

ANATOMICAL INVESTIGATIONS IN TEPHROSIA PENTAPHYLLA (ROXB.) G. DON

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ABSTRACT

Tephrosia pentaphylla (Roxb.) G. Don is a rare species belonging to family Fabaceae. Extracts contain various secondary metabolites like alkaloids, flavonoids and phenolic compounds that possess therapeutic properties. Present investigation deals with morphology, stem and leaf anatomy, micromorphology and maceration studies so as to standardize the species. The data will also be useful to reinforce taxonomic characters.

KEYWORD: Tephrosia, Anatomy, Fabaceae.

INTRODUCTION

Tephrosia pentaphylla (Roxb.) G. Don is widely known species belonging to tribe *Millettieae*, of family *Fabaceae*. It is also known as *Galega pentaphylla* Roxb. which is a synonym of this species. It is native to Eritrea, Ethiopia, India, Mozambique, Oman, Somalia, Sudan, Tanzania, Uganda and Yemen (Kew).

MATERIALS AND METHODS

The plant specimens were collected from Paithan to Pachod road, Dist. Aurangabad (MS), Field No. 1012, Latitude N 19°47'77", Longitude E 75°38'49", Altitude 458 m. Transverse sections of stem and leaf were taken by free hand sectioning method with the help of razors, followed by double staining and permanent mounting. The stems were macerated by Jeffery's method (Khandelwal, 2006). Trichomes observed and studied by scraping with the help of blades. For microphotography and dimensions Pixel-Pro software attached to Labomed 4-D microscope was used.

RESULTS AND OBSERVATIONS

I) Morphology

Tephrosia pentaphylla (Roxb.) G. Don in Sweet, Hort. Brit. Ed. 3: 170. 1839; Gamble, Fl. Pres. Madras 318. 1918. *Galega pentaphylla* Roxb., Fl. Ind. 3: 384. 1832. *Tephrosia senticosa* auct non L.; Wight, Ic. Pl. Ind. Or. t. 370. 1840; Baker in Hook.f., Fl. Brit. India 2: 112. 1876.

Much-branched undershrubs, 20-40 cm tall; branches divaricate, slender, terete. Leaves pinnate, 2-3.5 cm long; petioles 1.5-3 mm long; stipules subulate, 3-4 mm long,

hairy. Leaflets 5, rarely 3 or 7, oblanceolate, 1-2 × 0.4-0.5 cm, cuneate at base, emarginate, glabrous above, densely white appressed hairy beneath; petiolules 1-3 mm long. Flowers usually 1-2 in the axils of leaves; pedicels 3-6 mm long, hairy. Calyx silky outside, 4-5 mm long; teeth subulate, little longer than the tube. Corolla 9-12 mm long, orange salmon coloured; standard broadly cordate, 12 × 9 mm, hairy on the back, Wings 11 × 5.5, oblong; keels 10 × 8 mm; Stamens 10, diadelphous, staminal sheath 6.0 mm; ovary 5 mm, style 4 mm, glabrous. Pods oblong, 2.5-4 cm long, flat, curved. Seeds 7-10, oblong, brownish yellow, polished (Plate - 1).

Fl. & Fr.: September - November.

Distribution: India, Arabia Sudan Eritrea, Ethiopia, Somali Republic, Mozambique.

Localities: Aurangabad (Paithan to Pachod road), Paithan-Aurangabad Road.

Status: Rare.

Specimens examined: S. S. Chaudhari, 02, 15th October 1999, Beed, Maharashtra.

II) Anatomy of stem

The transverse section of stem showed angular outline. Epidermis is the outermost single layered cells covered externally with thick cuticle. Epidermal cells are squarish, barrel - shaped, upright, measured average 12.838 × 12.72 μm and range 8.85 - 16.43 × 4.97 - 18.78 μm. Glandular trichomes observed on epidermis, average 30.606 × 15.113 μm and range 14.97 - 51.44 × 10.23 - 19.35 μm. Epidermis followed by outer cortex upto 6 layered. Cells are oval, polygonal with angular thickenings collenchyma, filled with crystals, average 9.735 × 7.301 μm and range 5.42 - 12.54 × 2.85 - 14.32

μm . Inner cortex is few layered parenchyma cells filled with tannin, thin walled oval, polygonal. Endodermis observed below inner cortex, single layered barrel-shaped, radially elongated cells, average $20.613 \times 14.255 \mu\text{m}$ and range $12.26 - 26.24 \times 11.15 - 16.88 \mu\text{m}$. Pericycle found below endodermis which is upto 6 layered, double walled fibres occur in patches interrupted by 1 - 3 seriate thin walled cells. Pericycle fibres measured average c. $8.563 \times 5.523 \mu\text{m}$ and range $3.43 - 13.20 \times 2.52 - 9.47 \mu\text{m}$.

Pericycle is followed by phloem upto 9 - layered. Cells of phloem rectangular, polygonal, squarish, average $5.577 \times 4.109 \mu\text{m}$ and range $2.63 - 11.28 \times 2.14 - 10.27 \mu\text{m}$. Vascular cambium is found below phloem, cells rectangular, average $6.912 \times 3.001 \mu\text{m}$ and range $3.42 - 9.28 \times 1.73 - 4.05 \mu\text{m}$. Metaxylem vessels situated towards periphery, circular, oblong, oval, elliptic to polygonal, average $29.508 \times 25.463 \mu\text{m}$ and range $19.86 - 36.75 \times 19.97 - 35.00 \mu\text{m}$. Protoxylem vessels situated towards the centre, oval, rectangular or polygonal, average $8.915 \times 8.528 \mu\text{m}$ and range $4.26 - 15.59 \times 3.32 - 11.56 \mu\text{m}$. Xylem strands separated by multiseriate rays with radially elongated, barrel-shaped cells. At the centre pith observed. Cells circular, oval, polygonal, thin walled parenchymatous, average $36.404 \times 32.873 \mu\text{m}$ and range $5.50 - 83.03 \times 5.67 - 73.66 \mu\text{m}$. Crystals found in some pith cells.

III) Anatomy of leaf

The transverse section of leaf of showed typical dorsiventral structure. The epidermis of both the surfaces single layered, covered externally with cuticle. The upper epidermis composed of squarish to rectangular compactly arranged cells, average $33.183 \times 18.309 \mu\text{m}$ and range $17.62 - 42.20 \times 12.47 - 24.10 \mu\text{m}$. The lower epidermal cells squarish to rectangular, average $12.922 \times 10.648 \mu\text{m}$ and range $6.96 - 22.30 \times 4.22 - 17.75 \mu\text{m}$. Epidermal cells at the midrib region circular, oval or polygonal and smaller than the lamina region.

Mesophyll showed differentiation into palisade and spongy parenchyma. The upper epidermis followed by vertically elongated 2 - 3 layered palisade tissue. Cells columnar, thin walled, compactly arranged, average $22.522 \times 7.279 \mu\text{m}$ and range $14.83 - 29.55 \times 5.42 - 9.72 \mu\text{m}$. The spongy tissue 2 layered, oval to irregular, wavy cell wall, average $11.955 \times 8.541 \mu\text{m}$ and range $9.79 - 15.46 \times 7.01 - 13.17 \mu\text{m}$. Some spongy cells showed presence of starch grains.

At the midrib region, the lower epidermis followed by 3 - 5 layered parenchyma, a part of ground tissue. Parenchyma cells oval, circular, irregularly-shaped, average $23.220 \times 17.162 \mu\text{m}$ and range $8.89 - 45.79 \times 6.87 - 37.43 \mu\text{m}$. Angular collenchyma with irregular shaped cells, average $8.194 \times 5.493 \mu\text{m}$ and range $2.63 - 14.36 \times 1.86 - 10.62 \mu\text{m}$. Pericycle composed of double-walled, thick, sclerenchymatous cells 2 - 4 layered, average $9.706 \times 7.321 \mu\text{m}$ and range $2.81 - 14.94 \times 2.18$

- $12.67 \mu\text{m}$. Next to sclerenchyma few layers of phloem observed. Phloem cells rectangular, squarish, polygonal, average $6.940 \times 4.156 \mu\text{m}$ and range $2.31 - 9.41 \times 1.68 - 5.32 \mu\text{m}$. Metaxylem of 2 - 3 layers found below phloem. Cells circular to polygonal, thick walled, situated towards periphery, average $15.765 \times 12.762 \mu\text{m}$ and range $12.96 - 18.15 \times 9.90 - 16.83 \mu\text{m}$. Protoxylem circular to polygonal, situated towards centre, average $8.065 \times 6.88 \mu\text{m}$ and range $4.93 - 13.43 \times 4.75 - 9.20 \mu\text{m}$. Pith showed 2 - 4 layered thin walled, oval, pentagonal, and hexagonal to rectangular cells, average $15.470 \times 11.00 \mu\text{m}$ and range $4.88 - 29.68 \times 4.47 - 23.99 \mu\text{m}$ (Plate - 2).

IV) Micromorphology of leaves

Leaf showed presence of simple, unicellular, trichomes with bulbous base and pointed end, their average length is $320 \mu\text{m}$ and range $200 - 560 \mu\text{m}$, present on both the surfaces, but however, they are more common on lower surface.

Stomata anisocytic (Cruciferous), hypostomatic, $17.05 \times 8.85 \mu\text{m}$ in average and range $13.60 - 20.50 \times 7.50 - 10.20 \mu\text{m}$.

Upper epidermal cells much larger (average $33.183 \times 18.309 \mu\text{m}$ and range $17.62 - 42.20 \times 12.47 - 24.10 \mu\text{m}$.) than lower epidermal cells (the average cell size $12.922 \times 10.648 \mu\text{m}$ and range $6.96 - 22.30 \times 4.22 - 17.75 \mu\text{m}$) (Plate - 2).

V) Maceration

Parenchyma are of four types

- Parenchyma with many pits: Cells rectangular, oblong, thin walled, pits alternate, simple, distributed throughout, cell wall interrupted, with or without impregnation of starch grains, $30.00 - 55.00 \times 10.00 - 14.00 \mu\text{m}$.
- Parenchyma with few pits: Cells squarish, rectangular or rhomboid, arranged in rows, pits few, bordered, circular or oval, distributed along cell wall at one side, with or without impregnated with starch grains, $38.00 - 49.00 \times 14.00 - 21.00 \mu\text{m}$.
- Parenchyma with many pits: Cells circular, spherical, thin walled, pits simple, distributed throughout, cell wall with or without impregnated with starch grains, $12.00 - 21.00 \times 9.00 - 18.00 \mu\text{m}$.
- Parenchyma with many pits: Cells broader, rectangular or rhomboid, thin walled, cell wall pushed inside at one end, arranged end to end, pits simple, alternate, distributed throughout, with or without impregnation of starch grains, $40.00 - 52.00 \times 20.00 - 31.00 \mu\text{m}$.

Fibres are of two types

- Simple fibres, short, slender, thick walled, pointed sharp and tapering at both ends, outline entire, measured range $140.0 - 250.0 \times 6.00 - 12.00 \mu\text{m}$.
- Simple fibres longer, broader lumen, thick walled, tapering and sharply pointed at one end and blunt at

the other, outline entire, measured range 350.0 – 420.0 × 7.00 – 15.00 µm.

Tracheids are of two types:

- Tracheids simple, elongate, thick walled, blunt at one end, pointed at the other, perforation plates at one side, pits many arranged in many rows,

distributed throughout, 320.0 – 450.0 × 12.00 – 21.00 µm.

- Tracheids simple, elongate, thick walled, blunt at both the ends, lumen broader, pits simple, circular or oval, arranged in many rows, 240.0 – 350.0 × 20.00 – 35.00 µm.

No vessel elements are seen.

Table I: Morphological characters.

	Characters	Observation in <i>Tephrosia pentaphylla</i> (Roxb.) G. Don
Vegetative	Habit	Undershrub
	Plant Height	0.4 m
	Life Form	Erect
	Surface	Rough
Leaflets	Number	5
	Shape	Oblanceolate
	Dimensions (cm)	1.0 – 2.0 × 0.4 – 0.5
	Apex	Emarginate
	Upper Surface	Glabrous
	Lower Surface	Dense White Hairy
Stipules	Length (mm)	3.0 – 4.0
	Shape	Subulate
	Apex	Acute
	Pubescence	Hairy
Stalk	Petiole length (mm)	1.5 – 3.0
	Petiolule length (mm)	2.0
Inflorescence	Length (cm)	1.2
	Position/Type	Axillary Cyme
	Peduncle (cm)	0.5
	No. of flowers	c. 1
Bracts	Shape	Subulate
	Pubescence	Hairy
Calyx	Calyx Tube (mm)	4.5
	Upper Sepal (mm)	5.1
	Lower Sepal (mm)	5.3
	Teeth Shape	Subulate
	Apex	Acute
	Pubescence	Silky Outside
Corolla	Colour	Orange salmon
	Standard Size (mm)	12.0 × 9.0
	Standard Shape	Broadly Cordate
	Wing Size (mm)	11.0 × 5.5
	Keel Size (mm)	10.0 × 8.0
Androecium	Staminal Sheath Length (mm)	6.0
	Filament Length (mm)	2.6
Gynoecium	Ovary Length (mm)	5.0
	Style Length (mm)	4.0
	Style Pubescence	Glabrous
Pods	Size (cm)	4.0 × 0.7
	Shape	Oblong
	No. of Seeds	7 – 10
Seeds	Size (mm)	1.9 × 1.0
	Shape	Oblong
	Colour	Brownish yellow

Table II: Stem anatomy.

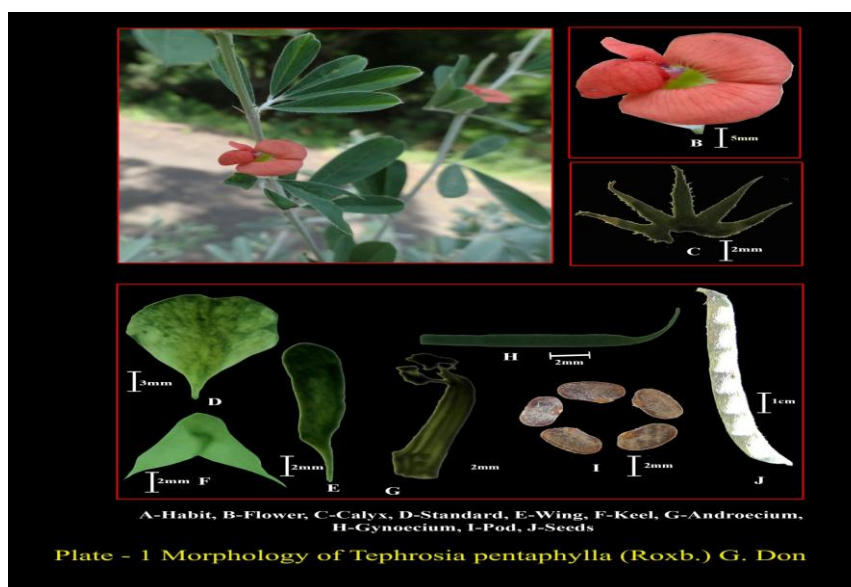
Cell Type	Dimensions in <i>Tephrosia pentaphylla</i> (Roxb.) G. Don	
	Average (μm)	Range (μm)
Epidermis	12.838 \times 12.72	8.85 – 1643 \times 4.97 – 18.78
Cortex	9.735 \times 7.301	5.42 – 12.54 \times 2.85 – 14.32
Pericycle Fibres	8.563 \times 5.523	3.43 – 13.20 \times 2.52 – 9.47
Phloem	5.577 \times 4.109	2.63 – 11.28 \times 2.14 – 10.27
Vascular Cambium	6.912 \times 3.001	3.42 – 9.28 \times 1.73 – 4.05
Metaxylem	29.508 \times 25.463	19.86 – 36.75 \times 19.97 – 35.00
Protoxylem	8.915 \times 8.528	4.26 – 15.59 \times 3.32 – 11.56
Glandular Trichomes	30.606 \times 15.113	14.97 – 51.44 \times 10.23 – 19.35
Endodermis	20.613 \times 14.255	12.26 – 26.24 \times 11.15 – 16.88
Pith	36.404 \times 32.873	5.50 – 83.03 \times 5.67 – 73.66

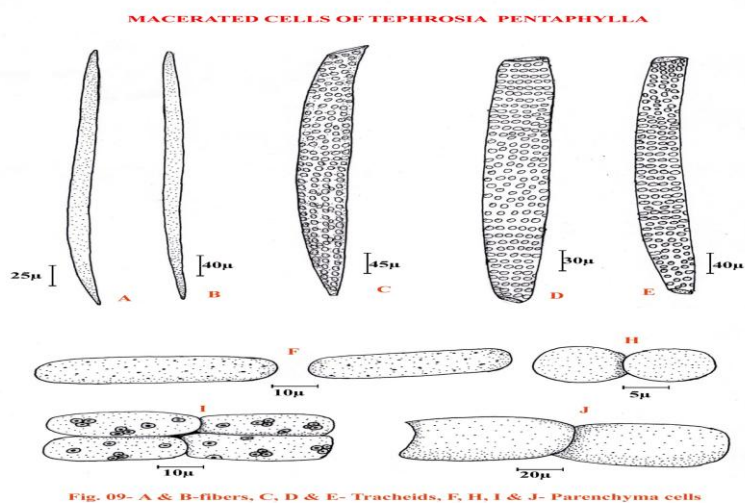
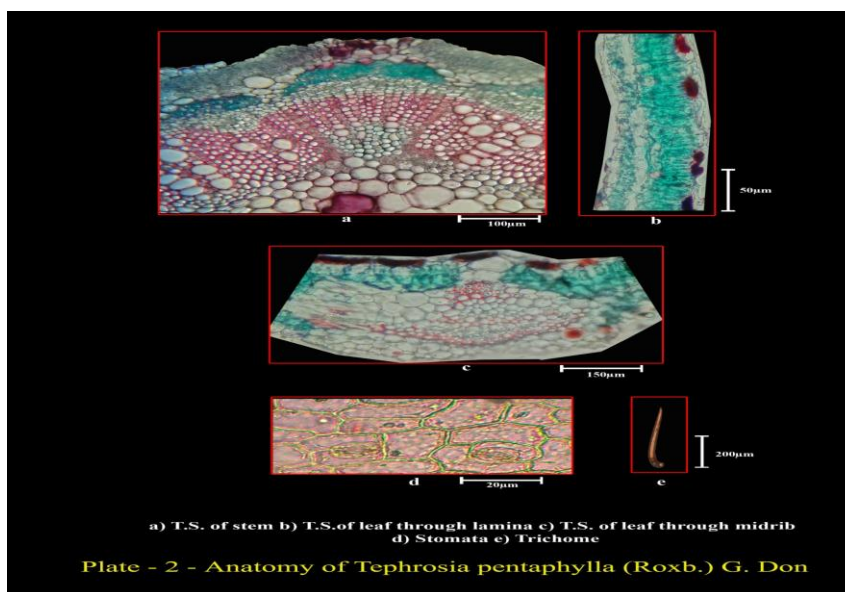
Table III: Leaf anatomy.

Cell Type	Dimensions in <i>Tephrosia pentaphylla</i> (Roxb.) G. Don	
	Average (μm)	Range (μm)
Upper Epidermis	33.183 \times 18.309	17.62 – 42.20 \times 12.47 – 24.10
Lower Epidermis	12.922 \times 10.648	6.96 – 22.30 \times 4.22 – 17.75
Angular Collenchyma	8.194 \times 5.493	2.63 – 14.36 \times 1.86 – 10.62
Palisade Mesophyll	22.522 \times 7.279	14.83 – 29.55 \times 5.42 – 9.72
Spongy Mesophyll	11.955 \times 8.541	9.79 – 15.46 \times 7.01 – 13.17
Phloem	6.940 \times 4.156	2.31 – 9.41 \times 1.68 – 5.32
Metaxylem	15.765 \times 12.762	12.96 – 18.15 \times 9.90 – 16.83
Protoxylem	8.065 \times 6.88	4.93 – 13.43 \times 4.75 – 9.20
Central Parenchyma	15.470 \times 11.00	4.88 – 29.68 \times 4.47 – 23.99

Table IV: Micromorphology of leaves.

Cell Type	Dimensions in <i>Tephrosia pentaphylla</i> (Roxb.) G. Don	
	Average (μm)	Range (μm)
Simple Trichomes	320	200 – 560
Glandular Trichomes	NA	NA
Stomata Type	Anisocytic (Cruciferous)	--
Stomata Dimensions	17.05 \times 8.85	13.60 – 20.50 \times 7.50 – 10.20
Stomata Presence	Hypostomatic	





CONCLUSION

Pods oblong, style glabrous. Stem showed pericycle fibres up to 6 layered. Glandular trichomes observed on epidermal cells of stem. Stomata anisocytic (Cruciferous), hypostomatic. These characters of morphology, leaf anatomy and dermatology are diagnostic to *Tephrosia pentaphylla* (Roxb.) G. Don and may be useful to standardise the species.

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