

# Development of flower and fruit of *Magnolia champaca* L. in Banda Aceh city

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**Abstract.** *Magnolia champaca* L., known as Jeumpa Kuneng or Bungong Jeumpa in Aceh, is culturally significant as the regional flower of Aceh Province. Used in traditional ceremonies, its fragrance and beauty inspire Acehnese poetry. Ethnobotanical studies highlight its medicinal properties, especially for treating various diseases, with the flower being the most used part. However, its utilization has potentially impacted its spread and reproduction, as seen by its declining presence in Banda Aceh. This study examines the duration and morphological characteristics of *M. champaca*'s development and evaluates reproductive success. Observations reveal a 24-26 day flower development process starting from generative bud emergence, with fruit formation from day 26 to 70, marked by ripening and blackening. Understanding these stages helps predict optimal fruit harvesting times. The reproductive and fruit types are monoecious hypogynous and dehiscent dry fruit. This study provides insights into the reproductive biology of *M. champaca*, aiding in conservation and sustainable utilization strategies.

## 1 Introduction

*Magnolia champaca* L. in Aceh is known as Jeumpa Kuneng or Bungong Jeumpa. This plant has been designated as the regional flower or identity flora of the Aceh Province according to Decree of the Minister of Home Affairs No. 48 of 1989 [1]. According to a prominent figure in the Aceh Traditional and Cultural Institution (LAKA) of NAD Province, the people of Aceh highly value the Bungong Jeumpa. This is evidenced by the utilization of this species in various traditional ceremonies. Additionally, the fragrance, beauty, and color of this flower have inspired Acehnese poets to create verses famously known as the Bungong Jeumpa song [2].

The utilization of plants by certain community groups is studied in the field of Ethnobotany. The medicinal properties of champaca flowers are known to be utilized by the community in the city of Banda Aceh for the treatment of 21 types of diseases. Various parts of the plant are utilized, including the roots, stem bark, leaves, flowers, fruits, and sap. Among these, the most commonly used part is the flower [2]. This flower used to be one of

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the ingredients in "Air Sembilan" (nine-type flower water) during funeral rituals in Peurelak, East Aceh District [3].

Flowers play a crucial role in the reproduction of plants, so the use of this flower may have reduced its spread and reproduction. Based on observations during 2022-2023, it is currently harder to find Bungong Jeumpa trees in Banda Aceh. We only found 8 individuals of yellow champaka flowers, located at the Baiturrahman Grand Mosque in Banda Aceh City. This contrasts sharply with Zumaidar's research [4] which reported 50 *M. champaca* trees in 2003. This is further supported by the difficulty encountered by traders in finding *M. champaca* flowers.

In a stand, determining the right harvest time is not easy because ripe fruit is often not visible from below the tree or monitoring pollination conditions in a stand regularly if its location is relatively far away. Therefore, efforts are needed to obtain techniques to predict fruit seasons based on phenology. The fruit ripening period can be predicted based on a good understanding of the timing of flower and fruit development. Understanding the duration required for the transition from one stage to another will greatly assist in predicting the right time for fruit harvesting. So, it is potentially possible to conduct research on the duration of the flowering and fruiting phases of *M. champaca*. Thus, this research aims to understand the duration and morphological characteristics of the flower and fruit development and the value of reproductive success.

## 2 Materials and Methods

Research on flower and fruit development was carried out in the courtyard of the Baiturrahman Grand Mosque (Fig. 1). There are six *M. champaca* trees planted, varying in height from 3 to 10 meters. Only three trees were sampled due to their active reproductive activity and lower height, which facilitated documentation without plucking flowers or fruits from the trees.

Data has been analyzed descriptively to determine the duration of the phases and their morphological characteristics. Observations were made on prospective flowers found on 3-4 productive branches. The stages of flower development observed included the emergence of flower buds until the flowers bloomed. These observations included changes in color, shape, and size, as well as calculating the duration of each stage. Fruit development was observed starting from the appearance of generative buds to young fruit and finally to ripe fruit. Observations included changes in color, shape, and size, as well as calculating the duration of these changes.

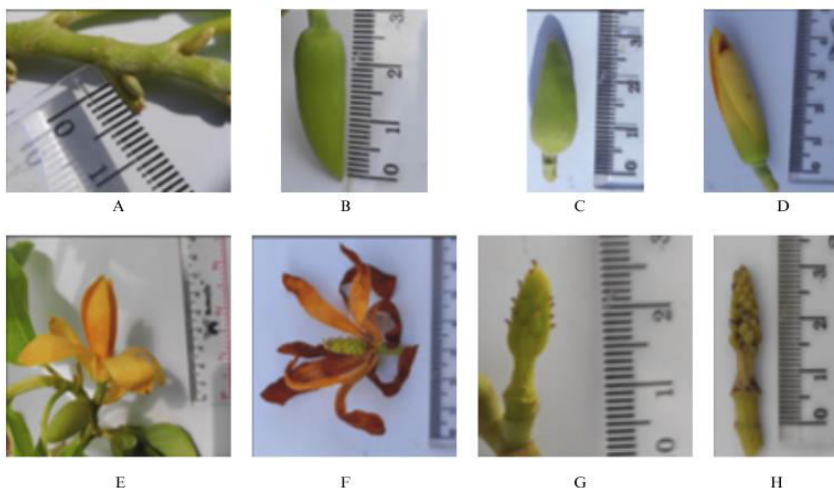
Observations were made daily to determine the time period and length of each stage of flower and fruit development. The tools used in this research were a smartphone, paper, and a ruler. This research was conducted from September to October 2023. The method involved observing the development of the flower and fruit every single day, with photos taken using a plastic ruler to measure the growth.



**Fig. 1.** Observation location, A) Map of the *M. champaca* tree at the Baiturrahman Grand Mosque, B) one of the *M. champaca* individuals.

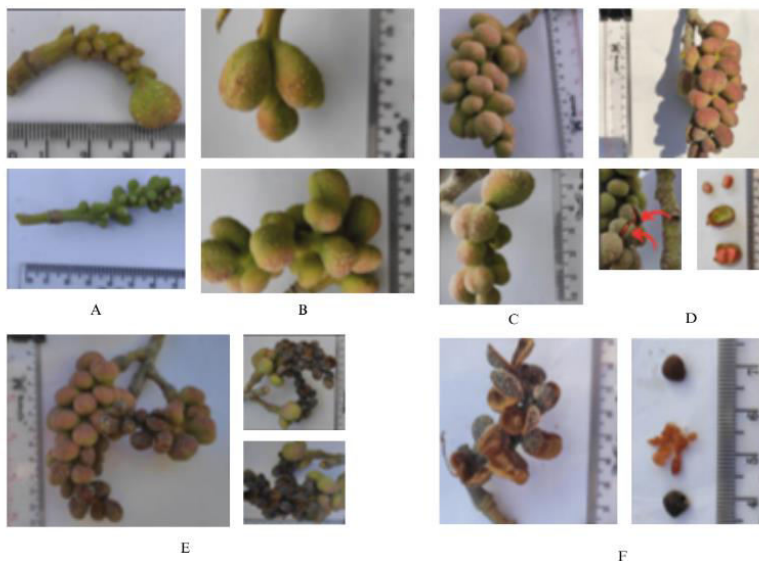
### 3 Results

In general, the development stages of generative organs (flowers and fruit) consist of five phases: (1) flower formation; (2) pollination and fruit/seed formation; (3) fruit growth; (4) ripening of fruit/seeds; and (5) distribution. Observation on *M. champaca* shows the development of flowers and fruit on the tree, from flower buds to fruit formation (Fig. 2).



**Fig. 2.** Observation result of flowering *M. champaca*.

Observing fruit development is a continuation of observing flower development. The stages observed start from the time signs of ovary fruit appear, fruit appears, young fruit, ripe fruit until black fruit and black seeds. Apart from time, changes in size, color and shape of the fruit were also recorded [4] (Fig. 3).



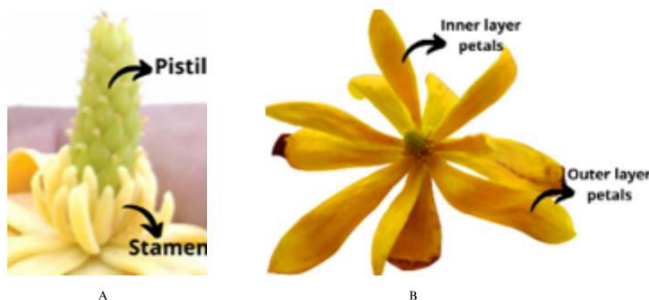
**Fig. 3.** Observation result of fruiting *M. champaca*.

The stages of flower and fruit development can be seen in Fig. 2 and Fig. 3, details can be seen in Table 1. The stages of flower development are divided into 7 stages (Fig. 2A-G), and the fruit development stages are again divided into 7 stages (Fig. 2H-N).

**Table 1.** Development of flower and fruit of *M. champaca*.

Step	Days	Characteristic
A	0-5	<ul style="list-style-type: none"> <li>• It's a delicate flower bud that is very fragile to the touch</li> <li>• It measures 0-0,5 cm length</li> <li>• Green colored</li> </ul>
B	5-12	<ul style="list-style-type: none"> <li>• It's a young flower bud</li> <li>• It measures 1-2,5 cm length</li> </ul>
C	12-14	<ul style="list-style-type: none"> <li>• It's a green flower bud with lines on its petals</li> <li>• It measures 2,5-3,5 cm length</li> </ul>
D	14-18	<ul style="list-style-type: none"> <li>• It's a yellow flower bud with its petals beginning to open</li> <li>• It measures 3,5-5 cm length</li> </ul>
E	18-23	<ul style="list-style-type: none"> <li>• It's a blooming yellow flower</li> <li>• It has a nice fragrance</li> <li>• It measures 6-8 cm in length, and 5-8 in width</li> </ul>
F	23-26	<ul style="list-style-type: none"> <li>• It's a withered brownish flower.</li> <li>• It no longer has any fragrance</li> <li>• The petals are easily detached at any time</li> </ul>
G	26-28	<ul style="list-style-type: none"> <li>• The pistil, which is the precursor to the fruit</li> <li>• It's measures 1-2 cm in length</li> <li>• Light green in color</li> </ul>
H	28-33	<ul style="list-style-type: none"> <li>• Several fruits have formed.</li> <li>• It's measures 2-2,5 cm in length</li> <li>• Its light green colored</li> </ul>
I	33-38	<ul style="list-style-type: none"> <li>• The fruit have enlarged.</li> <li>• Light green in color, beginning to turn reddish with white spots.</li> </ul>
J	38-45	<ul style="list-style-type: none"> <li>• All fruit are enlarged and entirely turning red in color.</li> <li>• It has 3-5 cm per fruit in length</li> <li>• One fruit cluster measures 5-10 cm in width and 5-20 cm in length depending on its arrangement</li> </ul>
K	45-50	<ul style="list-style-type: none"> <li>• All fruit lobes have turned red on the outward-facing side and light green on the side facing the branches</li> <li>• It no longer grows in length or width.</li> </ul>
L	50-54	<ul style="list-style-type: none"> <li>• Some parts of the fruit skin have split open, and some have released their seeds.</li> <li>• The fruit flesh is red with black seeds inside</li> </ul>
M	54-60	<ul style="list-style-type: none"> <li>• Some parts of the fruit skin have turn black</li> <li>• More fruits have opened up and released their seeds</li> </ul>
N	60-70	<ul style="list-style-type: none"> <li>• The entire fruit has turned black</li> <li>• All of the fruit flesh has been expelled</li> <li>• The fruit flesh is orangish-brown with black seed</li> </ul>

*Magnolia champaca* flowers have larger and wider flower crowns. Apart from that, there are many petals and actinomorpha. The yellow cempaka flower buds are larger and have an oval shape. The pistil of the flower has a short stalk arranged in a spiral manner which contains many ovules which can be seen in Fig. 4. The flower is hermaphroditic with curved and short stamens. The flowers on yellow cempaka are wider but thinner. Yellow cempaka fruit is a breed or polyculus fruit. Baka fruit or polyculus fruit is a fleshy fruit. Apart from that, cempaka fruit is an aggregate or clustered fruit.



**Fig. 4.** Organ placement, A) Reproductive organs, B) Inner and outer petals.

## 4 Discussion

The developmental stages of flower formation are the initial phase of the flowering and fertilization process, starting from the formation of generative buds or flower primordia buds until the flowers bloom. The flower development process lasts 24-26 days, starting from the emergence of generative buds in the leaf axils. The flower buds are located in the leaf axils, light green in color and about 0.4–0.5 cm long. In this type of plant, the generative buds are light green in the leaf axils or pseudoaxillary in the brachyblast. Around the buds there are fine white hairs. Next, the generative buds enlarge and begin to layer. The buds then turn yellow, the bud layer opens and releases a fragrant aroma. As the flowers develop, the fragrance of the *Magnolia champaca* flowers increases, this is in line with Naimah's opinion [5] that *Cananga odorata* flowers start to be green at the beginning of the blooming phase and gradually turn yellow when they reach full development. The fragrance of flowers changes during the development stages. Initially, from the initial bud stage until the flower fully blooms, there is no strong aroma. As the flowers mature, their fragrance increases, with the highest levels of fragrance occurring in the final stages of flowering. The enlargement of flower buds indicates the process of formation and development of the ovaries and reproductive organs, namely the pistil and stamens. A few days later, the flower blooms and releases a fragrant aroma. This flower only blooms briefly, then falls off. The fertilized stigma develops into a fruit bud.

The stamens are visible at the base when the flower opens, while the pistils are arranged spirally in a bunch. Monoecious flowering type. The pistil is located higher than the stamens, so the reproductive structure is hypogynous (Figure 4). The elongation of the pistil functions to facilitate pollination by moving the stigma away during the development stage of the female organ. Therefore, pollination requires the help of a pollinator or pollinator. With fragrant flowers and striking colors, it is thought that the pollinators of this plant are insects. The pollination and fruit/seed formation phase begins when the stamens attach to the stigma. Pollinated flowers can be identified by their flower crown. During observations, researchers found black ants (*Dolichoderus thoracicus*) walking on yellow shoots. Meanwhile, according to Figlar [7] and Orwa [8], pollination is assisted by beetles. This is in line with Zumaidar's statement [9] that the insects that visit *M. champaca* are Coleoptera, Hemiptera, Hymenoptera, Lepidoptera, and Thysanoptera. After pollination, the fruit/seed growth phase begins. If fertilization cannot occur then there are several factors that cause fertilization not to occur, one of which is an imbalance in the formation of gametes during the meiosis process to form pollen, which will later produce high levels of pollen infertility. This can cause no seeds [10].

The fruit formation process begins after the flower components (tepals, stamens, and pistil heads) wither and fall off. The fallen flower leaves behind bumps arranged spirally on a whitish-yellowish cluster (group of ovaries). It starts from day 26 and continues until day

70. At the tip of each bump, there are remnants of the pistil, which are brown in color. In one cluster of fruit, there are 5-30 fruits. Initially, the fruit is reddish-green with white spots. Then, the fruit skin will split on one side, causing the seeds and membranes to fall out. The remaining fruit skin will darken and dry up. This is in line with the opinion of Ozisik [7] that the type of fruit is Dehiscent Dry Fruit, meaning the fruit will open so that the seeds will jump out. The old fruit has a dark skin with white spots and is very hard.

In Aceh, *Magnolia champaca* flower is commonly used in traditional medicine due to its fragrance [6]. One example is its use as one of the scattered flowers in the Ranup Lampuan dance, as a symbol of honor and welcome for visitors. Additionally, *Magnolia champaca* flower is often used in bridal hairpins for women. *M. champaca* contains secondary metabolites that function as antioxidants and have potential as antiinflamasi agents. The ingredients contained in *M. champaca* can be used to be developed into medicinal compounds, so that *M. champaca* can be used as a potential source of treatment [9]. Metabolites in plants have an important role in plant growth and development, and are a source of phytochemicals involved in protection against stress, herbivory and disease in plants but are also beneficial in human nutrition and health.

The essential oil found in *Magnolia champaca* flowers contains phenol, isoeugenol, cineol, benzaldehyde, and phenylethyl alcohol [11]. Research by Masrura [12] indicated that the initial observed in *Magnolia champaca* flower extract is linalool with an area of 46%, supported by previous research stating that the chemical compounds produced from *Magnolia champaca* are linalool and beta-caryophyllene [13]. Linalool is known as one of the active compounds in essential oils that has sedative effects. Linalool, classified as a terpenoid alcohol compound, is liquid, colorless, and has a pleasant aroma [14]. Several studies also indicate that linalool can act as an anticancer agent [15].

The groups found in *Magnolia champaca* extract are monoterpenoids, sesquiterpenes, terpenoids, and steroids. Sesquiterpene groups are the most abundant in *Magnolia champaca* extract. There are 76 volatile compounds were identified on *Magnolia champaca*. *Magnolia champaca* have oxygenated monoterpenes and sesquiterpene hydrocarbons. This compound contributes to the antibacterial properties of the extracts. These extracts demonstrated more potent antibacterial effects against Gram-negative bacteria than Gram-positive bacteria [16].

## 5 Conclusions

The development stages of the *M. champaca* flower and fruit begin with the emergence of generative buds, followed by flower blooming, formation of withered flowers and tubers, development of fruit buds, ripening of fruits, and finally, blackening of the fruit. The flowering process lasts for 1-26 days, followed by a fruiting development period lasting approximately 70 days. The reproductive type is classified as monoecious hypogynous, while the fruit type is classified as dehiscent dry fruit. This study aims to understand the duration and morphological characteristics of its development, and to determine the value of reproductive success. Understanding reproductive success is very important for formulating strategies related to the number of trees, genetic diversity and tree density needed to develop plants as producers of seeds or seeds with optimal quality and quantity.

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