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Comparative morphology and stem anatomical studies of genus *Stereospermum* cham. (Bignoniaceae) in Kerala

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Abstract

Anatomical studies of the stem of three species of *Stereospermum* viz., *Stereospermum suaveolens*, *Stereospermum colais*, *Stereospermum colais* var *shendurunii* coming under Bignoniaceae were carried out and compared. The genus *Stereospermum* is one of the medicinal plants in Dasamula, which is extensively utilized for the preparation of various Ayurvedic formulations. Three species are commonly known as *pathiri* or *padal* in different localities. After taxonomic confirmation, stem anatomy of the three species of *Stereospermum* as per standard procedures was carried out. These species are distinct in their morphology and stem anatomical characters. Diagnostic keys were prepared, which can be used as a taxonomic tool for the delimitation of the species coming under *Stereospermum* as well as to ascertain the identity of *pathiri*.

Keywords: *Stereospermum*, pathiri, dasamula, bignoniaceae

Introduction

The genus *Stereospermum* Cham. is reported to have 24 taxa distributed in tropical Asia and tropical Africa [1]. Clarke [2] reported nine species from British India while three species are reported from Kerala [3]. *Stereospermum colais*, which is an important medicinal plant occurring in moist and semievergreen forest and plains throughout Kerala. *Stereospermum colais* var *shendurunii* is endemic to southern Western Ghats. *Stereospermum suaveolens* (G Don) DC restricted to the moist deciduous forests of Wayanad district. Among these *Stereospermum colais* roots are extensively utilized for the preparation of various Ayurvedic formulations such as dasamularishtam, chyavanaprasa and Agastyarasayanam [4]. Its close morphological resemblance the identification of the species is too difficult. Normally identification and delimitation of the group is possible only in the reproductive stage, especially based on corolla morphology. In these circumstances in order to identify the plant species in the vegetative stage stem anatomy were studied and its taxonomic significance is discussed for the first time.

Materials and methods

Collection and authentication of the plant: Three species of *Stereospermum* were collected from different localities in Kerala. Specimens of all species were collected in the flowering stage, studied their morphology, compared with authenticated specimens and determined their taxonomic identity. Voucher specimens were deposited in the Regional Herbarium of Kerala.

Microscopic studies: The materials for anatomical study were fixed in Formaldehyde- Acetic acid Alcohol mixture. Staining was carried out according to standard procedure [5] Anatomical microphotographs were transferred using the computer controlled microscopic system and camera. Trinocular 'Leica DM 3000' microscope attached with 'Leica DFC 295' digital camera connected to the computer and Leica Application Suite software was used for the observation and transferring microscopic images of the samples. Images are examined thoroughly and compared the anatomical characteristics.

Observations and results

***Stereospermum colais* (Buch.-Ham. ex Dillw.) Mabb [1].**

Large trees, up to 30 m high; bole rough; bark 1.2 cm thick. Leaves compound, imparipinnate, opposite, stipulate; rachis 10-21 cm long, slender, puberulent, swollen at base; leaflets 7-13, opposite; lamina 4.5-13 x 2-4.5 cm, elliptic-lanceolate, elliptic-oblong, ovate or obovate; base oblique, acute or obtuse; apex acuminate or caudate acuminate; margin entire or serrate, glabrous above and puberulent beneath; intercostae reticulate. Flowers bisexual, yellow veined with red, 2 cm long, in terminal drooping panicles; calyx 6 mm long, campanulate, shallowly

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lobed, lobes 3-5, dorsal lobe much larger than the others, puberulent, tube 1.2-1.5 cm, obtuse; corolla 2 x 1.5 cm across, infundibuliform, pubescent inside, base glandular hairy, lobes 5, subequal, crisped; stamens 4, didymous, divaricate; filaments unequal, smaller ones 1-1.2 cm, larger to 2.2-2.5 cm, simple and hairy below; anthers divergent, ca. 5 mm, oblong, included, staminodes present; ovary sessile, oblong, superior, 2-celled, syncarpous; many ovuled, 1 seriate; style slender; stigma 2, spoon shaped. Fruit a capsule, to 35 x 0.7 cm, subtetragonus, tapering at apex and base, epicarp thin, spirally splitting; seeds 8 mm long, wings obtuse at both ends.

Stem anatomy

TS almost circular in outline. Outer margin is ruptured at places due to the presence of lenticels. Cork is thick walled followed by cortical cells and phloem region cambium is seen in between xylem and phloem. Pith is wider zone. Fibre patches seen scattered to cortical region. Cork consists of 8-10 layered thick walled lignified cells. Cells are squarish to rectangular in shape. Cortex region is parenchymatous thin wallets with intercellular spaces. 15-20 layers are seen in cortical region. Sometime outer cortex is collenchymatous pericyclic fibre patches of varying size are seen in cortical region. Some of the cortical cells are filled with coloured matter. Phloem cells are condensed and compactly arranged. Phloem fibres are arranged continuously in the form of a ring, sometime it may be discontinuous. Cambium is present. Xylem elements are lignified. Medullary rays are uni or biseriate. Medullary ray cells are extending towards phloem region. Medullary ray cells are enriched with numerous starch grains. Vessels are round to oval in shape and varying in size. Vessels are seen in single or groups of 2-5. Pith is a wide zone made up of loosely arranged parenchyma cells. All the pith cells are enriched with numerous starch grains (Fig.d-f).

Stereospermum colais (Buch.-Ham. ex Dillw.) Mabb. var. *shendurunii*

Tall trees. Leaves imparipinnate, opposite, rarely subopposite, estipulate; rachis 10- 30 cm long, pubescent when young, stout, swollen at base, grooved above; leaflets 7-9, opposite or subopposite; lamina 8-18 x 3-7 cm, elliptic-lanceolate, ovate, ovate-oblong to obovate; base obliquely acute or rounded, apex acuminate or caudate-acuminate, midrib pubescent above, margin entire, intercostae reticulate. Panicle terminal, erect, peduncle stout, to 30 cm long; flowers ca. 5 cm across, bisexual, pedicel slender, puberulent, calyx 5-lobed, lobes unequal, dorsal lobe much larger than the others, puberulent, tube 1.2-1.5 cm; corolla regular, infundibuliform, 5-lobed, three dorsal lobes with three red lines, two ventral lobes partially united, a purple blotch at the mouth of the corolla tube, throat yellowish inside, tube dark pink outside, pubescent inside, base glandular hairy; stamens 4, 371 didymous; filaments unequal, smaller ones 1-1.2 cm, larger to 2.2-2.5 cm, simple and glandular hairy below; anthers divergent, ca. 5 mm, oblong, basifixed; ovary, ca. 5 x 5 mm, oblong, glabrous, style terminal, ca. 2 cm long, stigma bilobed, clavate. Fruit a capsule, 20-80 cm long, pendulous, 4-angled, smooth, lenticellate, 2-valved, tapering at both ends, epicarp thick and woody; seeds 2.5-3 x 0.3-0.6 cm, many, fixed on the cylindrical central suture, 2-winged, greyish-white or yellowish white, wings lacerate at apex.

Stem anatomy

TS almost circular in outline. Outer margin is ruptured at places due to the presence of lenticels. Cork is thick walled followed by cortical cells and phloem region cambium is seen

in between xylem and phloem. Pith is a wider zone. Fibre patches seen scattered to cortical region. Cork consists of 8-10 layered thick walled lignified cells. Cells are squarish to rectangular in shape. Cortex region is parenchymatous thin wallets with intercellular spaces. 15-20 layers are seen in cortical region. Sometime outer cortex is collenchymatous pericyclic fibre patches of varying size are seen in cortical region. Single or groups of stone cells of varying sizes are alternating with fibre patches. Some of the cortical cells are filled with coloured matter. Phloem cells are condensed and compactly arranged. Phloem fibres are arranged continuously in the form of rings, sometime they may be discontinuous. Cambium is present. Xylem elements are lignified. Medullary rays are uni or biseriate. Medullary ray cells are extending towards phloem region. Medullary ray cells are enriched with numerous starch grains. Vessels are round to oval in shape and varying in size. Vessels are seen in single or groups of 2-5. Pith is a wide zone made up of loosely arranged parenchyma cells. All the pith cells are enriched with numerous starch grains and crystals of calcium oxalate (Fig.g-i).

Stereospermum suaveolens (G. Don) DC.,

Deciduous trees, to 25 m high; bark grey, exfoliating in flat scales; blaze dull yellow. Leaves compound, imparipinnate, opposite, estipulate; rachis 150-450 mm long, pubescent, slender, swollen at base; leaflets 5-11, opposite; petiolules 10-20 mm, slender, pubescent; lamina 7.5-16 x 5-7.5 cm, elliptic or ovate; base oblique, acute or unequally rounded; apex acuminate; margin entire or serrulate on young trees, shiny and glabrous above and pubescent beneath, coriaceous; lateral nerves 6-8 pairs, pinnate, prominent, puberulent beneath; intercostae reticulate. Flowers bisexual, dull crimson, in drooping panicles, pubescent, 18 mm long; calyx campanulate, hairy, lobes 3-5, short, broad; corolla 3-4 cm long, funnel shaped, pubescent outside, lobes 5 unequal, rounded, crisped; stamens 4; didynamous, included, staminodes present, anther divaricate; disc cupular, fleshy; ovary sessile, superior, 2-celled, syncarpous; ovules many; style slender; stigma 2. Fruit a capsule, 30-60 x 0.5 cm, nearly terete, grey, lenticellate; seeds 3 cm long, trigonus, with a transverse groove without and a prominent ridge within, wedge shaped, with a membranous wing with obtuse ends.

Stem anatomy

TS of the stem is circular in outline with wavy margin. Well-developed cork, wide cortex followed by phloem region and comparatively wide Xylem zone. Central region is occupied by large parenchymatous pith. The outer cork region consisting of 6-10 layers of irregularly shaped cells. Cortical region is very wide made up of 25 – 35 layers of parenchymatous cells with intercellular spaces. Cells of the outer cortex contains yellow depositions and some of the cells contain chlorophyll. Prismatic, acicular, rhomboidal and cluster crystals of calcium oxalate are distributed throughout the cortical cells. Pericyclic fibre patches of varying size are distributed in cortical region as a broken ring manner. Stone cells in groups or single can also seen in between pericyclic fibre groups. Phloem is 15-20 cell wide made up of compactly arranged condensed cells. 2-3 phloem fibre patches arranged in the form of ring in phloem region, Xylem consisting of tracheids, fibres, vessels and parenchyma. Cambium is distinct. Vessels are arranged radially and are seen in single or in group of 2-3. Medullary rays are uni to multi seriate. Pith is parenchymatous filled with crystals of calcium oxalate (Fig.a-c).

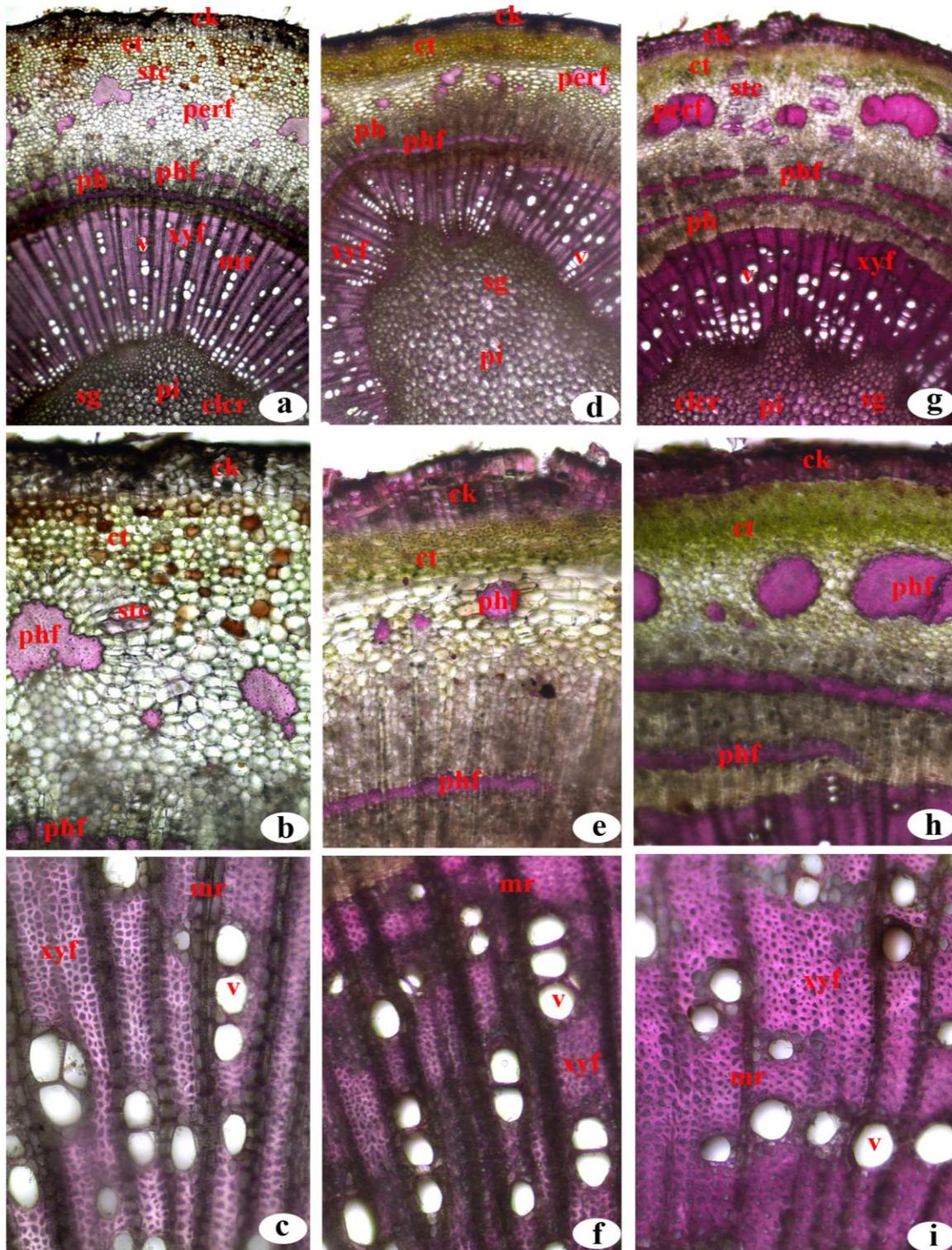


Figure 2. Anatomical comparison of the stems of *Stereospermum* spp. **a - c**, *S. suaveolens* (G. Don) DC. **d - f**, *S. colais* (Buch.-Ham. ex Dillw.) Mabb. **g - i**, *S. colais* (Buch.-Ham. ex Dillw.) Mabb. var. *shendurunii*. **ck**, cork; **clcr**, calcium oxalate crystals; **ct**, cortex; **mr**, medullary ray; **perf**, pericyclic fibres; **ph**, phloem; **phf**, phloem fibres; **pi**, pith; **sg**, starch grains; **v**, vessels; **xyf**, xylem fibres.

Table 1: Comparative morphological characteristics of *Stereospermum* Cham., species

Characters	<i>S. suaveolens</i>	<i>S. colais</i>	<i>S. colais var shendurunii</i>
Habit	Tree	Tree	Tree
Strength	Erect	Erect	Erect
Duration	Deciduous	Deciduous	Deciduous
Leaves	Imparipinnate, opposite	Imparipinnate, opposite	Imparipinnate, opposite
Stipule	Absent	Absent	Absent
Rachis	tomentose	tomentose	tomentose
Terminal leaf	simple	Normal	Normal
Petiolule	Present	Present	Present
Lamina margin	Entire or serrulate	Entire or serrate	Entire or serrate
Shape	Elliptic or ovate	Elliptic or lanceolate	Elliptic or lanceolate
Apex	Acuminate	Acuminate	Acuminate
Base	Oblique or acute	Acute or obtuse	Oblique or acute
Lamina	Pubescent	pubescent	Pubescent
Inflorescence	Panicle	Panicle	Panicle
Calyx	Campanulate	Campanulate	Tubular
Calyx lobe	3-5	3-5	5 lobed
Corolla	funnel	Infundibulum (funnel)	Infundibulum
Corolla lobes	crisped	crisped	regular
Stamen	4	4	4
Filament	Unequal, included	Unequal, included	Unequal, included
Staminode	Present	Present	present
Ovary	2 celled	2 celled, oblong	2 celled oblong
Stigma	2lobes	2 lobes, spathaceous	2 lobed
Fruit	Capsule, terete, trigonus	Capsule, subtetragonous	Capsule, tetragonous,
Seeds	winged	winged	winged

Table 2: Anatomical characteristics of studied *Stereospermum* Cham., species

Characters	<i>S. suaveolens</i>	<i>S. colais</i>	<i>S. colais var shendurunii</i>
Cork cells	6-10 celled, irregular in shape	6-8 layered, thick walled, compactly arranged	6-8 layered thick walled lignified
Yellow Deposit	Present in cortical region	Absent	Absent
Stone cells	Present in between the pericyclic fibres	Present in cork region.	Single or groups of stone cells in cortical region
Pericyclic fibres	Group of 2-3	Small in size	
Phloem fibres	2-3 arranged in ring manner	1-2 layered, arranged in ring manner alternate with phloem cells.	Phloem fibres alternate with stone cells
Parenchyma	paratrachel	Paratracheal	Paratracheal
Xylem fibres and	Present	Present	Present
Medullary rays	Uni- multiseriate	uni or biseriate, extends to phloem region. numerous starch grains in ray cells	uni or biseriate, extends phloem region. numerous starch grains in ray cells
Vessels	Uniform size arranged in radial rows	Varying sizes arranged in radial manner	Varying size, single or groups of 2-5
Pith	Parenchymatous calcium oxalate crystals and lesser number of starch grains	Pith and medullary ray cells filled with starch grains	Pith region with starch grains
Calcium oxalate Crystals	Prismatic or needle shape. Crystals may be solitary or cluster	Crystals are not seen	Prismatic, acicular and rhomboidal crystals throughout the cortical cells and pith cells

Discussion

General morphological characters of three species of *Stereospermum* are given in Table 1. Comparative stem anatomy of the three species of *Stereospermum* and its taxonomic significance are discussed. Anatomical features of three species are varying, they are almost circular line with wavy margin. outer margin ruptured due to the presence of lenticel. Few layer cork cells, in *S. suaveolens* cork cells are irregular in shape while in other two species cork cells thick lignified walls and are compactly arranged. Single or group of stone cells present in the cortical region. In *S. colais var shendurunii* stone cells alternate with fibre patches. But in *S. colais* stone cells are absent. Starch grains present in pith region of *S. colais* and *S. colais var shendurunii*, while starch grain absent in *S. suaveolens*. Prismatic, rhomboidal calcium oxalate crystals present in cortical and pith regions of *S.*

colais var shendurunii and *S. suaveolens*, but crystal absent in *S. colais*. Comparative anatomical features of three species depicted in Table.2.

Artificial Keys prepared based on anatomical features

Cork cells 6-10 layers of irregularly shaped, Single or groups of stone cells in cortical region, Starch grains few or absent, Prismatic, acicular, rhomboidal and cluster crystals of calcium oxalate are distributed throughout the cortical cells and pith cells - *S. suaveolens*

Cork cells 8-10 layered thick walled lignified, stone cells not so common, Pith and medullary ray cells filled with starch grains, calcium oxalate crystals are not seen - *S. colais*

Cork cells 8-10 layered thick walled lignified, Single or groups of stone cells in cortical region, stone cells of varying sizes are alternating with fibre patches, Pith region with starch

grains, Prismatic, acicular and rhomboidal crystals of calcium oxalate are distributed throughout the cortical cells and pith cells - *S. colais* var *shendurunii*

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