

Anatomy and Developmental Morphology of Medicinal Plants *Jatropha curcas* and *Jatropha podagrica* (Euphorbiaceae)

*Kajian Anatomi dan Perkembangan Morfologi Tanaman Ubatan *Jatropha curcas* dan *Jatropha podagrica* (Euphorbiaceae)*

Wun Sun Jie, Nor Nafizah Mohd Noor, Norhayati Daud, Fatimah Mohamed and Hasimah Alimon
Department of Biology, Faculty of Sciences and Mathematics, Universiti Pendidikan Sultan Idris,
35900 Tanjong Malim, Perak Darul Ridzuan, Malaysia
e-mel: norhayati.daud@fsmt.upsi.edu.my

Abstract

The anatomy, morphology and fruit development of two species of *Jatropha*, namely *Jatropha curcas* and *Jatropha podagrica* were studied. Anatomical character of *J. curcas* and *J. podagrica* are of taxonomic significance for species delimitation, especially the outline of abaxial lamina, presence of secretory cells in lamina, outline of midrib, arrangement of vascular tissues in midrib and location and type of crystals in the petiole. Morphologically, the leaf of *J. curcas* has acute apex, cordate base and glabrous with five slight lobes while *Jatropha podagrica* has short acuminate apex, peltate base and glabrous with deep lobes. The Development of *J. podagrica* fruit was studied especially on the changes of pericarp, endosperm and embryo

Keywords *Jatropha curcas*, *Jatropha podagrica*, anatomy, morphology, fruit development

Abstrak

Anatomi, morfologi dan perkembangan buah dua spesies *Jatropha* telah dikaji. Karakter anatomi *J. curcas* dan *J. podagrica* mempunyai nilai taksonomi dalam membezakan antara spesies terutamanya garis bentuk lamina bahagian abaxial, kehadiran sel perembes, garis bentuk midrib, susunan tisu vaskular di midrib dan lokasi kristal dalam petiol. Dari segi morfologi *J. curcas* adalah tirus di hujung, kordat pangkal dan berbentuk glabrus dengan lima sedikit lobus manakala *J. podagrica* adalah runcing di hujung, berpangkal peltat dan berbentuk glabrus dengan lobus yang dalam. Perkembangan buah *J. podagrica* telah dikaji terutamanya pada perubahan perikarpa, endosperma dan embrio.

Kata kunci *Jatropha curcas*, *Jatropha podagrica*, anatomi, morfologi, perkembangan buah

Introduction

Accurate identification of medicinal plants is important. Plant anatomy, morphology and physiology critically contribute to plant identification (fundamental components of all aspects of plant biology). There are anatomical principles and generalizations such that a single microscope slide can provide great insight into the total biology of a plant

(Mauseth, 1988). Studies on the anatomy of plants have provided important informations for identification of plants and answers to structural and physiological problems.

According to Comor *et al.* (2009), the family Euphorbiaceae contains 290 genera and 750 species. The genus *Jatropha* comprises 165-175 species which have a disjunct distribution in seasonally dry tropical regions. *Jatropha podagrica* is a medicinal plant that is used in Ghana and Nigeria as antipyretic, diuretic, choleric and purgative (Bever, 1986). It also has ethnopharmacological uses as antihypertensive, treatment of gonorrhea, jaundice and shingles and used as mouthwash (Goh *et al.*, 1995). *Jatropha curcas* seed oil is used in local medicine in dropsy, sciatica, paralysis, worms and skin diseases in tropical West Africa (Bever, 1986). Its seed oil is important in the production of biodiesel (Ashwani & Satyawati, 2008). Table 1 shows that the anatomical comparison between *Jatropha curcas* and *Jatropha podagrica*.

The family Euphorbiaceae produces latex that contains alkaloids, lignans, phloroglucinol derivatives, terpenes, anthraquinones and cyanogens glycosides amongst others. *Jatropha curcas* contains a phytotoxin called curcin which is very toxic and should be used with caution. Most of its organs are used in traditional remedy preparation that include leaves, seeds, mature fruits, stems, roots and barks. Each organ is used to treat certain specific diseases. In general, it is used to treat ear disease, toothache, eczema, ringworm, scabies, sores, ulcers, cuts and abrasions, snake bites, sprains and to reduce pain after circumcision (Khatijah *et al.*, 2008).

Materials and Methods

Jatropha curcas and *J. podagrica* were collected from the herbal garden of UPSI. The morphology and anatomy of *Jatropha* was studied in this research. For morphological study, sample plants were observed in the field, then voucher herbarium specimens were prepared. In the anatomical study, microtechnique procedure of Nor Nafizah (2006) and Cutler *et al.* (2008) were applied. Anatomical slides of leaf margin, lamina, midrib and petiole were prepared. Leaf clearing procedure and epidermal preparation were also conducted for venation and epidermal observation. Data were collected and recorded through observation under light microscopy. Microimages were then captured by using Nikon eclipse 2000-U camera microscope. The development of fruit, process of flowering and fruiting were observed. The flower samples used in the study were tagged in order to make sure that the same flowers were under observation. Fruits in different developmental stages were also observed anatomically by undergoing dehydration infiltration and staining processes.

Results and Discussion

Leaf clearing of *J. curcas* and *J. podagrica* showed open main venation, branching of vein ending, incomplete marginal vein, lacking of areole and druses crystals scatter on the epidermis (Figure 1:A-D). According to Metcalfe & Chalk (1979), *Jatropha* contained clustered crystals in both the upper and lower epidermis.

Table 1 Anatomical comparison between *Jatropha curcas* and *Jatropha podagrica*

Species	<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>
Venation		
Main venation	Open	Open
Veinlets	Branching	Branching
Marginal vein	Incomplete	Incomplete
Areole	Lacking	Lacking
Crystals	Druses	Druses
Epidermis		
Anticlinal wall		
Adaxial	Straight	Straight
Abaxial	Straight	Straight
Stomata	Paracytic; present on abaxial only	Paracytic; present on adaxial and abaxial
Sclereids	Not seen	Present
Margin		
Shape	Tip obtuse & incurved	Tip obtuse & incurved
Sclerenchyma	Not seen	Not seen
Lamina		
Outline		
Adaxial	Flattened with slightly bumping	Flattened with slightly bumping
Abaxial	Flattened with slightly bumping	Papillated
Hypodermis	Not seen	Not seen
Palisade	1-2 layers	1-2 layers
Mesophyll	6-8 layers	10-12 layers
Sclereids	Not seen	Not seen
Crystals	Druses in mesophyll tissues	Druses in mesophyll tissues
Trichomes	Not seen	Not seen
Secretory cells	Not seen	Present
Midrib		
Outline		
Adaxial	Slightly convex	Slightly convex
Abaxial	Rounded to U-shaped	Rounded to V-shaped
Ground tissue		
Collenchyma cells	Both scattered around vascular bundles	Both scattered around vascular bundles
Parenchyma cells		
Vascular tissues		
Shape	V-shaped	U-shaped
Type	Open	Open
Sclerenchyma	Nil	Nil
sheath		
Trichome	Not seen	Not seen
Crystals	Druses in parenchyma and phloem cells	Druses in parenchyma and phloem cells
Secretory cells	Latisifers in ground tissues	Latisifers in ground tissues
Petiole		
Outline	Circular in shape with hollow centre	Circular in shape with hollow centre
Ground tissue		
Collenchyma	Both scattered around vascular bundles	Both scattered around vascular bundles
Parenchyma		
Vascular tissue		
Type	Open	Open
Shape	Separate bundles form in ring with medullary bundles	Separate bundles form in ring with medullary bundles
Trichome	Not seen	Not seen
Crystals	Druses in parenchyma cells	Druses in parenchyma and phloem cells
Secretory cells	Present	Present

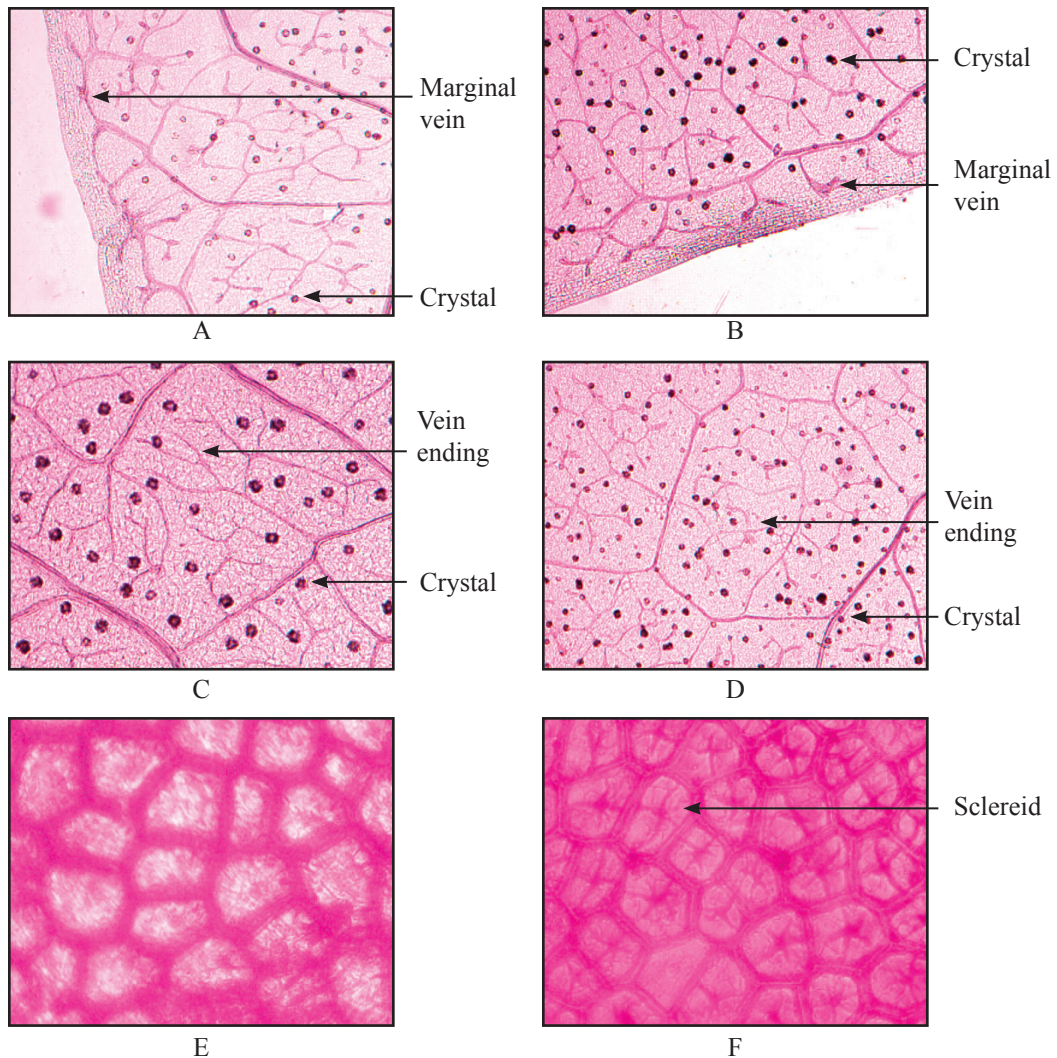


Figure 1 Leaf venation and epidermal characters. A: Incomplete marginal venation of *J. curcas*. B: Incomplete marginal venation of *J. podagrica*. C: Branching veinlet of *J. curcas*. D: Branching veinlet of *J. podagrica*. E: Adaxial epidermis of *J. curcas*. F: Adaxial epidermis of *J. podagrica*. (Magnification = 5x10 A-D; 40x10 E-F)

Anticlinal walls of adaxial and abaxial epidermis are straight with paracytic stomata. Stomata are confined to the lower surface; occurring more rarely on both surfaces (Metcalf & Chalk, 1979). The margin for both *Jatropha* species are in tip obtuse and incurved shape. *Jatropha curcas* has flattened with slightly bumping outline for both abaxial and adaxial lamina while *J. podagrica* has flattened with slightly bumping outline for adaxial lamina and papillated outline for adaxial lamina (Figure 2:E&F). *Jatropha podagrica* has thicker spongy mesophyll than *J. curcas*. Druses were abundant in the mesophyll of *J. curcas* but secretory cell was not seen; however, secretory cells were found in the lamina of *J. podagrica*.

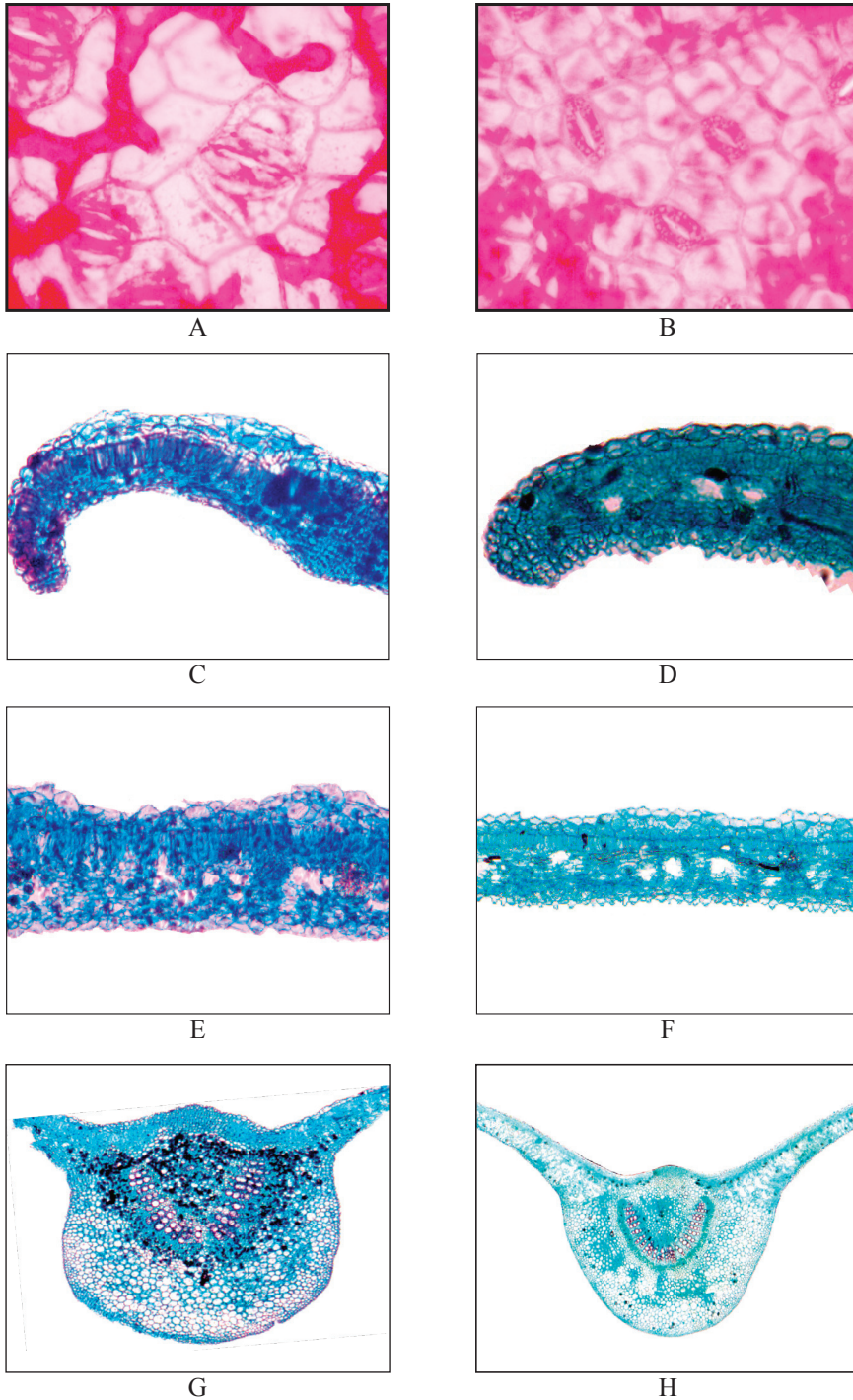


Figure 2 A: Abaxial epidermis of *J. curcas* with stoma (arrow). B: Abaxial epidermis of *J. podagrica* with stoma. C: Margin T.S of *J. curcas*. D: Margin T.S of *J. podagrica*. E: Lamina T.S. of *J. curcas*. F: Lamina T.S. of *J. podagrica*. G: Midrib T.S. of *J. curcas*. H: Midrib T.S. of *J. podagrica*. (Magnification = 40x10 A-B; 10x10 C-H)

Both species are different in the outline a abaxial in midrib: *J. curcas* has rounded to U-shaped outline while *J. podagrica* has rounded to V-shaped outline. Both species have slightly convex adaxial outline. The vascular tissues of *J. curcas* is V-shaped while that of *J. podagrica* is U-shaped. The vascular bundles are generally collateral (Metcalf & Chalk, 1979). Therefore, the outline of abaxial and the shape of vascular tissues in the midrib form an important traits in distinguishing both species.

The petioles of *Jatropha* are similar with the midrib. The little differences occur in the outline of the petiole whereby the petiole outline of both *Jatropha* species are circular in shape with hollow centre. The vascular tissues are arranged in separate bundles formed in a ring with medullary bundles.

The development of *Jatropha podagrica* fruit structures were identified based on the book by Rudall (2007). *Jatropha podagrica* fruits are shallowly longitudinally grooved and trilocous (Goh *et al.*, 1995). Fruits in weeks 2, 5 and 8 showed free central placentation (Table 2). The caruncle on the seed functions as an oil-body to attract ants as agents of

Table 2 Development of *J. podagrica*'s Fruit

Fruit	Week 2 (Figure 3C)	Week 5 (Figure 3D)	Week 8 (Figure 3E)
Placentation	Free central	Free central	Free central
Pericarp	Thin exocarp with one layer cells, mesocarp possess multilayered parenchyma cells	Thin exocarp with two layer cells, mesocarp possess multilayered spongy parenchyma cells, endocarp lignified	Two layer cells of exocarp, mesocarp possess multilayered spongy parenchyma cells, endocarp is lignified
Endosperm	Present and attached with integument	Well developed, not attached to integument (right side), endosperm developing (left side)	Consists of loosely parenchyma cells
Embryo	Not seen	Developing	Fully developed with endosperm

dissemination (Rendle, 1979). Fruits of week 2 are with thin exocarp. The mesocarp contains parenchyma cells which are not well developed and tightly packed together. The parenchyma cells become spongy and thicker in weeks 5 and 8. The endosperm begins to appear in week 2 while the embryo begins to develop at around week 5 and becomes well developed in week 8 within the endosperm which serves as nutrient reserves in seed (Esau, 1977). The endocarp starts to lignify at around week 5 as lignin layer could be observed above the outer integument which becomes lignified in week 8 as it is preparing to split.

Comparing *J. curcas* and *J. podagrica*, they share similar morphological characteristics, including venation, margin and colour of leaves as they are within the same genus (Table 3). Leaves are arranged alternately with palmately veined. Secretory cells were observed in both *Jatropha* midrib and petiole while also present in the lamina of *J. podagrica*. These plants usually have laticifers which commonly are articulated or non-articulated (Watson & Dallwitz, 1992). The juice is acrid and in many species, milky form indicating the presence

Table 3 Leaf morphological comparison between *J. curcas* and *J. podagrica*

Species	<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>
Leaves		
Apex	Acute	Short acuminate
Venation	Reticulate, palmate, divergent, basal, marginal, actinodromous, perfect	Reticulate, palmate, divergent, basal, marginal, actinodromous, perfect
Shape	Broadly ovate, glabrous with 5 slight lobes, symmetrical	Oval with 3-4 distinct and deep lobes, glabrous, symmetrical
Base	Cordate	Peltate
Margin	Entire	Entire
Colour	Green	Green
Width	12.0-15.0 cm	15.0-17.0 cm
Length	10.0-12.0 cm	15.0-17.5 cm

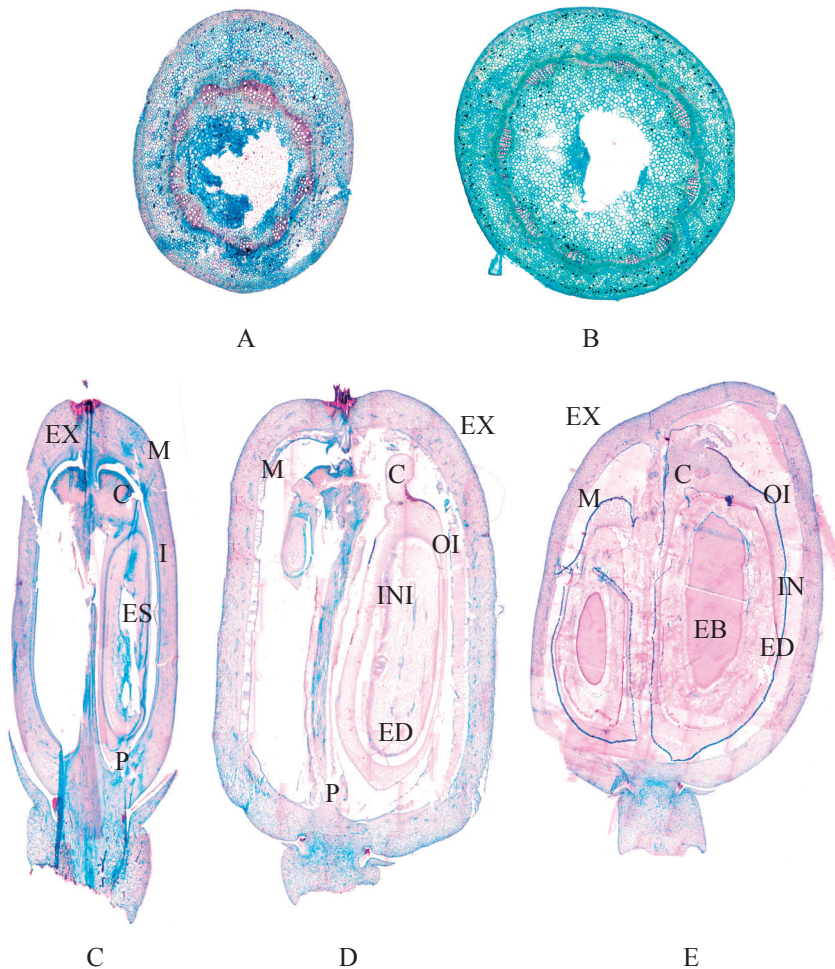


Figure 3 A: Petiole T.S. of *J. curcas*. B: Petiole T.S. of *J. podagrica*; Fruit T.S of *J. podagrica*. C: Fruit in week 2. D: Fruit in week 5. E: Fruit in week 8. (Magnification = 10x10) (EX-exocarp; M-mesocarp; C-caruncle; I-integument; ES-embryo sac; P-placenta; OI-outer integument; IN-inner integument; ED-endosperm; EB-embryo)

of starch, gums and resins (Swingle, 1946). Both *Jatropha* are monoecious plant with both staminate and carpellate flowers occurring on the same plant. The flowers are small. Fruits are dehiscent and capsular schizocarp (Wiart, 2000).

Jatropha podagrica flowers are unisexual (Wiart, 2000) with male and female flowers usually occurring on the same plant. They are radially symmetrical. Female flowers are hypogynous with superior ovary while male flowers have numerous stamens. Observation of growth revealed female flowers grew and bloomed earlier than male flowers which grew and surrounded the female flowers at the centre. This is to ensure chances of pollination. The flowers are male bias.

Conclusion

Both *Jatropha* species varied in shape, lamina, apex and base of leaf but similar in venation, margin and colour of leaves. In the aspect of anatomy, both *Jatropha* species are similar in their venation and epidermis but show differences in the outline of abaxial lamina, presence of secretory cells in lamina, outline of midrib, arrangement of vascular tissues in midrib and location of crystals in the petiole. These differences in anatomical characters could be used in identification of the species. The exocarp of *J. podagrica* fruit is thin and the mesocarp consists of parenchyma cells which became spongy in week 5. The endosperm started to appear in week 2 while the embryo began to develop and the endosperm lignified by week 5.

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