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The Inflorescence and Infructescence Morphology of *Phaleria macrocarpa* (Boerl.) Scheff

Morfologi bunga dan buah *Phaleria macrocarpa* (Boerl.) Scheff

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Abstract

The importance of *Phaleria macrocarpa* fruits is well known in traditional medicine to treat cancer, high blood pressure, impotency, insomnia, influenza, rheumatism, allergies, heart disease, bladder complaints, uric acid and liver problems. This led to studies on its phytochemicals and their functions, but very few were focused on the structures of flower and fruits. Hence, this study aims at determining the development of the structure of *Phaleria macrocarpa*'s flowers and fruits including the seeds. Tagging methods and observation of the anatomy and morphology of the flowers and fruits were carried out at Taman Herba Universiti Pendidikan Sultan Idris. *Phaleria macrocarpa*'s flower is tubular shaped, whitish, fragrant, perfect flower with four sepals, four or five petals, 8 stamens and a carpel with floral formula $K^{4}_{br}\ C^{(4[5])}_{br}\ A^{8}\ G^{\underline{1}}$. The inflorescences are umbel type, borne from all over the tree, down the trunk and the branch axils. The development of the fruit took 80 – 90 days after flowering. The colour of matured fruit is green and turns to brightly red or maroon when it ripens. The fruit is round or elliptical in shape, 3 – 5 cm in diameter of matured fruit, simple fleshy fruit in drupe form with one or two seeds. It is dicotyledonous with exalbuminous seeds type.

Keyword *Phaleria macrocarpa*, perfect flower, fruit, seed, traditional medicine

Abstrak

Kepentingan buah *Phaleria macrocarpa* terkenal dalam perubatan tradisional untuk merawat kanser, tekanan darah tinggi, mati pucuk, insomnia, selesema, sakit sendi, alahan, penyakit jantung, masalah pundi kencing, asid urik dan masalah hati. Ini menggalakkan kajian ke atas fitokimia dan fungsi mereka tetapi sedikit yang memberi tumpuan kepada struktur bunga dan buahnya. Oleh itu, penulisan ini berdasarkan kajian untuk menentukan perkembangan struktur bunga, buah dan biji *Phaleria macrocarpa*. Kaedah penandaan dan pemerhatian anatomi dan morfologi bunga dan buah telah dijalankan di Taman Herba, Universiti Pendidikan Sultan Idris. Bunga *Phaleria macrocarpa* berbentuk tiub, warna putih, mempunyai bau yang harum, bunga sempurna dengan empat sepal, empat atau lima kelopak, lapan stamen dengan formula bunga $K^{4}_{br}\ C\ ^{(4\,[5])}_{br}\ A^{8}\ G^{1}$. Jambak bunganya jenis umbel dan muncul di seluruh pokok terutama batang dan ketiak cabang. Pertumbuhan buah mengambil masa 80 – 90 hari selepas berbunga. Warna buah yang matang adalah hijau dan bertukar menjadi merah terang atau merah hati apabila masak. Buah berbentuk bulat atau

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lonjong, buah matang berukuran 3 – 5 cm diameter, berisi ringkas jenis drup dengan satu atau dua biji dikot dengan biji jenis exalbuminus.

Kata kunci *Phaleria macrocarpa*, bunga, buah, biji, perubatan tradisional

Introduction

P. macrocarpa is a member of Family Thymelaeaceae, locally known as *Mahkota Dewa.* It is originated from Papua, Indonesia and distributed in the South East Asia. *P. macrocarpa* can grow up to three meter in height, with distinct red fruits. *P. macrocarpa* has been used traditionally to cure diseases and health ailments such as high blood pressure, impotency, insomnia, influenza, rheumatism, allergies, heart disease, bladder complaints, uric and liver problems. Scientific researches successfully proved that the fruits contain anti-histamine which is very important to treat the allergy symptoms such as difficulty breathing, itchiness and also skin eruption (Abdul Aziz, 2009), and latest findings have shown potential in cancer treatment (Harmanto, 1998; Madhuril & Pandey, 2009; Faried *et al*., 2007) and as anti-oxidant, anti-inflammatory and cytotoxicity agent (Hendra *et al*., 2011). There are some important constituents in the fruit's extracts studied such as icariside C3, phalerin and mangiferin due to vasorelaxant activity (Oshimi *et al.*, 2008), 29-Norcucurbitacin derivatives (Dikdik *et al.,* 2008), gallic acid as an anticancer compound (Manduril & Pandey, 2009; Faried *et al.*, 2007) and antitoxicity effect (Suatma *et al.*, 2008).

Most studies on this plant focused on the chemical constituents from stem, leaves and fruit extracts and their biochemical activities (Dikdik *et al.* 2008; Suatma *et al.*, 2008; Oshimi *et al*., 2008; Kintoko & Lope Pihie, 2006). The findings show that the fruits have some active substances such as alkaloid, saponin, flavonoid and polifenol. Other than fruits, some researches had focussed on *P. macrocarpa*'s leaves. A 3, 4, 5-trihydroxy-40-methoxybenzophenone-3-O-b-D-glucoside, named as phalerin, has been isolated from the leaves of *P. macrocarpa*, which showed cytotoxicity against myeloma cell line (NS-1) (Hartati *et al*., 2005). The chloroform extracts of *P. macrocarpa*'s leaf was found to have an antiproliferative effect when evaluated *in vitro* on three human cell lines (HeLa, HM3KO, MCF-7) and normal cell line (Chang's liver) using methylene blue assay (Kintoko & Lope Pihie, 2006).

A study on the structure and development of *P. macrocarpa* has been ignored as it is tedious and it takes quite a long time for the plant to flower and fruit. Nonetheless it is very important to understand the flower and fruit development of *P. macrocarpa* as to determine the best developmental stage to optimize the production of important constituents of the plant.

Methodology

Tagging

Tagging method was modified from Alimon *et al.* (2005) and the flower was tagged by using threads. The widely open flowers were tagged using different colour of threads on the different day. This method is used in order to see the different stages of the development of the fruits and seeds by referring to the colour of the thread.

Observation

The observation of *P. macrocarpa* has been carried out to both organs; flower and fruit development. The widely open flowers were observed, sectioned and photographed under the light microscope. The structure of the flowers and fruits were sketched. Identification of the detail structures was carried out by the plant taxonomist. Herbarium sheets of the specimens are prepared and deposited in Biology department herbaria.

Results and Discussion

a. Floral morphology and development

P. macrocarpa produces fragrance flower with tubular in shape and white in colour. The development of flowers takes place for seven days. Early budding is green in colour and begin to change into white colour on the fourth day. On the fourth day, the budding is 0.8–0.9 cm in length. On the sixth day, one day just before the bloom the length of the budding is 1.6 - 1.7 cm. *P. macrocarpa* is a flowering plant with perfect flowers; having both stamens and carpels in the same flower (Figure 1). It is also a complete flower with four floral whorls; sepals, petals, stamens and carpel. *P. macrocarpa*'s flower has four parts; four sepals, four to five petals, 8 stamens and only one carpel with long style and rounded stigma. There are often same numbers of petals and sepals and they may appear alternately when viewed from the centre of the flower (Rudall, 2007; MacAdam, 2009).

The flower is quite special because its petals are fused together; this flower is called as sympetalous or also known as gamopetalous. Sympetalous is a compound structure made up of fused petals (Mauseth, 1988). The form of corolla is regular and gamopetalous with tubular shape; when the corolla is cylindrical or tube-like (Dutta, 1995). The flower of *P. macrocarpa* is biradially symmetrical. The arrangement mode of the sepals or petals, more particularly the later, in a floral bud with respect to the members of the same whorl is known as aestivation. *P. macrocarpa*'s aestivation of the flower is tubular type because the members of a whorl make contact with each other by their margins, or when they lie close to each other without overlapping (Dutta, 1995).

The carpel of *P. macrocarpa*'s flower consists of rounded shape of sticky stigma with long style and its ovary is covered with the fusion petals. Male organs called stamens consist of oval shaped anther and brown in colour, very short filament attached to the petals' wall. This flower has both stamens and carpel in the same flower. *P. macrocarpa* is monoecious plant due to its flower bearing both stamens and carpels (Dutta, 1995; MacAdam, 2009).

The relative position of calyx, corolla and androecium, give the different type of ovary's position. The ovary position of *P. macrocarpa's* flower cannot be classified into *hypogynous*. It is because *hypogynous* ovary as sepals, petals, stamens is attached below the ovary and with no fusion. On the other hands, it is also hard to classify it into perigynous, in which sepals, petals and stamens fused together to form a cup shaped extension of receptacles which enclosed all of them on the rim of *hypanthium*. The perigynous ovary is half-inferior or maybe sunken in the receptacle (Dutta, 1995). Nevertheless, *P. macrocarpa* has tubular inserted epipetalous, in which petal and sepal are fused, not differentiated, and stamens are in tubular perianth where stamens are inserted in certain points at the petal, and therefore it is classified as *hypogynous*.

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The type of flower's inflorescence is umbel due to one to four flowers borne at a peduncle. Besides that, the peduncles may have one to three at a point at all over the tree, down the trunk and the branch axils (Dutta, 1995). The flowers of *P. macrocarpa* bloom throughout the year and mostly drop off to the ground. Very few of the flowers will successfully develop to mature fruits. Some of the young fruits may drop off during the development before reaching the maturation stage.

Flower formulas are a short hand way of depicting about a flower. The floral formula for *P. macrocarpa*'s flower can be written as K^{4}_{br} $C^{(4[5])}_{br}$ A^{8} $G^{\underline{1}}$. The formula translates to the *P*. *macrocarpa*'s flower has four free calyx with biradial symmetry; four corolla but rarely has five corolla with fused petals and biradial symmetry; eight stamens; gynoecium is unicarpellate, the ovary position is superior.

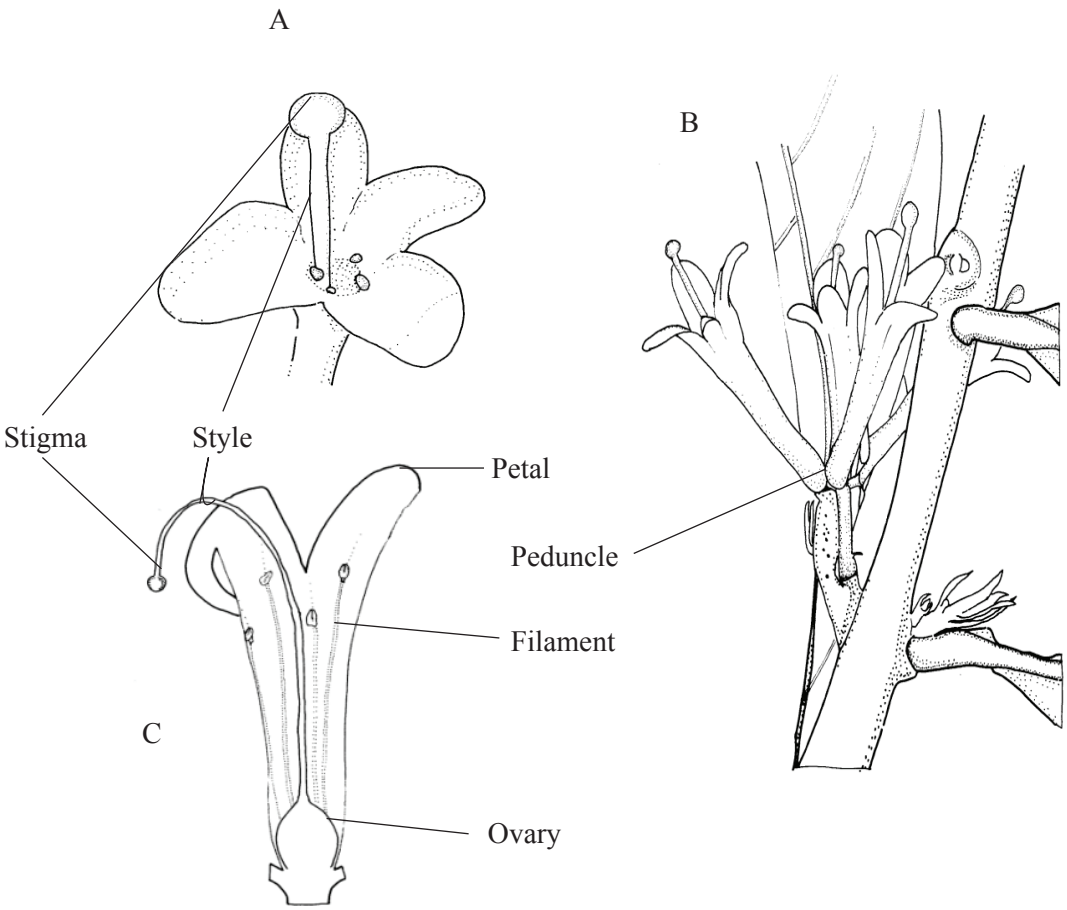

Figure 1 Flower of *P. macrocarpa*; (A) widely opened flower; (B) flowers' inflorescence on a peduncle; (C) cross section of a flower showing petals, style and round stigma.

b. Fruit morphology and development

The development of the widely open flowers to the ripe fruit is about 80–90 days. *P. macrocarpa*'s fruit is classified as simple fruit with one fruit develops from one carpel or

several united carpels of a flower with or without accessory parts (Dutta, 1995). It has one or two seeds in each fruit developed. Based on the observation, the fruit with one seed has asymmetrical shape compared to the fruit with two seeds, which is bilaterally symmetry. The young fruit has tiny skin with green colour but it will turn to bright red or maroon when it becomes ripen. Otherwise, if the green young fruit is taken, its skin also will turn to maroon if it is placed at room temperature for a few days. The pulp of the fruit is thick, white in colour. The seeds are located at the inner part covered with hard, stony endocarp. In the cross section vision, the hard endocarp is tightly attached to the fibrous pulp (Figure 2). Its white pulp looks like *Areca catechu's pulp*.

The fruit has three main parts which are pericarp, mesocarp and endocarp. Fruits derived from a single ovary have a fruit wall call pericarp, which is typically derived from ovary wall (Rudall, 2007). It is typically divided into three layers which are the outer exocarp, central mesocarp and inner endocarp. The simple fruit type of *P. macrocarpa* is fleshy in the form of drupe, with one or more chambered and one or more seeded fruit developing from a monocarpellary or syncarpous pistil. The pericarp differentiates into the epicarp which forms the skin of the fruit. The mesocarp is often fleshy and the endocarp is hard and stoney. Hence this fruit is also known as stone-fruit such as mango, plum and peach (Dutta, 1995).

Referring to Dutta (1995), the seeds of *P. macrocarpa* can be classified as exalbuminous with seed coats consist of two free layers; the outer layer is called testa and the inner is tegmen, and are provided with hilum; representing the attachment with the stalk, micropyle and raphe; a ridge form by the funicle or stalk in many seeds. The embryo lying within consists of an axis and two fleshy cotyledons laden with food material. The outer layer of *P. macrocarpa* seed coats is thin, soft and white in colour, whilst the second layer, tegmen is thicker, harder and dark brown.

P. macrocarpa's seed is located in the stony endocarp with two outer layers. The first outer layer is white colour, very thin and soft but the second layer is thicker, dark brown and quite hard. This cotyledon is attached at *hilum*. The opposite site of the attachment is where the cotyledon is attached to the stalk from the bottom of the attachment until to the top of cotyledon which is called *raphe*.

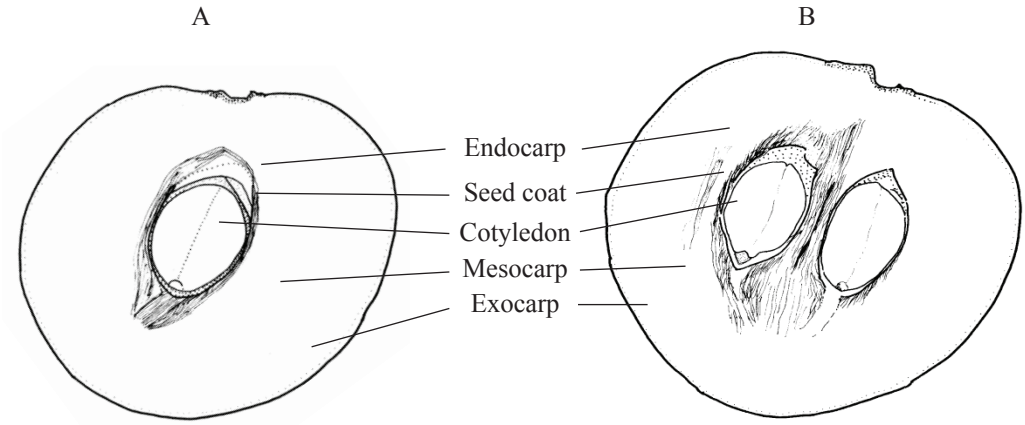

Figure 2 *P. macrocarpa* fruits. (A) cross section of one-seeded fruit; (B) two-seeded fruit.

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Conclusion

This study is focusing on the development of flowers and fruits of *Phaleria macrocarpa*. The development period of flowers from budding until widely open is seven days and the development of fruit until ripen is about 80-90 days. The flower is tubular shape, white and fragrance. The ovary is superior with tubular aestivation and the floral formula is $K^{4}_{br}\ C^{(4[5])}_{br}\ A^{8}\ G^{\underline{1}}$. The fruit is simple fleshy with drupe form, dicotyledonous seeds with exalbuminous seeds type.

Acknowledgements

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