Variation of leaf morphology of *hibiscus rosa-sinensis* L. under various light intensities at Universitas Indonesia campus area and Citayam, Depok

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Abstract. *Hibiscus rosa-sinensis* L. is a plant that has been cultivated as an ornamental plant, especially in Indonesia. Universitas Indonesia, located in Depok, has ten variations of *H. rosa-sinensis* in size, shape, and color of flowers. The flower shape consists of three types, namely, single, double, and crested. In this study, it is reported the comparison of leaf morphology from several types of *H. rosa-sinensis* L. Twenty leaves from each variety were used for morphometric measurement, and light intensity data from each location of the plant variety was also collected. There are two locations, Universitas Indonesia (UI) Campus Area and Citayam. The results showed that two individuals Crested Peach plant in Citayam, which grown under different light intensity has significantly different in leaf surface area but no difference in stomata surface area. Big Single Red and Double Pink located in UI exposure by the same light intensity has the same leaf surface area and stomata surface area. Comparing Small Single Red Citayam and Small Single Red UI exposure by different light intensity has significantly different in leaf surface area and stomata surface area. Two Crested Peach in UI, exposed by the same light intensity, were significantly different in leaf surface area and has the same stomata surface area. This study showed that light intensity could influence the variation of leaf morphology of several *Hibiscus rosa-sinensis* L. flower types, but not all flower types.

1. Introduction

*Hibiscus rosa-sinensis* is one of the most popular ornamental plants in Indonesia. This plant classified to the family Malvaceae and tribe Hibisceae [1]. In Indonesia, *Hibiscus rosa-sinensis* has the name 'Kembang Sepatu'. This plant has diversity in flower shape, flower color and leaf shape. In general, the flower consists of two forms, namely single and double, but there is also a pile called crested. Single flower means that it only has one corolla layer. Double has corolla in layers and crested between single and double [2].

*Hibiscus rosa-sinensis* is also commonly found in the campus of the Universitas Indonesia. There are several variations of *Hibiscus rosa-sinensis* flowers in the University of Indonesia campus area, namely big single red, small single red, single cream, small single pink, double red, double pink, and crested peach [3]. In the Citayam area, there are Small Single Red, Double Red, and Crested Peach of
H. rosa-sinensis. In addition to differences in morphology in flowers, H. rosa-sinensis also has differences in leaf morphology. The morphology of the leaves of H. rosa-sinensis generally is a single leaf, ovate-shaped, leaf tip-shaped acutus or acuminatus, and leaf edges of serratus [4].

In general, differences in leaf morphology in plants are caused by environmental, genetic, and phenotypic plasticity influences [5]. H. rosa-sinensis that studied in this study has locations with different environmental conditions. There are significant differences in the intensity of light in some locations of this plant growth. It is known that environment will affect the surface area of leaves and stomata. So that in this research will prove the difference in light intensity can affect leaf morphology, especially leaf surface area and stomata size.

2. Materials and Method
The materials used in this research were 20 leaves from each H. rosa-sinensis variations, distilled water, and safranin for stomatal dyeing. The three variations used were Crested Peach, Small Single Red, and Double Red from UI and Citayam, Depok.

The leaves were collected from 5 variations of H. rosa-sinensis at UI campus area in Depok, and Citayam and the environmental data (light intensity, temperature and humidity) from each location were noted. Light intensity is the main focus of this research. After collected the leaves, leaf surface area was measured. Measurement of leaf surface area was used to analyze the influence of differences in light intensity. Size of stomata was also measured to know the correlation between leaf surface area and size of stomata.

For measuring the size of stomata, firstly the leaves were blended with water and then filtered. The filtered leaves suspension in a tube was dyed with safranin before dropped on the object-glass and observed under the light microscope. The ImageJ software was used for measurement of the size of stomata and leaf surface area.

3. Results and Discussion
3.1. The environmental factor measurement
The environmental factor that measured in this research were the light intensity, temperature, and humidity. The results showed that the highest of light intensity located in the Faculty of Literature, and the lowest one located in Citayam. The temperature between all the locations is not significantly different. The temperature ranged from 26.6 ºC to 31.3 ºC, while the humidity ranged from 31% to 78%. The highest humidity was located in Citayam and the lowest humidity in Faculty of Mathematics and Natural Sciences. The results of the environmental factor measurement are shown in Table 1.

| Flower Type                  | Location  | Light Intensity (Lux) | Temperature (ºC) | Humidity |
|------------------------------|-----------|-----------------------|------------------|----------|
| Crested Peach CitL (CP Cit1) | Citayam   | 26.644                | 26.6             | 78%      |
| Crested Peach CitD (CP Cit2) | Citayam   | 1.440                 | 26.6             | 78%      |
| Small Single Red Cit (SSR Cit) | Citayam | 1.714                 | 26.6             | 78%      |
| Small Single Red (SSR2)      | FIB UI    | 44.000                | 29.9             | 47%      |
| Double Red Cit (DR Cit)      | Citayam   | 10.020                | 26.6             | 78%      |
| Double Red 1 (DR1)           | FMIPA UI  | 14.083                | 28.5             | 55%      |

3.2. Leaf surface area and stomata surface area
In this research, we compared leaf surface area and stomata surface area with each light intensity to know the correlation pattern between light intensity, leaf surface area, and stomata surface area of the H. rosa-sinensis variations. The comparison performed between Crested peach Citayam 1 (CP Cit1) and Crested peach Citayam 2 (CP Cit2), between Small Single Red Citayam (SSR Cit) and Small Single Red UI (SSR1), and between Double Red Citayam (DR Cit) and Double Red UI (DR1).
Figure 1A shows that although the two individuals of Crested Peach from Citayam grown in the same location, they are grown under different light intensity, in which Crested Peach Cit1 grown unshaded, with higher light intensity compared to Crested Peach Cit2 that grown in the shaded area by a higher tree. The results of leaf surface measurement showed that Crested Peach CP Cit2 has bigger leaf surface than CP Cit1 and significantly different (P<0.05) (Figure 1B). This phenomenon is opposite to the light intensity. CP Cit1 with higher light intensity has a smaller leaf surface area. Plants use light to produce mass by a metabolic reaction called photosynthesis. Higher light intensity caused a smaller size of the leaves. Lower light intensity caused a larger size of the leaves due to the plant adapts their leaf size in the different light intensity to create a more efficient photosynthesis rate [6]. Comparison of the stomata size between CP Cit1 and CP Cit2 were not significantly different (Figure 1C). In this case, the light intensity influenced only the size of the leaf, not the size of stomata because phenotypic of the plant not only influenced by light intensity but also influenced by genetic factor [7].

Figure 1. Comparison of leaf surface area and stomata surface area with light intensity of Crested Peach Citayam

A different pattern was observed when the comparison was made between the Small Single Red flower plant from Citayam (SSR Cit) and Small Single Red (SSR 2) UI. The light intensity between two different locations was significantly different. The light intensity in UI (SSR 2) was about 25 times higher to that of in Citayam (SSR Cit) (Fig 2 A). Figure 2C shows that the leaf surface area of SSR Cit and SSR 2 is significantly different (P<0.05). It means light intensity influence the leaf surface area of SSR Cit and SSR 2.

Figure 2. Comparison of leaf surface area and stomata surface area with light intensity of Small Single Red Citayam and UI
The Double Red flower of *H. rosa-sinensis* plant showed different pattern. Figure 3 (A.B. and C), shows that there were no significant differences in light intensity, leaf surface area (P>0.05) and stomata surface area (P>0.05) of the Double Red plant that grown in Citayam (DR Cit) and that one grown in FMIPA UI (DR UI). This phenomenon correlates to Figure 1 which showed that different light intensity makes different leaf size. Figure 3 shows that similar light intensity produces the similar leaf sizes. It showed that light intensity has a critical role in influencing leaf size. However, Figure 3 also showed that the size of stomata was changed. It is proposed that there is an interaction between light intensity factor with the genetic factor. Research reveals that light can influence the regulation of gene expression in plant [8]. Many factors should be considered that affected the variation that occurred in *H. rosa-sinensis* because of unpredictable environment changes.

![Figure 3. Comparison of leaf surface area and stomata surface area with light intensity of Double Red Citayam and UI](image)

4. Conclusions

*H. rosa-sinensis* has many types of flowers and leaf morphology. The size of leaf and stomata can be affected by changes in light intensity. However, what was observed in *H. rosa-sinensis* proved that not only the light intensity nor only genetic factor that influenced the leaf morphology, but also interaction between light and gene can be seen in DR Cit vs. DR 1.

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