2) : 79–92.

[12] Leviastuti, A., & Setiawati, T. (2020). Analisis Struktur dan Penapisan Fitokimia Daun Sembung (*Blumea balsamifera* L.) pada Kelembaban Udara yang Berbeda di Pangandaran. *Biotika Jurnal Ilmiah Biologi*, 18(1) : 32–42.

[13] Li, A., Li, S., Wu, X., Zhang, J., He, A., Zhao, G., & Yang, X. (2016). Effect of Light Intensity on Leaf Photosynthetic Characteristics and Accumulation of Flavonoids In L*ithocarpus litseifolius* (Hance) Chun.(Fagaceae). *Open Journal of Forestry*, 6(5) : 445–459.

[14] Makalalag, A. K., Sangi, M. S., & Kumaunang, M. G. (2019). Skrining Fitokimia dan Uji Toksisitas Ekstrak Etanol dari Daun Turi (*Sesbania grandiflora* Pers). *Chemistry Progress*, 8(1) : 38-46.

[15] Martin, R. E., Asner, G. P., Bentley, L. P., Shenkin, A., Salinas, N., Huaypar, K. Q., Pillco, M. M., Ccori Álvarez, F. D., Enquist, B. J., & Diaz, S. (2020). Covariance of Sun and Shade Leaf Traits along a Tropical Forest Elevation Gradient. *Frontiers in Plant Science*, 10 : 1810.

[16] Mitra, S., Maiti, G. G., & Maity, D. (2015). Structure and Distribution of Heteromorphic Stomata In *Pterygota alata* (Roxb.) R. Br.(Malvaceae, Formerly Sterculiaceae). *Adansonia*, 37(1) : 139–147.

[17] Müller, J. V, & Guzzon, F. (2024). The Forgotten Giant of the Pacific: A Review on Giant Taro (*Alocasia Macrorrhizos* (L.) G. Don). *Genetic Resources and Crop Evolution*, 71(1) : 519–527.

[18] Nasution, F. H., Santosa, S., & Putri, R. E. (2019). Model Prediksi Hasil Panen Berdasarkan Pengukuran Non-Destruktif Nilai Klorofil Tanaman Padi. *Agritech*, 39(4) : 289–297.

[19] Paradiso, R., & Proietti, S. (2022). Light-Quality Manipulation to Control Plant Growth and Photomorphogenesis In Greenhouse Horticulture: the State of The Art and the Opportunities of Modern LED Systems. *Journal of Plant Growth Regulation*, 41(2) : 742–780.

[20] Rezai, S., Etemadi, N., Nikbakht, A., Yousefi, M., & Majidi, M. M. (2018). Effect of Light Intensity on Leaf Morphology, Photosynthetic Capacity, and Chlorophyll Content in Sage (*Salvia officinalis* L.).*Horticultural Science and Technology*, 36(1) : 46–57.

[21] Setiawati, T., Ayalla, A., Nurzaman, M., & Mutaqin, A. Z. (2018). Influence of Light Intensity on Leaf Photosynthetic Traits and Alkaloid Content of Kiasahan (*Tetracera scanden*s L.). *IOP Conference Series: Earth and Environmental Science*, 166(1) : 12025.

[22] Seyedi, F. S., Nafchi, M. G., & Reezi, S. (2024). Effects of Light Spectra on Morphological Characteristics, Primary and Specialized Metabolites of *Thymus vulgaris* L. *Heliyon*, 10(1).

[23] Singh, S. K., Patel, J. R., & Dangi, A. (2019). Physicochemical, Qualitative and Quantitative Determination of Secondary Metabolites and Antioxidant Potential of *Alocasia Macrorrhizos* Leaf Extracts. *The Pharma Innovation Journal*, *8*(1) : 399–404.

[24] Suratman, S., Pitoyo, A. R. I., Kurniasari, S., & Suranto, S. (2016). Morphological, Anatomical and Isozyme Variation Among Giant Taro. *Biodiversitas Journal of Biological Diversity*, *17*(2) : 422-429.

[25] Tjitrosoepomo, G. (2020). *Morfologi Tumbuhan* (22nd ed.). Bulaksumur : Gadjah Mada University Press.

[26] Vaidya, M. (2016). Study of Stomata in some species of Alocasia and Syngonium of family Araceae juss. *International Journal Of Advances In Pharmacy, Biology And Chemistry*, 5(2) : 180–185.

[27] Wahyuningsih, S. (2020). Anatomical Charateristics of Araceae Family in Liwa Botanical Garden, West Lampung, Lampung. *Jurnal Ilmiah Biologi Eksperimen Dan Keanekaragaman Hayati*, 7(2) : 65–72.

[28] Wen, F., Chen, S., Wang, Y., Wu, Q., Yan, J., Pei, J., & Zhou, T. (2023). The Synthesis of Paris Saponin VII Mainly Occurs In Leaves and Is Promoted by Light Intensity. *Frontiers in Plant Science*, 14, 1199215.

[29] Yang, J., Song, J., & Jeong, B. R. (2022). Lighting from Top and Side Enhances Photosynthesis and Plant Performance by Improving Light Usage Efficiency. *International Journal of Molecular Sciences*, 23(5) : 2448.

[30] Yang, K., Chen, G., Xian, J., & Chang, H. (2023). Divergent Adaptations of Leaf Functional Traits to Light Intensity Across Common Urban Plant Species In Lanzhou, Northwestern China. *Frontiers in Plant Science*, 14, 1000647.

https://doi.org/10.3389/fpls.2023.1000647

[31] Yue, C., Wang, Z., & Yang, P. (2021). The Effect of Light on the Key Pigment Compounds of Photosensitive Etiolated Tea Plant. *Botanical Studies*, 62(1): 21.

[32] Zhang, J., Ge, J., Dayananda, B., & Li, J. (2022). Effect of Light Intensities on the Photosynthesis, Growth and Physiological Performances of Two Maple Species. *Frontiers in Plant Science*, 13, 999026.

[33] Zhao, D., Han, C., Zhou, C., & Tao, J. (2015). Shade Ameliorates High Temperature-Induced Inhibition of Growth In Herbaceous Peony (*Paeonia lactiflora*). *International Journal of Agriculture and Biology*, 17(5).