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The Diversity of *Hibiscus rosa-sinensis* based on Morphological Approach

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Abstract

The aim of this research was to know the morphological diversity of *Hibiscus rosa-sinensis* through visual observation. The character of the qualitative and quantitative morphology of *Hibiscus* was analyzed descriptively. The result showed that there are 15 types of *Hibiscus* have morphological differences. There are two kinds of leaf shape that is ovatus and deltoideus. While The leaf base is obtusus, rotundatus and truncatus. The leaf apex includes acute and acuminate. All cultivars have a similar leaf margin that is serrate. The leaf colors are variable ranging from green, young green, dark green and variegate (combination between green and white). The flowers have 6 main color variations i.e beige, yellow, red, orange, pink and white. The corolla forms a single petal or a double petal, with two types of corolla uniquely buds and brech. It can be concluded that the cultivar of *Hibiscus rosa-sinensis* is variable in leaves and flowers.

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1. Introduction

Indonesia is a country which has a high level of biodiversity. This is due to the geographical aspect of its forest resources located around the equator, across many islands, and between the continents of Asia and Australia. Furthermore, the country potential locations described show some certain characteristics of the resources in the form of tropical rain forest ecosystems. *Hibiscus rosa-sinensis* is one of the plant species spread throughout Indonesia. The beauty of this plant is found in the diversity of flowers for its shape, size and color (Gilman, 1999). This plant has many benefits such as how its flower is used as natural dyes for food and beverages (Oktiarni et al., 2013); mineral content, vitamin C and antioxidant substances are very beneficial to human health (Ahad et al., 2011; Raduan et al., 2013; Meena et al., 2014; Zubairi et al., 2014). In addition, *Hibiscus* is used as an ingredient of industrial products, religious and region symbols in some countries (Magdalita et al., 2011). Besides, the leafy leaves are highly potential as pollutant absorbers. These potentials make this plant cultivated as a commercially valuable ornamental plant (Kumar et al., 2012).

Hibiscus is a plant of the *Malvaceae* family originating from East Asia and widely cultivated as an ornamental plant in the tropics and subtropics (Rukmana, 2002). Variations in

morphology and *trichome* distribution are supporting characters of the taxonomy that distinguish species within the *Hibiscus* genus (Shaheen et al., 2009). According to Braglia et al. (2015), it was more than 3000 varieties of *H. rosa-sinensis* which have been identified. Hammad (2009) wrote that *H. rosa-sinensis* can be classified by the variation of the crown of flowers (single *petal* or double *petal*). *H. rosa-sinensis* flowers can only last for one day after blooming, but these plants can bloom throughout the year (Suryowinoto, 1997).

Based on the preliminary studies, there are many *Hibiscus* plants found in Baubau City, Southeast Sulawesi Province. However, research on diversity in *Hibiscus* with morphological approach has not been conducted and found in both libraries and internet. Hence, research on the diversity of *Hibiscus* species through this morphological approach is deserved to be conducted.

2. Method

The research carried out in Baubau City is classified as observational research based on morphological characteristics. It is conducted in three months, October to December, 2017. The object applied in this research is *Hibiscus rosa-sinensis* and its cultivars. The observed morphological parameters include leaf shape and size, flower type, flower color, and flower diameter. The stages of the research include: (1) preparation of the research, (2) data collection, (3) morphological characteristics observation, and (4) data analysis. Data analysis is applied qualitatively by observing the leaf color, leaf type (*circumscription*), leaf base (*basis folii*), leaf tip (*apex folii*), leaf margin (*margo folii*), and type and color of flower corolla. Meanwhile, quantitative analysis is applied by measuring the morphometry of leaves and flower diameter. The average results of the calculations are analyzed using the *Microsoft Excel* Program.

3. Result and Discussions

In general, the resulted descriptions of the fifteen species of *Hibiscus* with variations in the color of the crown of flowers found in Baubau City are as it follows: *Hibiscus* is a perennial crop of shrubs, height between 1 - 3.5 m, many branched stems, round woody, greenish thin-skinned in the young flower and brownish in the adult, and rough skin surface. For single alternate leaf, rounded petiole, 1 - 5 cm long, *circumsriptio* type (leaf shape) includes *ovatus* shape and *deltoideus* (equilateral triangle). The characteristic of *basis folii* (leaf base) which is directly related to the stem consists of *obtusus* (blunt), *rotundatus* (rounded) and *truncatus*

(flat). The *apex folii* type (leaf tip) is classified into *acutus* (pointed) and *acuminatus* (tapered). Meanwhile, *margo folii* (leaf edges) overall *Hibiscus* flowers only show *serratus* edge (serrated) (Table 1). Leaf color varies with color gradations ranging from light green, green, dark green and variegata (green with white combination). Flowers have 6 variations of *corolla* (crown) colors ie beige, yellow, red, orange, pink and white. with the crown (single petal) or double flower (double *petal* /layered crown) located on the *flos lateralis* or *flos axillaris* (axillary leaf), with two unique corolla types of buds and breech (Fig. 1) . This plant produces flowers continuously in large quantities, but the flowers only last for one or two days only.

Table 1. Morphological Characteristics of *Hibiscus rosa-sinensis* leaf in Baubau city

No	The Color of Flower Corolla (<i>Hibiscus rosa-sinensis</i>)		Leaf Characteristics			
		Color	<i>circumsriptio</i>	<i>basis folii</i>	<i>apex folii</i>	<i>margo folii</i>
1	Yellow	Green	<i>deltoideus</i>	<i>truncatus</i>	<i>acutus</i>	<i>serratus</i>
2	Red	Green	<i>ovatus</i>	<i>rotundatus</i>	<i>acuminatus</i>	<i>serratus</i>
3	Red, small	Green	<i>deltoideus</i>	<i>truncatus</i>	<i>acutus</i>	<i>serratus</i>
4	Red, breech type	Green	<i>ovatus</i>	<i>obtusus</i>	<i>acuminatus</i>	<i>serratus</i>
5	Pink, small	Green	<i>ovatus</i>	<i>rotundatus</i>	<i>acutus</i>	<i>serratus</i>
6	White	Green	<i>ovatus</i>	<i>rotundatus</i>	<i>acutus</i>	<i>serratus</i>
7	White, pink basis	Green	<i>deltoideus</i>	<i>truncatus</i>	<i>acutus</i>	<i>serratus</i>
8	Beige	Light green	<i>ovatus</i>	<i>obtusus</i>	<i>acuminatus</i>	<i>serratus</i>
9	Red, bud type	Light green	<i>ovatus</i>	<i>rotundatus</i>	<i>acuminatus</i>	<i>serratus</i>
10	<i>Pink baby</i> , light red Basis	Light green	<i>ovatus</i>	<i>rotundatus</i>	<i>acuminatus</i>	<i>serratus</i>
11	Pink, dark red basis	Light green	<i>ovatus</i>	<i>rotundatus</i>	<i>acuminatus</i>	<i>serratus</i>
12	Red, double petal type	Dark green	<i>deltoideus</i>	<i>truncatus</i>	<i>acuminatus</i>	<i>serratus</i>
13	Orange, dark red basis	Dark green	<i>deltoideus</i>	<i>truncatus</i>	<i>acutus</i>	<i>serratus</i>
14	Pink, double petal type	Dark green	<i>deltoideus</i>	<i>truncatus</i>	<i>acutus</i>	<i>serratus</i>
15	Red, variegata leaf type	variegata	<i>ovatus</i>	<i>rotundatus</i>	<i>acuminatus</i>	<i>serratus</i>

Based on the observations and measurements in Table 2, it can be understood that the leaf size of the *Hibiscus* with different flower color shows a fairly striking size comparison. This was proven by the difference in the length and width of the leaves on each flower with different colors. Based on the results of data analysis, leaves with the highest average length consecutively found in the *Hibiscus* with soft pink color with dark red base ($13,84 \pm 0,57$) and dark red base pink ($13,22 \pm 0,68$). The smallest leaf length was found in white *Hibiscus* ($4,20 \pm 0,53$). In general, large leaf size is a type with a superior character. That is, the size of

the leaves can be used as a parameter of flower diameter. The larger the leaves, the diameter of the flowers will be even greater.



Figure 1. Color variation of Variasi *Hibiscus rosa-sinensis* in Baubau city; a. single petal; b. double petal; c. Breech shaped; d. bud shaped

Table 2. The Data of leaf morphometry and the diameter of *Hibiscus rosa-sinensis* in Baubau City

No.	Corolla Type	Leaf (cm)		Flower Diameter (cm)
		Length	Width	
1	Beige, white basis	9,56 ± 0,79	6,10 ± 0,34	9,90 ± 0,66
2	Yellow	9,73 ± 0,59	9,03 ± 0,19	10,80 ± 0,20
3	Red	11,54 ± 0,50	5,54 ± 0,32	9,42 ± 0,35
4	Red, small	5,10 ± 0,48	4,45 ± 0,74	5,73 ± 0,21
5	Read, breech type	11,10 ± 0,47	7,18 ± 0,51	7,30 + 0,26
6	Red, double petal	9,30 ± 0,54	6,38 ± 0,43	9,23 ± 0,21
7	Red, bud	10,73 ± 0,67	5,10 ± 0,26	3,07 ± 0,21
8	Red, variegate	11,58 ± 0,36	6,70 ± 0,45	9,30 ± 0,66
9	Orange, dark red basis	11,90 ± 0,56	9,80 ± 0,19	12,87 ± 0,35
10	Pink baby, light red basis	13,84 ± 0,57	9,12 ± 0,36	12,23 ± 0,76
11	Pink, double petal	11,68 ± 0,52	9,83 ± 0,45	10,37 ± 0,35
12	Pink, small	4,93 ± 0,64	3,23 ± 0,21	8,83 ± 0,15
13	Pink, dark red basis	13,22 ± 0,68	7,98 ± 0,78	12,53 ± 0,15
14	White	4,20 ± 0,53	3,10 ± 0,29	9,07 ± 0,21
15	White, light red basis	5,38 ± 0,40	3,68 ± 0,53	5,35 ± 0,21

The color of the hibiscus leaves shows different color variations of green, light green, dark green, and variegata. Variegata generally express the plant parts in the form of stripes or spots with different colors. In the leaves of the hibiscus plant, variegated color is a combination of green and white. According to Wang et al., (2016), variegata or kimera are the results of

genetic or mutation changes in plant cells. This occurs because of the reduced amount of chlorophyll (green leaf substance) of the plant, resulting in albino symptoms, yellow stripes on leaves, and white spots or non-green color caused by genetic influences (Cocciolone and Cone, 1993). Variegata phenomena can occur naturally or artificially. Natural process results from the influence of genetic diversity or mosaics, ongoing mutations, and alien pathogen attacks (Chen et al., 2000). In the hibiscus flower, these variegata properties only appear on the leaves. This is presumably because mutations occur only on leaves. The location of the mutation determines the variegata pattern that appears. This means that if the mutated gene is in the leaf only, then variegata will appear in the leaf only too.

The next variations are also found in *circumscription*, *folii base* characteristics and *apex folii* of hibiscus leaves. *Circumscriptio* is a form of *Hibiscus* leaves as a whole. Based on observations, circumscription of *Hibiscus* leaves showed ovatus shape, with base type (leaf base) and *apex folii* (leaf tip) are *acuminatus* (tapered) and *acutus* (pointed). This is in accordance with the statement of Van Steenis (2003), that *Hibiscus* has stalked leaves, ovatus, *acuminatus* on the *folii base* and *acutus* at the *apex folii*. However, from the observation, another *circumscription* form of *deltoideus* (equilateral triangle) is found in yellow, red with pink basis, red with double petal, pink with double petal, and orange with dark red basis. In addition, there are also other shapes of *folii basis* namely *obtusus* (blunt), *rotundatus* (rounded), and *truncatus* (lean or flat). Likewise with *apex folii*, beside the shape of *acutus* (pointed), it is also found the shape of *acuminatus* (tapered) on red *hibiscus*, red with breech type, beige, red with bud type, pink baby with light red basis, pink with dark red basis, red with double petal type, and red with variegata leaf type (Table 1).

According to Van Steenis (2003), the variations of the circumscription, base and *apex folii* shapes are caused by crossing the *Hibiscus* with other species, so there are other variations of characteristics from the *Hibiscus* brood stock. In addition, external factors such as temperature and air pollution can also cause variations in leaf shape, color, leaf length, width, and length of the petiole (Karlsson and Werner, 2001., Leghari and Zaidi, 2013). Environmental conditions also affect the high diversity of plants through leaf tissue modification as a form of adaptation to the tense environmental conditions (Viscosi et al., 2009, Nawaz et al., 2011). The form of adaptation through leaf tissue modification of *H. rosa-sinensis* cv., Lemon shifon and *H. rosa-sinensis* Wilders white has more stomata density than other cultivars, epidermal layer thickening, increased epidermal cell area, increased stomata, increased cortical cell area and trichomes per unit area (Noman et al., 2012, 2014).

Based on the observation, the color of the flower corolla has a varied variety. The data show that the color of the *Hibiscus* corolla in general is red, pink, yellow, orange, beige, and white. Despite, some of them show a combination of pink with light red basis, orange with dark red basis, and white with pink basis. The color variation in the *Hibiscus* flowers is determined by the presence of *antocyanin* pigment, *antosantin* and *plastid* pigment present in the cell. According to Henuhili (2007) in his research on the inheritance of floral color on orchids, that *anthocyanin* determines red, dark red, blue, and bluish red. while anthocyanin determines the yellow color of ivory to the old yellow. Biochemical analysis of the pigment of flower showed a correlation between the genetic trait and biochemical changes. In other words, the phenotype character (the color of the flower) will be expressed if there is an interaction between gene factors and environmental factors. One of the environmental factors that play a role in the variation of flower color is temperature and lighting during growth (Warner and Erwin., 2001, 2003). In addition, the presence of HrsACS and HrsACO genes contributes to the changes in the morphological structure of *Hibiscus*, at an early stage of flower growth and at the time of bud flowers. The involvement of ACS and ACO genes during the growing stage of flower due to hormone stimulation (regulation of ethylene and endogenous acids absorbed) and the environment (Trivellini et al., 2011a, 2011b). Several studies on the ethylene hormone response to aging in flower or as a response from the external environment have been widely applied (Kuroda et al., 2003; Ma et al., 2006; Mutui et al., 2007, Nawaz et al., 2011).

Flower diameter also varies and can be classified into small, medium and large types. Flower diameter with small type can be found on hibiscus with small red color, white with pink basis, and bud hibiscus. Meanwhile, the diameter of flowers with a large type can be found in three types of *Hibiscus* in pink with dark basis, baby pink with light red basis, and orange with dark red basis. The smallest diameter of buds was found in bud *Hibiscus* ($3,07 \pm 0,21$ cm), while the largest diameter was found in orange with dark red basis *Hibiscus* ($12,87 \pm 0,35$) (Table 2). The size of the flower diameter of a plant is generally determined by the dominant gene. Several types of *Hibiscus* that have the highest diameter of the flower are thought to be superior varieties or genetic resources of *Hibiscus* germplasm. Hence, this species can serve as an elderly cross or gene donor in plant breeding to obtain a superior character that produces flowers of jumbo size and a new flower color variant. *Hibiscus* cultivars through interspecific hybridization conducted by Kang et al (2015) produce a new *Hibiscus* species called *Woolred*, has a nice growth and unique flower shape that is pink violet

with red spots, medium-sized with fan-shaped petals, flower sized 11.5 cm, leaf length 7.7 cm, and leaf width 4.2 cm.

4. Conclusion

Based on the observation and data analysis, it can be concluded that 15 species of *Hibiscus* have morphological differences. *Circumscriptio* of *Hibiscus* leaves have two shapes: *ovatus* and *deltoideus*. The *basis folii* type consists of *obtusus*, *rotundatus* and *truncatus*. Meanwhile, the type of *apex folii* is divided into *acutus* and *acuminatus*. Having a similar *margo folii* is called *serratus* type. Leaf color varies with color gradations ranging from light green, green, dark green and variegata (green and white combination). The flowers have 6 main color variations: beige, yellow, red, orange, pink and white. The corolla has two shapes: single petal or double petal, with two unique corolla types: bud and breech.

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