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Anatomical studies on *Tephrosia spinosa* (L.f.) Pers.

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ABSTRACT

Tephrosia spinosa (L.f.) Pers. is a rare species of family Fabaceae. The plant has significant medicinal value, used traditionally as anti-rheumatic, antipyretic, anti-diarrhoeal, anti-inflammatory. It is used to get rid of excessive thirst. Present investigation deals with morphology, stem and leaf anatomy, micromorphology to standardize the species.

Keywords: *Tephrosia*, anatomy, Fabaceae.

Introduction:

The genus *Tephrosia* Pers. of Fabaceae (Papilionoideae tribe Millettieae) comprises c. 345 species (Mabberley, 2008). Being one of the largest genera in the family Fabaceae (Geesink, 1984) it enjoys pantropical distribution. The genus is represented in India by 27 species and one variety (Sanjappa, 2010).

Tephrosia spinosa (L.f.) Pers. is a rare species of family Fabaceae. It is used in traditional system of medicine for antirheumatic, antipyretic, indigestion, antidiarrheal, anti-inflammatory, stomachic, febrifuge, anthelmintic and to control excessive thirst.

Materials and Methods:

The plant specimens were collected from the outskirts of Warangal, Andhra Pradesh, field number 1069. Herbarium specimens were deposited in BAMU herbarium, Dept of Botany, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. Stem and leaf material was preserved in 70% alcohol for anatomical studies. Free hand sectioning method was used to take transverse sections of stem and leaf followed by double staining and permanent mounting. Trichomes and stomata studied by scraping and peeling method. Labomed Lx-400 microscope attached to Pixel-pro software was used for microphotography and dimensions.

Results and Observations:

I) Morphology:

Tephrosia spinosa (L.f.) Pers., Syn. pl. 2: 330. 1807; Wight & Arn. Prodr. Fl. Ind. Orient. 214. 1834; Wight, Icon. Pl. Ind. Orient. t. 372. 1840; Hook.f. Fl. Brit. India 2: 112. 1876; Gamble, Fl. Madras 1: 320(226). 1918; Matthew, Mat. Fl. Tamilnadu Carnatic 199. 1981; Bosman & Haas, Blumea 28: 472.1983. *Galega spinosa* L.f. Suppl. Pl. 335. 1782.

Vernacular Names: Tamil: *Mullu kolinji*; English: Spinous Wild Indigo.

Herbs; branchlets grey-canescens. Leaves c. 3 cm; leaflets 4 or 5 pairs, obovate, 0.7-1.5 × 0.3-0.5 cm, chartaceous, appressed-pubescent, base cuneate, margin entire, apex truncate, emarginate; petiole c. 4 mm; petiolule c. 0.8 mm; stipular spines c. 5 mm. Flower(s) 1 cm across, axillary, 1 or 2; bracts 2 mm; pedicel c. 3 mm. Calyx-tube 1.5. mm; canescens; lobes lanceolate, appressed-pubescent; upper lobes 1 mm; lower one 2 mm. Corolla red; standard orbicular, 8.5 × 6 mm, hairy; wings obovate, 6.5 × 3 mm; keels 7 × 4 mm. Staminal sheath 6 mm, hairy; filaments 2 mm. Ovary c. 5.5 mm, appressed-hispid; style 4 mm, glabrous. Pod 3 × 0.4 cm, appressed-pubescent, continuous within; seeds c. 7, ellipsoid, brownish yellow, 3 mm. (Plate – I; Table No. I)

Fl. & Fr.: September – October.

Exsiccata: TAG, 1069, Warangal (Telangana).

Distribution.: India (Plains of Peninsular India), Sri Lanka, Indonesia.

Localities: Warangal (NIT campus, Nearby fields), Andhra Pradesh.

Status: Rare

II) Anatomy of Stem: The transverse section of stem showed almost spherical outline. Epidermis is the outer most layer covered externally with thick cuticle. Cells of epidermis squarish, rectangular, rarely polygonal or barrel-shaped, average 7.402 × 7.348 μm and range 3.22 – 13.98 × 4.07 – 10.20 μm. Hypodermis single layered comprised of rectangular, squarish, rhomboidal or polygonal cells, average 16.106 × 7.927 μm and range 8.94 – 25.89 × 4.27 – 10.57 μm. At ridges the hypodermis observed as upto 6

layered patch. Rest of the region of stem the inner cortex is parenchymatous, thin walled, elliptic-oblong, or polygonal cells filled with crystals, measured average $21.471 \times 11.847 \mu\text{m}$ and range $14.42 - 28.92 \times 8.50 - 16.04 \mu\text{m}$. Cortex followed by single layered endodermis composed of barrel-shaped cells. Pericycle found next to endodermis in patches interrupted by parenchyma. Pericycle composed of double walled fibres 1 – 5 layered, squarish, ovate-elliptic, elliptic-oblong, polygonal measured average $8.850 \times 5.286 \mu\text{m}$ and range $4.00 - 13.10 \times 2.65 - 9.72 \mu\text{m}$. Phloem upto 9 – layered observed below pericycle. Cells squarish, polygonal, average $11.418 \times 5.233 \mu\text{m}$ and range $5.65 - 15.20 \times 3.25 - 8.92 \mu\text{m}$. Vascular cambium 2 – 3 layered, cells rectangular measured average $8.334 \times 2.934 \mu\text{m}$ and range $5.40 - 10.99 \times 2.43 - 3.76 \mu\text{m}$. Metaxylem circular to polygonal traversed by multiseriate medullary rays, situated towards the periphery, average $52.062 \times 40.448 \mu\text{m}$ and range $40.52 - 57.51 \times 30.99 - 48.31 \mu\text{m}$. Protoxylem circular to polygonal, situated towards the centre, average $12.762 \times 13.796 \mu\text{m}$ and range $6.49 - 17.15 \mu\text{m}$. Pith is represented by thin walled parenchyma cells. Pith cells filled with starch grains and crystals of calcium oxalate. Average cell size $31.80 \times 28.105 \mu\text{m}$ and range $10.07 - 61.98 \times 6.25 - 47.43 \mu\text{m}$. (Plate II; Table No. II)

III) Anatomy of Leaf: The transverse section of the leaf showed typical dorsiventral structure. The upper and lower surface epidermis single layered, covered externally with thick cuticle. The upper epidermal cells squarish, rectangular, barrel-shaped, upright, oval, polygonal, average $22.143 \times 15.812 \mu\text{m}$ and range $17.03 - 26.95 \times 9.60 - 17.78 \mu\text{m}$. The lower epidermal cells comparatively smaller in size, oval, polygonal, rectangular, barrel-shaped, elongated, average $c. 12.381 \times 9.379 \mu\text{m}$ and range $10.00 - 16.58 \times 4.40 - 14.88 \mu\text{m}$. The cells of epidermis at the midrib portion are oval, circular or polygonal and smaller than those in the lamina portion. Mesophyll showed clear cut differentiation into palisade and spongy tissues. Below the upper epidermis 4 – 5 layered palisade comprised of columnar, vertically elongated, compactly arranged cells, filled with chloroplasts observed which measured average $17.689 \times 9.33 \mu\text{m}$ and range $13.91 - 21.76 \times 7.15 - 12.12 \mu\text{m}$. The spongy mesophyll cells 3 – 6 layered beneath the lower epidermis, oval, polygonal to irregular, loosely arranged filled with starch grains, average $28.616 \times 14.842 \mu\text{m}$ and range $18.79 - 36.17 \times 9.94 - 24.72 \mu\text{m}$.

At the midrib region the lower epidermis followed by 2 – 3 layered angular collenchyma a part of ground tissue, average $21.057 \times 17.570 \mu\text{m}$ and range $11.06 - 32.05 \times 9.44 - 28.31 \mu\text{m}$. This region followed by 2 – 4 layered sclerenchymatous patch composed of compactly arranged, circular, oval to polygonal cells, average $9.123 \times 7.106 \mu\text{m}$ and range $6.52 - 18.53 \times 4.72 - 15.83 \mu\text{m}$. Sclerenchymatous patch followed by 4 – 8 layered phloem of squarish, rectangular to polygonal cells, average $6.783 \times 6.733 \mu\text{m}$ and range $3.63 - 8.80 \times 3.40 - 10.44 \mu\text{m}$. Phloem followed by metaxylem vessels, circular to polygonal, situated towards periphery, average $13.126 \times 10.978 \mu\text{m}$ and range $9.71 - 15.83 \times 8.47 - 13.68 \mu\text{m}$. Protoxylem rectangular to polygonal, situated towards centre, average $8.102 \times 5.937 \mu\text{m}$ and range $6.08 - 11.65 \times 4.40 - 7.05 \mu\text{m}$. Centrally located pith cells parenchymatous 2 – 4 layered, oval, thin walled, pentagonal, and hexagonal to rectangular shaped (Plate II; Table No III)

IV) Micromorphology of Leaves: Leaf showed presence two types of trichomes viz. simple, unicellular, long trichomes with bulbous base and pointed end, their average length is $1519.60 \mu\text{m}$ and range $1060 - 1881 \mu\text{m}$ and simple, unicellular, short trichomes average length $327.70 \mu\text{m}$ and range $133 - 551 \mu\text{m}$, present on both the surfaces, but however, they are more common on lower surface. Stomata anomocytic (Ranunculaceous), amphistomatic, $17.66 \times 8.53 \mu\text{m}$ in average and range $12.70 - 22.70 \times 7.60 - 8.30 \mu\text{m}$. Upper epidermal cells much larger (average $22.143 \times 15.812 \mu\text{m}$ and range $17.03 - 26.95 \times 9.60 - 17.78 \mu\text{m}$.) than lower epidermal cells (the average cell size $12.381 \times 9.379 \mu\text{m}$ and range $10.00 - 16.58 \times 4.40 - 14.88 \mu\text{m}$). (Plate II; Table III)

Table I: Morphological Characters:

	Characters	Observation in <i>Tephrosia spinosa</i> (L.f.) Pers.
Vegetative	Habit	Annual Herb
	Plant Height	0.3 m
	Life Form	Erect
	Surface	Smooth
	Number	09 – 11
	Shape	Obovate

Leaflets	Dimensions (cm)	0.7 – 1.5 × 0.3 – 0.5
	Apex	Truncate/emarginated
	Upper Surface	Glabrous
	Lower Surface	Appressed pubescent
Stipules	Length (mm)	2.0 – 5.0
	Shape	Linear subulate
	Apex	Pointed
	Pubescence	Sparsely Hairy
Stalk	Petiole length (mm)	3.0 – 4.0
	Petiolule length (mm)	0.8
Inflorescence	Length (cm)	7.0
	Position/Type	Axillary, Lax raceme
	Peduncle (cm)	3.5
	No. of flowers	c. 5
Bracts	Shape	Lanceolate
	Pubescence	Hairy
Calyx	Calyx Tube (mm)	1.5
	Upper Sepal (mm)	1.0
	Lower Sepal (mm)	2.0
	Teeth Shape	Lanceolate
	Apex	Acute
	Pubescence	Canescent
Corolla	Colour	Deep Pink
	Standard Size (mm)	8.5 × 6.0
	Standard Shape	Orbicular
	Wing Size (mm)	6.5 × 3.0
	Keel Size (mm)	7.0 × 4.0
Androecium	Staminal Sheath Length (mm)	6.0
	Filament Length (mm)	2.0
Gynoecium	Ovary Length (mm)	5.5
	Style Length (mm)	4.0
	Style Pubescence	Glabrous
Pods	Size (cm)	3.0 × 0.4
	Shape	Linear falcate
	No. of Seeds	7 – 11
Seeds	Size (mm)	1.4 × 1.3
	Shape	Ellipsoid
	Colour	Brownish yellow

Table II: Stem Anatomy

Cell Type	Dimensions in <i>Tephrosia spinosa</i> (L.f.) Pers.	
	Average (µm)	Range (µm)
Epidermis	7.402 × 7.348	3.22 – 13.98 × 4.07 – 10.20
Hypodermis	16.106 × 7.927	8.94 – 25.89 × 4.27 – 10.57
Cortex	21.471 × 11.847	14.42 – 28.92 × 8.50 – 16.04
Pericycle Fibres	8.850 × 5.286	4.00 – 13.10 × 2.65 – 9.72
Phloem	11.418 × 5.233	5.65 – 15.20 × 3.25 – 8.92
Vascular Cambium	8.334 × 2.934	5.40 – 10.99 × 2.43 – 3.76
Metaxylem	52.062 × 40.448	40.52 – 57.51 × 30.99 – 48.31
Protoxylem	12.762 × 13.796	6.49 – 17.15 × 6.31 – 18.76

Pith	31.80 × 28.105	10.07 – 61.98 × 6.25 – 47.43
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Table III: Leaf Anatomy

Cell Type	Dimensions in <i>Tephrosia spinosa</i> (L.f.) Pers.	
	Average (µm)	Range (µm)
Upper Epidermis	22.143 × 15.812	17.03 – 26.95 × 9.60 – 17.78
Lower Epidermis	12.381 × 9.379	10.00 – 16.58 × 4.40 – 14.88
Angular Collenchyma	21.057 × 17.570	11.06 – 32.05 × 9.44 – 28.31
Palisade Mesophyll	17.689 × 9.33	13.91 – 21.76 × 7.15 – 12.12
Spongy Mesophyll	28.616 × 14.842	18.79 – 36.17 × 9.94 – 24.72
Phloem	6.783 × 6.733	3.63 – 8.80 × 3.40 – 10.44
Metaxylem	13.126 × 10.978	9.71 – 15.83 × 8.47 – 13.68
Protoxylem	8.102 × 5.937	6.08 – 11.65 × 4.40 – 7.05

Table IV: Micromorphology of Leaves

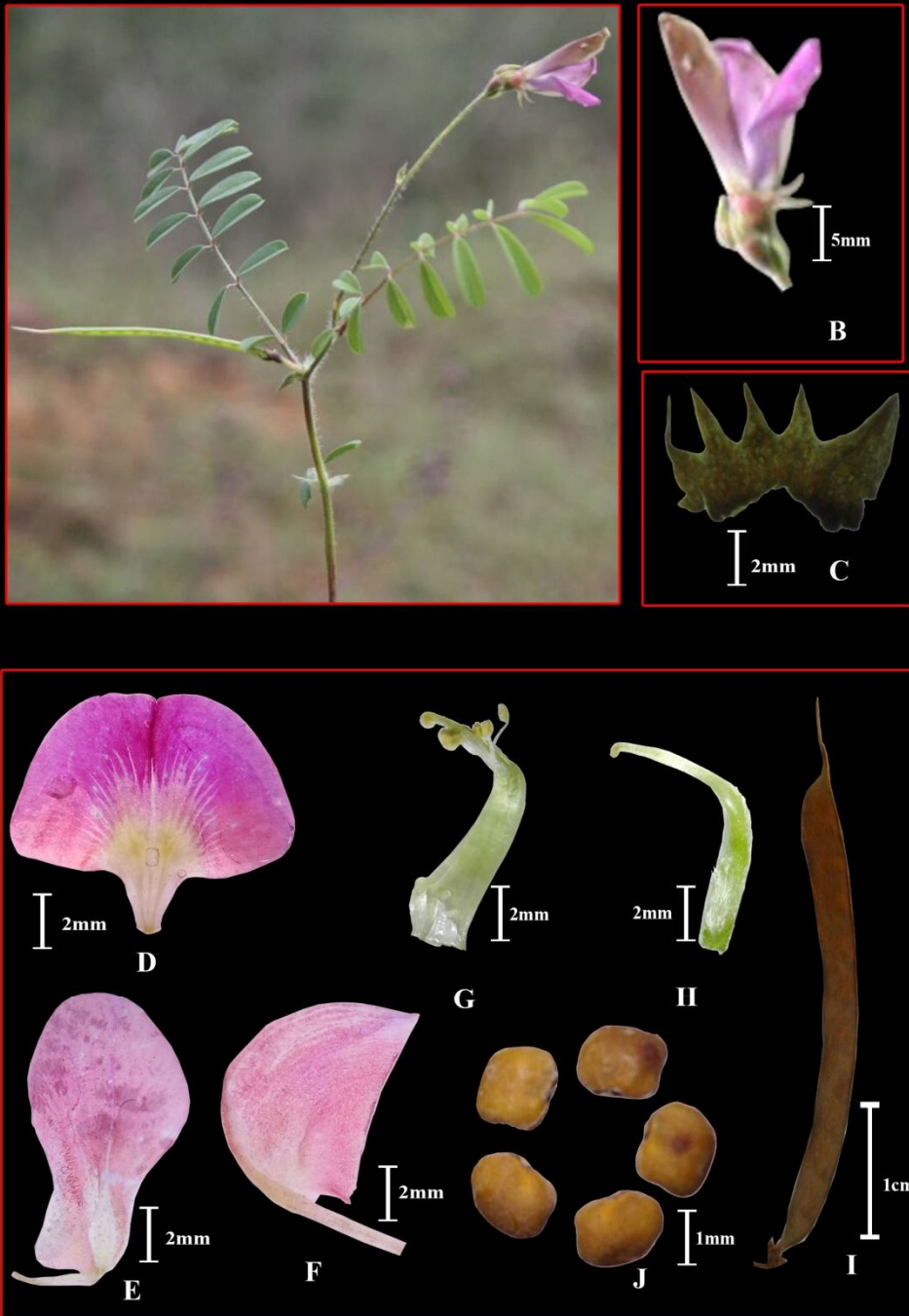
Cell Type	Dimensions in <i>Tephrosia spinosa</i> (L.f.) Pers.	
	Average (µm)	Range (µm)
Simple Trichomes	1519.6	1060 – 1881
Glandular Trichomes	NA	NA
Stomata Type	Anomocytic Ranunculaceous	--
Stomata Dimensions	17.66 × 8.53	12.70 – 22.70 × 7.60 – 8.30
Stomata Presence	Amphistomatic	

Conclusion: Pods linear falcate, style glabrous. Stem revealed 1 – 5 layered pericycle fibres. Starch grains and crystals of calcium oxalate reported in pith. Trichomes simple, unicellular. Stomata anomocytic (ranunculaceous), amphistomatic. These features of morphology, leaf anatomy and micromorphology are diagnostic to *Tephrosia spinosa* (L.f.) Pers. and may be useful to standardise the species.

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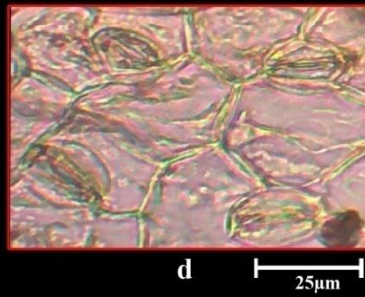
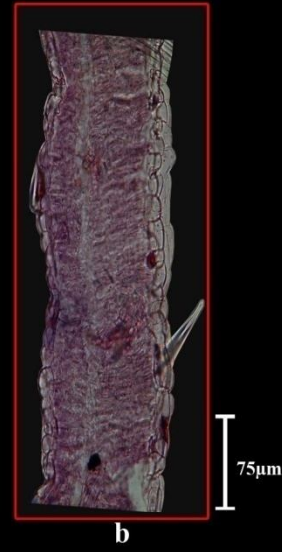
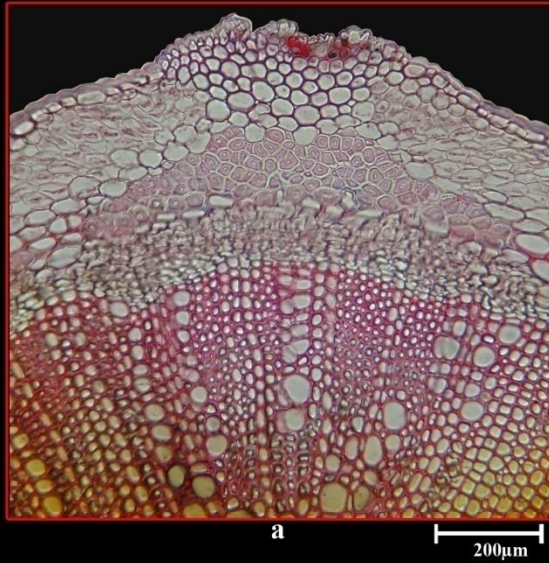
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A-Habit, B-Flower, C-Calyx, D-Standard, E-Wing, F-Keel, G-Androecium, H-Gynoeceum, I-Pod, J-Seeds

Plate I : Morphology of *Tephrosia spinosa* (L.f.) Pers.



a) T.S. of stem b) T.S. of leaf through lamina c) T.S. of leaf through midrib
d) Stomata e) Trichome

Plate II : Anatomy of *Tephrosia spinosa* (L.f.) Pers.