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Explorating Flower Morphology and Pollen Types of Various Angiospermae Families from Huluduotamo Village, Gorontalo

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Abstract

Huluduotamo village is one of the villages in Suwawa district, Bone Bolango regency, Gorontalo Province. The village is situated in the middle of the countryside within the Suwawa district area. The potential of Huluduotamo village is the potential of natural resources; thus, the exploration of flower morphology and pollen types of various angiosperm families was carried out in the village. Therefore, this study aims to look at and figure out the shape of pollen from different plant families, mainly the genus of Malvaceae and Fabaceae, by looking at pollen units, aperture types, wall thickening, and exine decoration. We conducted the sampling in the Huluduotamo village, Gorontalo, using direct observation methods and descriptive analysis under a microscope. The study found that the pollen from Hibiscus rosa-sinensis L. plant in the malvaceae family has a monad pollen unit, an apantoporate aperture type, thickening of the centrifugal wall, and decoration on the echinate exine. Some plants, like Caesalpinia pulcherrima L. in the Fabaceae family, have pollen that is made up of a single unit, an atricolporate aperture for the red variety and a parasyncolporate aperture for the yellow variety, and psilate axine decoration. The similarity of the monad pollen unit shows how angiosperm plants reproduce, while differences in aperture types and axine ornamentation show how the shape of the plant has changed to support reproduction. This research provides important information for the identification of plant species and supports flowering plants.

Keywords: *Angiospermae; Fabacea; Malvaceae; Pollen Morphology; Pollen Aperture*

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INTRODUCTION

The word *angio*, which means flower, and the word sperm, which means seed, combine to form angiosperm plants, which are essentially closed seed plants. The fruit leaves of angiosperm plants contain closed ovules, also known as carpels. The flower organs that surround the fruit leaves are made up of woody plants and wet stems, taproots and fibrous, branched or unbranched stems, and single and compound broad leaves of different types and veins. There are monocots and dicots (Afrida, 2022). Angiosperms are one of approximately 300,000 species of flowering plants—the largest and most diverse group of plants in the *Plantae* kingdom. Angiosperms represent about 80 % of all green plants known today. Angiosperms are vascular seed plants whose *ovules* (eggs) are fertilized and develop into seeds in a closed cavity. Angiosperm plants typically enclose the *ovary* in a flower, which houses either the male or female reproductive organs, or both. Fruit comes from the mature flower organs of angiosperm plants and is therefore a characteristic of angiosperm plants (Dennis, 2024).

The main reproductive organ in *Angiospermae* plants is the flower, which functions as a place where sexual reproduction occurs. The structure of *Angiospermae* flowers consists of several important parts. The male reproductive organ is called the stamen, which consists of the anther (stamen head) and filament. The anther functions as a place for the formation of pollen containing male gamete cells, while the filament is the stalk that supports the anther. The female reproductive organ is called the *pistil* (*pistil* or carpel), which consists of the stigma, style (*pistil* stalk), and *ovary*. The stigma functions to catch pollen, while the style connects it to the *ovary*, where the fertilization process occurs. Inside the ovary there is an ovule (*ovulum*), which, after being fertilized, will develop into a seed (Raven et al., 2019).

Flowers are a vital part of the plant cycle. Flowers are reproductive organs in *Magnoliophyta* or *Angiospermae* plants that act as intermediaries for the fusion of sperm with egg cells to produce embryos. This fusion process begins with pollination, followed by fertilization, which will then lead to seed formation. In higher plants, seeds are the next generation and function as a means of dissemination (Iriawati & Suradinata, 2018). This study is in line with previous research conducted by Suliartini et al., (2023). The study, titled "Exploration and identification of types of medicinal plants in the Senaru coffee plantation tourist village as basic information in the development of medicinal plant tourism," found that different types of plants are beneficial for your health. The medicinal plants in the Senaru coffee plantation are either wild plants that people grow or plants that individuals grow on purpose.

The plants are a type of angiosperm, meaning they have flowers as a means of reproduction. The flowers on both plants have male and female reproductive organs. According to Zanin et al., (2017), the peacock flower *Caesalpinia pulcherrima*, is one of the well-known species of the genus Caesalpinia, a legume plant spread across several countries in Central America, South America, and India. In Indonesia, the peacock flower is an introduced ornamental plant that is quite well-known and has been widely distributed because it has bright flower colors and can flower all year round. *Caesalpinia pulcherrima* also shows several medicinal properties and has a fairly diverse chemical content. Hibiscus flowers (*Hibiscus rosa-sinensis L.*) are one of the ornamental plants that have many color variants. These flowers are large, colorful, and odorless.

Hibiscus is an ornamental plant in the form of a perennial shrub. This plant originates from East Asia and is widely used as an ornamental plant in tropical and subtropical regions (Febrionny et al., 2023).

The peacock flower *(Caesalpinia pulcherrima)* is one of the well-known species of the genus Caesalpinia, a legume plant spread across several countries in Central America, South America, and India. In Indonesia, the peacock flower is an introduced ornamental plant that is well-known and has been widely distributed because it has bright flower colors and can flower all year round. *Caesalpinia pulcherrima* also shows some medicinal properties and has a fairly diverse chemical content (Deepakkumar & Rasmanan, 2016).

Yellow peacock flowers have petals and crowns that are entirely yellow, and red peacock flowers have red petals and red crowns with light yellow edges. The color of the stamens and pistils of the peacock flower is bright red, but the yellow peacock flower has yellow stamens and pistils (Bharati et al., 2017). Defining the two colors of the peacock flower, there is no difference in morphology between the two flower colors. Both have 5 petals, 5 crowns, 10 stamens, and 1 pistil (Wahdina, 2017). According to Weiss (1995), differences in flower color, especially in the crown of the flower, are usually related to the types of pollinators that play a role in flower pollination, and the visible pattern is an indicator of the position of nectar or pollen. In the peacock flower, *Caesalpinia pulcherrima*, the main pollinator is a butterfly. Generally, differences in pigment composition, especially anthocyanins and carotenoids, cause differences in flower crown color.

Hibiscus rosa-sinensis This flower is a single flower plant from the leaf axils. The color of the flower crown leaves is bright red. The stamen stalks are numerous and red. The pistil stalk is red with white located at the tip. Flowers consist of a crown, petals, a stalk, a pistil, a stamen stalk, and an anther. Hibiscus plants have a flower morphological structure with additional petals *(epicalyx)* (Tjitrosoepomo, 2020). The arrangement of the hibiscus flower crown is gamopetalous, which is attached to the base and free at the top. *Hibiscus rosa-sinensis*, or often called hibiscus flowers, are widely found in Indonesia. *Hibiscus rosa-sinensis* frequently exhibits a variety of flower crown colors. Masnadi et al., (2019) research typically describes the genetic diversity in *Hibiscus rosa-sinensis* through variations in flower crowns (Hammad, 2009). Pramesti (2021) research states that hybridization carried out on *Hibiscus rosa-sinensis* is rarely carried out in Indonesia so that propagation still uses stem cuttings and grafting techniques. Gene expression is not only limited to the color of the flower crown or flower physiology; genes can also express the shape of the pollen produced by *Hibiscus rosa-sinensis*.

There are differences in *Hibiscus rosa-sinensis* pollen from different cultivars only in the polar/equatorial index, the number of spines, the length of the spines, and the distance between the spines. These differences only affect the differences in the pollen's properties and not the differences in how the species is classified. Also discovered this distinction, Hanum et al., (2014) discovered variations in grain size, echinate length or length of exine ornamentation spines, distance between echinates, and polar/equatorial index. From the results, we can say that changes in the polar/equatorial index will stay different, even though the cultivars studied are all from

the same species, *Hibiscus rosa-sinensis*. The point of this study is to look at and figure out the shape of pollen from different plant families, mainly Malvaceae and Fabaceae, by looking at pollen units, aperture types, wall thickening, and exine decoration.

METHOD

Location and Time of Research

This study used two types of plants, namely red flowers and *hibiscus*, carried out on Thursday, November 14, 2024. Meanwhile, the location of the study was in Huluduotamo Village, Suwawa District, Bone Bolango Regency, Gorontalo Province.

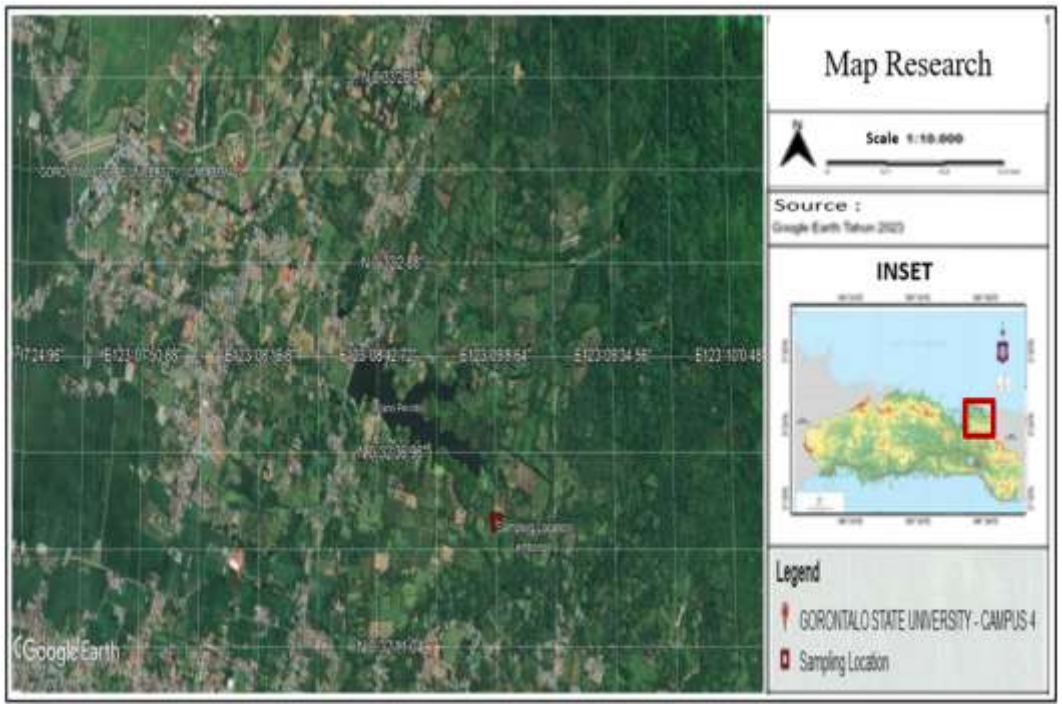


Figure 1. Research Location Map

Research Type

The type of research conducted was observational. The samples were taken directly at the research location, and microscope observations were carried out to see the reproductive organs in Angiospermae plants. The data obtained were processed using descriptive analysis methods.

Tools and Materials

The tools used in this study were a cellphone camera as a tool to document all activities carried out, a notebook, an electric microscope, a slide, a cover glass, a cutter, and a cellphone.

Research Stages

Sampling

The samples taken directly by the direct observation method and descriptive analysis using microscopes were crucial in scientific research, especially in biology. The microscopes allowed detailed observation of small objects, such as cells and tissues, and documented their morphological characteristics. The advantage of this method depended on the reproducibility of the results, where observations by other researchers produced similar findings. Thus, microscopes contributed to a deeper understanding of biological phenomena (Davis et al., 2023).

Observation of Flower Morphology

By looking at flower morphology, specifically the shape of the male reproductive parts of plants, called stamens, scientists learned a lot about how flowering plants (angiosperms) reproduce. The stamens consisted of two main parts: the anther, which functions as a place for pollen formation, and the filament, which supported the anther. The process of pollen formation in the anther through meiosis produced pollen cells that have strong walls, which was important for the protection of genetic material during pollination. The morphological adaptations varied, depending on the pollination mechanism, either by wind or insects. The study of stamen morphology contributed to the understanding of the plant life cycle, classification, and applications in agriculture. Recent research has shown that morphological analysis can help in the development of more productive and pest-resistant plant varieties (Saefudin & Julisawati, 2016).

Microscope Observation

Before observing under a microscope, the first stage was preparing the tools and materials to be used. The second stage was cleaning the tools to be used with 70 % alcohol measuring 1 liter. The third stage was taking the stamens from the leaves of the *Angiospermae* plant using a knife or cutter and place them on a glass slide. The forth stage was dripping aquadest on the glass slide that already contained stamens and covered it with a cover glass. The fifth stage was observing under a microscope to determine the type of pollen. The process of identifying and classifying pollen based on morphological characteristics and modern techniques was the process of determining the type of pollen. The characteristics, such as size, shape, and surface patterns of pollen, were used to distinguish plant species by referring to Dahlias (2019).

Data Analysis

The data analysis was conducted by conducting data analysis from the results obtained and analyzing morphological and anatomical data of flowers and pollen types in various types of plants.

RESULTS AND DISCUSSION

Flower Morphology

Based on morphological observations, the hibiscus (*Hibiscus rosa-sinensis* L) in the Malvaceae family has a morphology consisting of 5 flower crowns, 5 flower petals, 5 pistil heads, and 125 stamens. Similarly, the Peacock Flower (*Caesalpinia pulcherrima* L) in the Fabaceae family has a morphology consisting of 5 flower crowns, 5 flower petals, 1 pistil, and 10 stamens. The red color has a morphology of 5 flower crowns, 5 flower petals, 1 pistil, 10 stamens, and the peacock flower (*Caesalpinia pulcherrima* L). The yellow color has morphological characteristics of 5 flower crowns, 5 flower petals, 1 pistil, and 10 stamens.

The results of microscopic observations based on several types of families observed obtained different pollen morphology results. The *Malvaceae* family with the hibiscus species (*Hibiscus rosasinensis* L.) has a periporate type aperture because the aperture has round gaps spread across the surface of the pollen grains; this is reinforced by the results of research from Shaheen (2009). which also states that the pollen form of hibiscus is a periporate type aperture. Hibiscus (*Hibiscus rosa-sinensis* L.) has a monad pollen unit, which means single, that the pollen unit in the hibiscus species has a monad-type unit. The Hibiscus rosa-sinensis pollen unit is a monad (one pollen unit). This means that Hibiscus rosa-sinensis pollen successfully separated at the meiosis II stage (Hesse et al., 2009). Umami (2021) provided the same description, stating that the pollen unit is of the monad type.

Table 1. Morphology of Flowers in Huluduotamo Village, Gorontalo

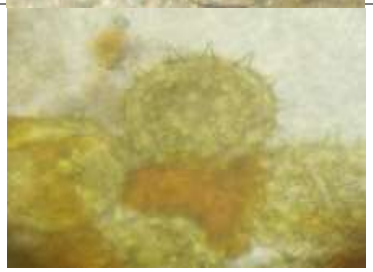
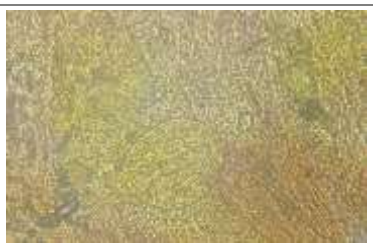
Flower Type	Figure	Description
Hibiscus rosa-sinensis (*Hibiscus rosa-sinensis* L)		There are: 5 flower crowns 5 flower petals 5 pistil heads 125 stamens
Red peacock flower (*Caesalpinia pulcherrima* L)		There are: 5 flower crowns 5 flower petals 1 pistil 10 stamens
Yellow peacock flower (*Caesalpinia pulcherrima* L)		There are: 5 flower crowns 5 flower petals 1 pistil 10 stamens

Looking at the shapes of pollen from the Malvaceae and Fabaceae families, we can see that the pollen unit, the type of wall thickening, the aperture, and the exine ornamentation are all different. Table 2 presents the observations of pollen characteristics.

Flower Anatomy

The centrifugal cell wall thickening type makes the pollen wall thicker on the outside, and the echinate type of exine ornamentation makes it look like a thorn. This fits with research from Hanum et al., (2014), which says that hibiscus flowers have echinate type exine ornamentation. There are two parts to the pollen wall. The innermost part is the intine, and the outermost part is the exine. The exine is usually equipped with ornamentation. *Hibiscus rosa-sinensis* pollen has exine ornamentation that is shaped like a thorn, which is commonly called echinate. This is the same as the opinion of Umami et al., (2021) and Hanum et al., (2014), which states that *Hibiscus rosa-sinensis* pollen has thorny ornamentation.

Table 2. Anatomy of Pollen in Stamens

Flower's Type	Figure	Magnification
Hibiscus rosa-sinensis (*Hibiscus rosa-sinensis* L)		40 x 0.25
Red peacock flower (*Caesalpinia pulcherrima* L)		40 x 0,25
Yellow peacock flower (*Caesalpinia pulcherrima* L)		40 x 0,25

From *Fabaceae* family species, *Caesalpinia pulcherrima* L., with color variations were used, namely red and yellow. Pollen morphology observations produced the conclusion that the *Caesalpinia pulcherrima* L. pollen unit is only a monad. Other studies have found that the *Caesalpinia pulcherrima L.* pollen unit also has a monad pollen unit. Pollen grains are isopolar, radially symmetrical, and in the large size category (51-100 µm) because the pollen diameter is 58.16-74.11 µm.

Pollen Characteristics

Table 3. Characteristics of Peacock and Hibiscus Pollen

Plant Name	Pollen Characteristics				Description
	Aperture	Pollen Unit	Pollen Patching	Exine Ornamentation	
Caesalpinia pulcherrime **(warna merah)**	Tricolporate	Monad	Centrifugal	Echinate	The flowers are yellowish red with the type of inflorescence, namely corymb. The flowers are red, yellowish orange, large, and very striking. Each flower consists of five petals, one of which is smaller than the others.
Hibiscus rosa-sinensis **L**	Periporate	Monad	Centrifugal	Echinate	The flower has a trumpet-like shape, with hermaphroditic flower sex, symmetrical flower petals, and additional petals; the base of the flower resembles a cup, and the flower color is pink.
Caesalpinia pulcherrima **L (warna kuning)**	Parasyncolporate	Monad	Medium	Psilate	The flowers have a striking shape with a circular arrangement in a long cluster (raceme). Each flower has small bell-shaped petals. Yellow peacock flowers are often found as ornamental plants, adding beauty to gardens or landscapes with their bright colors and unique shape.

According to Fitri et al., (2016), *Caesalpinia pulcherrima* L. has pollen with isopolar polarity because both have exactly the same distal and proximal parts. It has both aperture types, which are tricolporate, namely three pores with channels. The thickening of the cell walls in *Fabaceae* pollen is usually centrifugal, which means that the thickening that points outward makes the structure of the pollen stronger, like it does in species from the *Malvaceae* family. The type of ornamentation in *Caesalpinia pulcherrima* pollen is included in the psilate category, which means that the surface is smooth without additional ornamentation, such as thorns or nets.

Based on the characteristics of the type of pollen in the plants *Caesalpinia pulcherrima* L. (Red), *Hibiscus rosa-sinensis* L., and *Caesalpinia pulcherrima* L. (Yellow), which are included in the angiosperm plants, these plants have the same type of pollen, namely monad. According to Des et al., (2013), monad pollen is pollen that is separate or free from each other (solitary). Angiosperms generally have a monad pollen type (single or solitary). Monad pollen is characterized by its scattering or separation from its tetrad.

This plant also differs in its aperture, where *Caesalpinia pulcherrima* L. (red) has a tricolporate aperture type, *Hibiscus rosa-sinensis* L. has a periporate aperture type, and *Caesalpinia pulcherrima* L. (yellow) has a parasyncolporate aperture type. According to Nugroho (2014), aperture is a thin layer of exine and a thick layer of intine. Aperture functions as a protector, regulator of ion transformation, and a gap for the exit of pollen sprouts on the stigma during the pollination process. Tricolporate is a type of aperture that has 3 gaps.

CONCLUSION

The study found that pollen from the Malvaceae and Fabaceae families had very different shapes in terms of the number of pollen units, the types of holes they had, how thick their walls were, and how they were decorated on the outside. *Hibiscus rosa-sinensis* There are monad pollen units in Hibiscus pollen, a pantoporate aperture type, centrifugal wall thickening, and echinate exine ornamentation. *Caesalpinia pulcherrima* L. pollen, on the other hand, is isopolar and has a tricolporate aperture in red varieties and a parasyncolporate aperture in yellow varieties. It also has psilate exine ornamentation. These morphological variations reflect specific plant adaptations to their reproductive functions, especially in the pollination process. The similarity of monad pollen units shows the typical characteristics of Angiospermae plants, which allows for dispersal and successful fertilization.

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