

COMPARATIVE MORPHOLOGICAL AND HISTOLOGICAL STUDIES OF *TALINUM TRIANGULARE* (JACQ.) WILLD. AND *TALINUM PANICULATUM* (JACQ.) GAERTN. (MYANMAR GINSENG)

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Abstract

Talinum triangulare (Jacq.) Willd. (waterleaf, Ceylon ginseng or leaf ginseng) and *T. paniculatum* (Jacq.) Gaertn. (fame flower, jewels of opar or ginseng jawa) belong to the family Talinaceae. Both were locally known as Myanmar-ginseng. Their leaves have been used as leafy vegetables and roots as medicinal purposes. These were look alike with each other but they have different botanical characters. The root of *T. triangulare* (Jacq.) Willd was light brown and *T. paniculatum* (Jacq.) Gaertn was dark brown. *T. triangulare* (Jacq.) Willd. can easily be distinguished from *T. paniculatum* (Jacq.) Gaertn. by its triangular peduncle and cymose inflorescence (terete peduncle and paniculate cyme in *T. paniculatum* (Jacq.) Gaertn). The fruits of *T. paniculatum* (Jacq.) Gaertn were colorful like jewels while the fruits of *T. triangulare* (Jacq.) Willd were creamy white with reddish spots and persistent sepals. By using the methods of Trease and Evans (2009), their common histological characters were found as the presence of paracytic stomata, starch grains, calcium oxalate crystals and mucilages in leaves, stem and root. *T. triangulare* (Jacq.) Willd. can be differentiated from *T. paniculatum* (Jacq.) Gaertn. by the presence of triangular outline young stem, presence of papillae and rounded xylem vessels.

Introduction

T. triangulare (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. are commonly known as Myanmar ginseng and belong to the family Talinaceae (formerly Portulacaceae).

T. triangulare (Jacq.) Willd. are used as leafy vegetables and it is a good source of some minerals (e.g., calcium, magnesium and potassium) and vitamins (e.g., ascorbic acid and pyridoxine). The extract from the leaves and roots is used to cure asthma, diuretic, and for the management of gastrointestinal disorders. It is also used to treat scabies, fresh cuts, high blood pressure, and anemia. Some studies reported the presence of alkaloids, flavonoids, saponins and tannins (Ikewuchi, *et al.*, 2017).

The leaves of *T. paniculatum* (Jacq.) Gaertn are used as vegetables and medicinal purposes such as reproductive tonic (Thanamool, *et al.*, 2013). It is also used in folk medicine to treat ulcers and microbial infections. It has secondary metabolites such as tannins, steroids and triterpenes (Dosreis, *et al.*, 2015).

Some authors identified wrongly and confusedly between these two species. They reported the pharmacognostic studies of these two species but the botanically identification was incorrect. Moreover, some local people misunderstand that these two species are same with the Korean ginseng or *Panax ginseng*. The family of these two species was quite different with the Korean ginseng or *Panax ginseng* (Araliaceae) although their roots structure and medicinal properties were similar.

The misidentification of plant species and the use of unrelated or closely related inferior quality species can hinder their medicinal properties, the adverse effects of which may even kill a consumer. Therefore, this study was conducted to identify accurately these two species from morphological and histological point of views.

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Materials and Methods

Collection of plant species

The selected plant species were collected from Thingunyun Township, Yangon.

Identification of plant species

Morphological study

The size, shape, color and measurement of vegetative and reproductive parts of both plant species were photographed and recorded for the morphological study. Both plant species were identified based on their morphological characters with the help of literatures available such as Backer (1963), Dassanayake (1996) etc.

Histological study

The histological characters of fresh leaves, stem and root were studied by free hand sections according to the methods of Trease and Evans (2009). The tissue distributions of lamina, midrib, stem and root of both species were studied for anatomical studies. The surface views of lamina, midrib and stem of both species were studied for cytology. The following reagents were used for histological study.

- (1) Chloral hydrate solution as the clearing agent
- (2) Phloroglucinol-HCl solution as the test reagent for lignified cell walls
- (3) Iodine solution B.P for starch grains
- (4) Conc. H₂SO₄ for crystal examination

Results

Morphological characters of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

Scientific name	:	<i>T. triangulare</i> (Jacq.) Willd.
Myanmar name	:	Myanmar ginseng
Common name	:	Waterleaf, Ceylon spinach, Leaf Ginseng
Family	:	Talinaceae
Flowering period	:	Throughout the year
Parts used medicinally	:	Leaves and roots

Perennial herbs, about 60 cm in height. **Roots** swollen and fleshy, light brown colour. Stems succulent and green at the upper, and slightly woody, dark purple or brownish and erect at the base. **Leaves** alternate, simple, subsessile, exstipulate, obovate or spatulate, 3.0 – 10.0 × 0.9 – 3.0 cm, succulent, apex emarginate, base narrowly cuneate, margin entire. **Inflorescences** terminal or axillary, cymose, peduncle triangular. **Flowers** bisexual, regular, actinomorphic, pedicellate. **Sepals** 2, aposepalous, lanceolate, 6.0 – 7.0 × 3.0 – 3.5 mm, persistent, white with green prominent veins. **Petals** 5, apopetalous, obovate (12.0 × 6.0 mm), pink. **Stamens** numerous, apostemonous, filament unequal (2.0 – 4.0 mm long), anther dorsifixed. **Carpels** (3), syncarpous, ovary ovoid, about 1.5 × 1.5 mm, free central placentation, style slender, 3.5 mm long, stigma trifid, pinkish. **Fruits** capsule, ovoid, creamy white with reddish brown spots, many seeded, persistent sepals. **Seeds** globose, reniform (1.2 × 1.2 mm), shining black.

Scientific name	:	<i>T. paniculatum</i> (Jacq.) Gaertn.
Myanmar name	:	Myanmar ginseng
Common name	:	Fame flower, Jewels of Opar, Ginseng Jawa
Family	:	Talinaceae
Flowering period	:	Throughout the year
Parts used medicinally	:	Leaves and roots

Perennial herbs, about 50 cm in height. **Roots** swollen, fleshy, dark brown colour. **Stems** succulent and green at the upper, and slightly woody, dark purple or brownish and erect at the base. **Leaves** alternate, simple, sessile, exstipulate, obovate or obovate-lanceolate (2.0 – 6.5 × 0.8 - 2.5 mm), succulent, apex mucronate, base narrowly cuneate, margin entire. **Inflorescences** terminal, panicle, peduncle long and terete. **Flowers** bisexual, regular, actinomorphic, pedicellate. **Sepals** 2, aposepalous, ovate (1.7 × 1.5 mm), caducous, brown. **Petals** 5, apopetalous, obovate or elliptic (3.0 × 2.0 mm), pinkish. **Stamens** numerous, apostemonous, filament unequal, 1.5 -2.0 mm long, anther dorsifixed. **Carpels** (3), syncarpous, ovary ovoid, about 0.8 × 0.8 mm, free central placentation, style slender, 1.2 mm long, stigma trifid, pink. **Fruits** capsule, globose, colourful, many seeded. **Seeds** globose reniform (0.8 × 0.8 mm), shining black.



Figure 1 Habit of *T. triangulare* (Jacq.) Willd and *T. paniculatum* (Jacq.) Gaertn.



Figure 2 Root of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.



Figure 3 Various sizes of *T. triangulare* (Jacq.) Willd. leaves



Figure 4 Various sizes of *T. paniculatum* (Jacq.) Gaertn. leaves

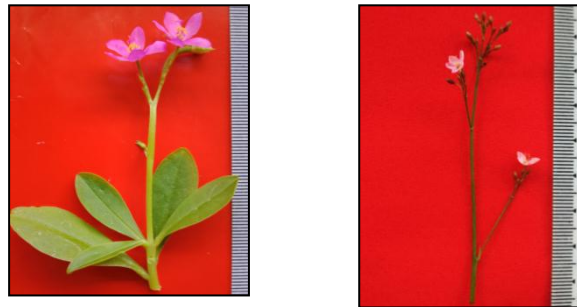


Figure 5 Inflorescence of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

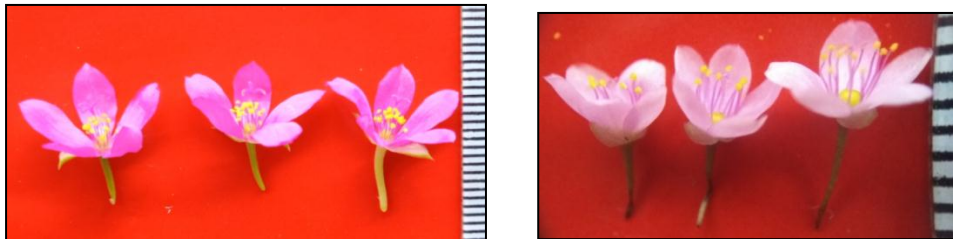


Figure 6 Flowers of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

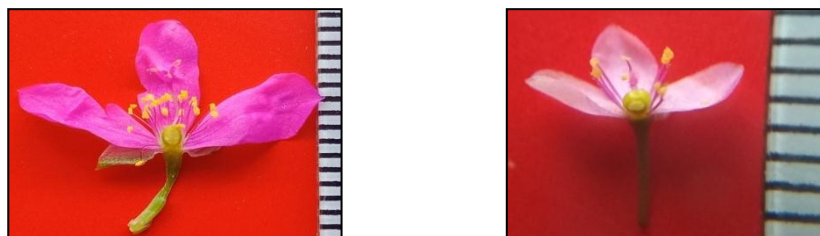


Figure 7 L.S of flower of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

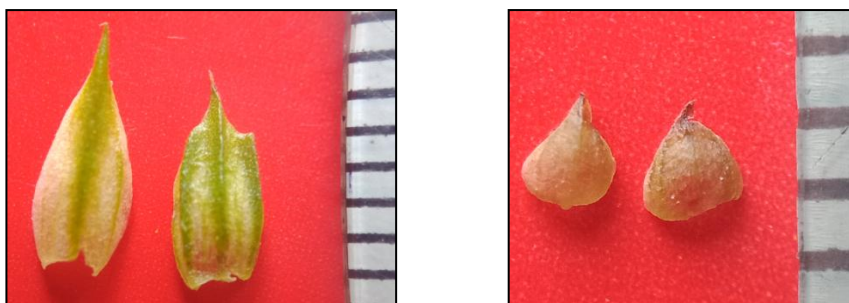


Figure 8 Sepals of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

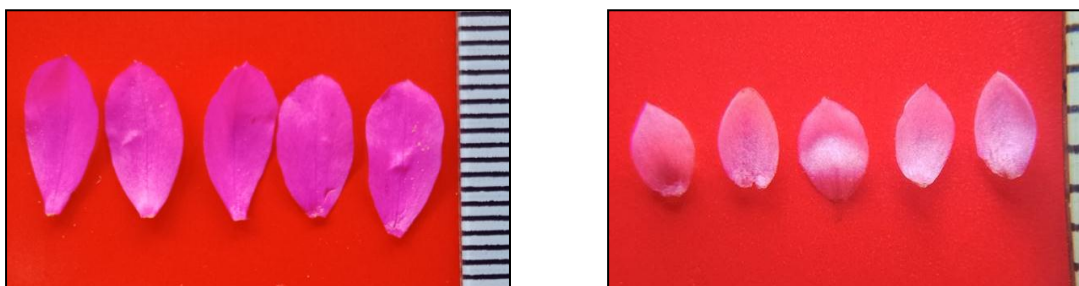


Figure 9 Petals of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

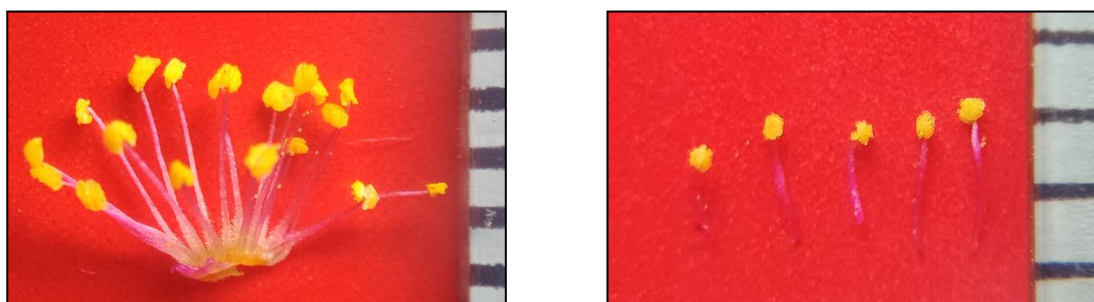


Figure 10 Stamens of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

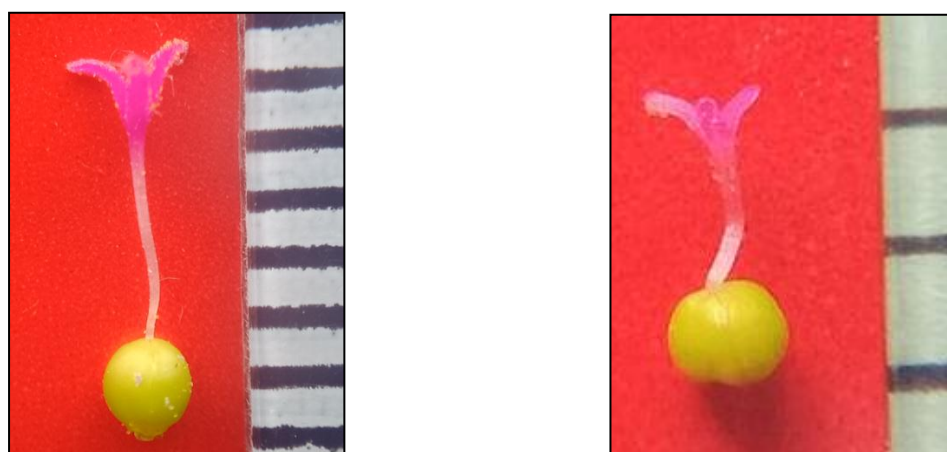


Figure 11 Gynoecium of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

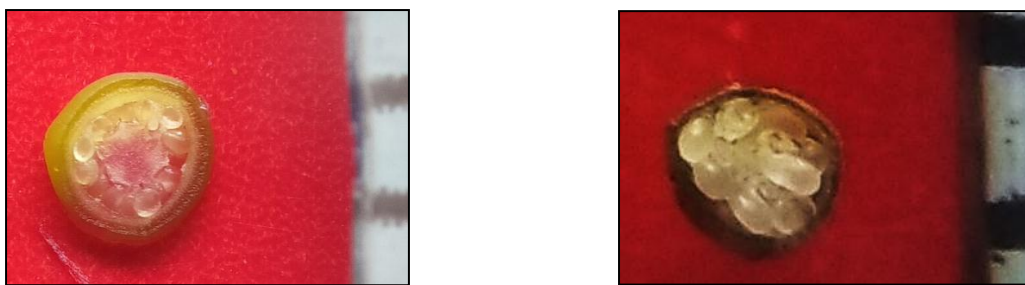


Figure 12 T.S of ovary of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn



Figure 13 Fruits of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

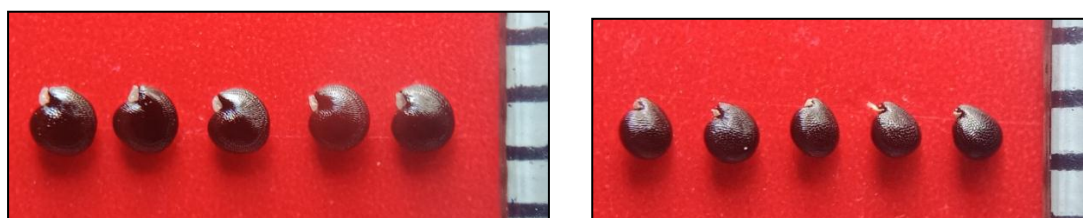


Figure 14 Seeds of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

Histological characters of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

Lamina

In surface views of lamina of both plants, epidermal cells were slightly wavy on upper surfaces. The wavy epidermal cells were present on lower surfaces of both plants. The upper epidermal cells of *T. triangulare* (Jacq.) Willd. were longer than of *T. paniculatum* (Jacq.) Gaertn. Paracytic stomata were found on both surfaces of both plants.

In transverse sections of lamina, both plants have two palisade mesophyll layers under upper epidermis and four layers of spongy mesophyll above lower epidermis. Both plants have calcium oxalate crystals in the mesophyll layers. The larger crystals were found in the mesophyll of *T. triangulare* (Jacq.) Willd.

Midrib

In both plants, the epidermal cells were elongated in surface view of lower portions. Paracytic stomata were also found.

In transverse sections of lamina of both plants, the upper portions were narrow and the lower portions were convex and rounded. The vascular bundles were collateral type. The ground tissue consists of 7 – 9 layers of parenchymatous cells.

Stem

In surface views of both plants, the epidermal cells were pigmented, thick-walled and rectangular to polygonal in shaped.

In transverse sections of the young stems, *T. triangulare* (Jacq.) Willd. was triangular in outline. The young stem of *T. paniculatum* (Jacq.) Gaertn. was more or less rounded in outline. Vascular bundles were arranged into ring in both plants. The cuticle layer of *T. triangulare* (Jacq.) Willd. was thicker than that of *T. paniculatum* (Jacq.) Gaertn.

The collenchymatous layers were more in *T. paniculatum* (Jacq.) Gaertn. The sclerenchymatous bundle cap was found only in *T. triangulare* (Jacq.) Willd. The mucilage and starch grains were abundantly present in both young stems. The larger starch grains were found in stem of *T. paniculatum* (Jacq.) Gaertn. Papillae were found only on the stem of *T. triangulare* (Jacq.) Willd.

Both old stems were circular in outline. The sclerenchymatous bundle caps were present in old stem of both plants.

Root

In transverse sections of both young roots, the vascular bundles were pentarch. The ground tissues consist of about three layers of parenchymatous cells. In old roots, starch grains were found only in *T. paniculatum* (Jacq.) Gaertn.

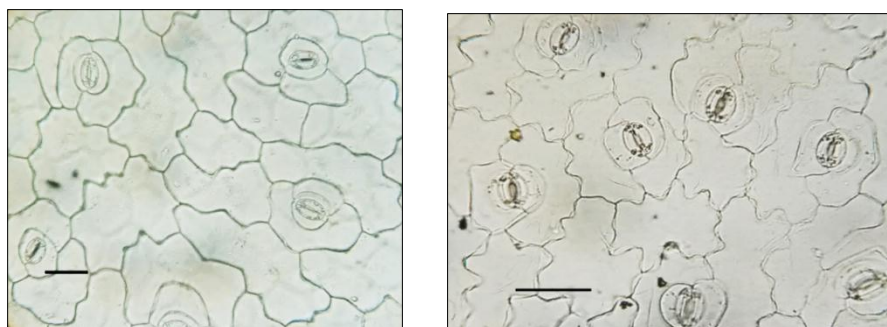


Figure 15 Upper and lower epidermis of *T. triangulare* (Jacq.) Willd. lamina; Bar = 50 μ m

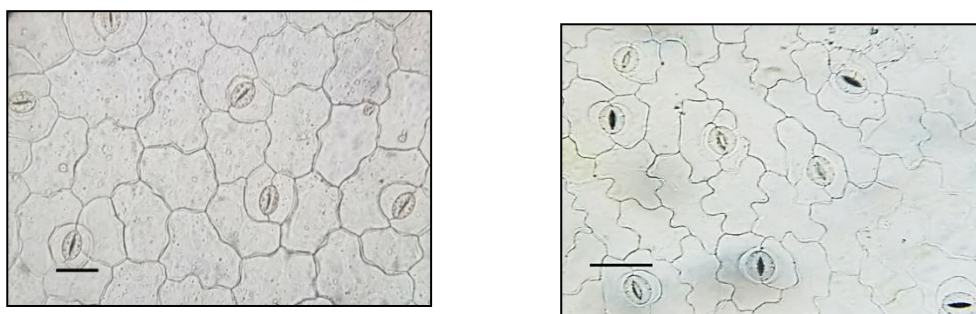


Figure 15 Upper and lower epidermis of *T. paniculatum* (Jacq.) Gaertn lamina; Bar = 50 μ m

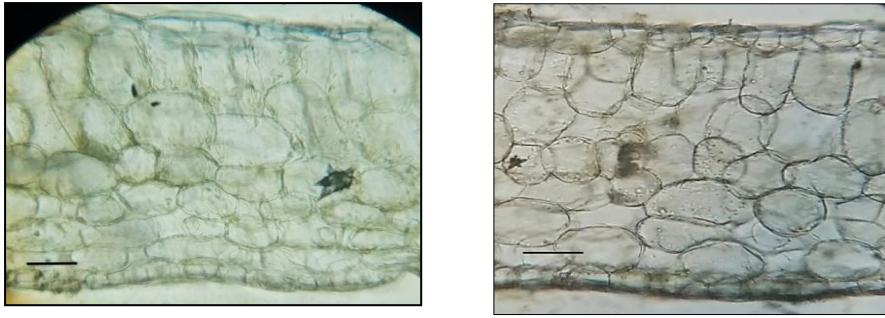


Figure 16 T.S of lamina of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.; Scale bar = 50 μ m



Figure 17 Epidermis of midrib of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. Bar = 50 μ m

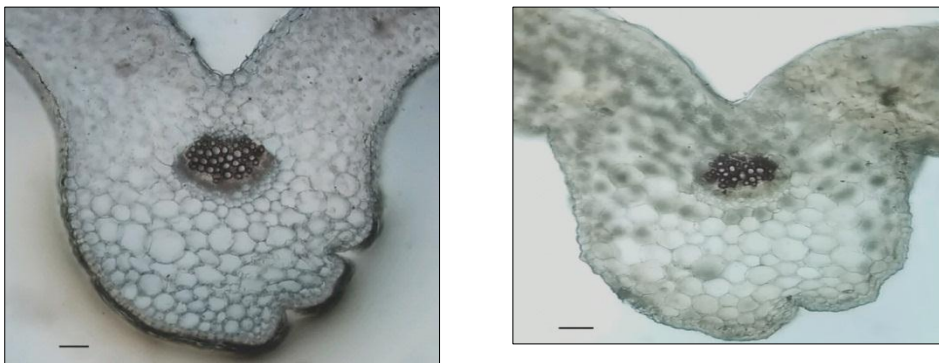


Figure 18 T.S of midrib of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. Bar = 100 μ m

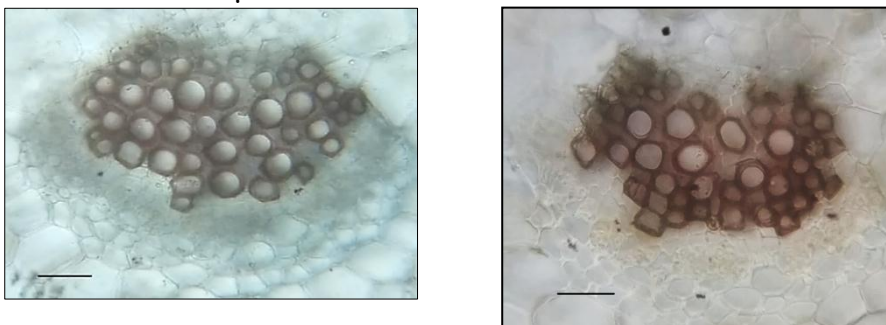


Figure 19 Vascular bundles of midrib of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. Bar = 50 μ m

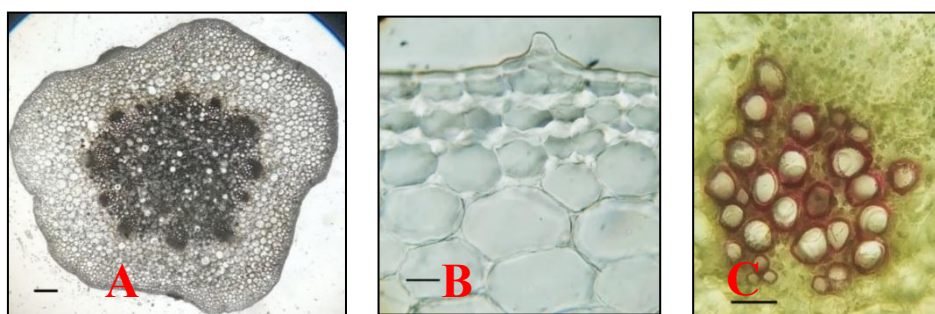


Figure 20 T.S of young stem of *T. triangulare* (Jacq.) Willd., (A) Outline; Bar = 300 µm (B) Collenchyma and parenchyma cells, (C) Vascular bundle; Bar = 50 µm

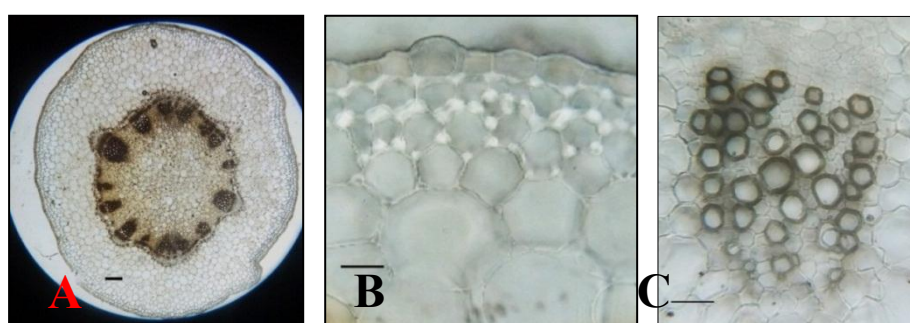


Figure 21 T.S of young stem of *T. paniculatum* (Jacq.) Gaertn., (A) Outline treated with iodine solution; Bar = 300 µm, (B) Collenchyma and parenchyma cells, (C) Vascular bundle; Bar = 50 µm

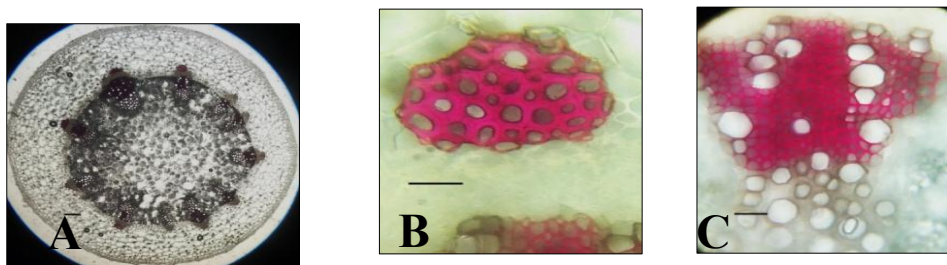


Figure 22 T.S of old stem of *T. triangulare* (Jacq.) Willd. (A) Outline; Bar = 300 µm, (B) Group of pericyclic fibers, (C) Vascular bundle; Bar = 50 µm

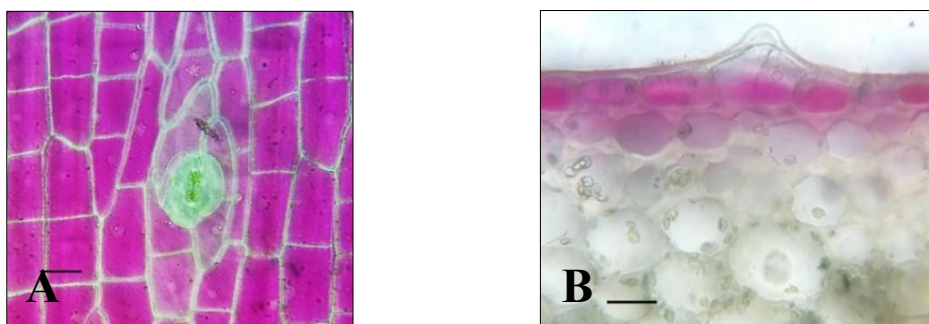


Figure 23 Epidermis of old stem of *T. triangulare* (Jacq.) Willd. (A) Surface view (B) Transverse section; Bar = 50 µm

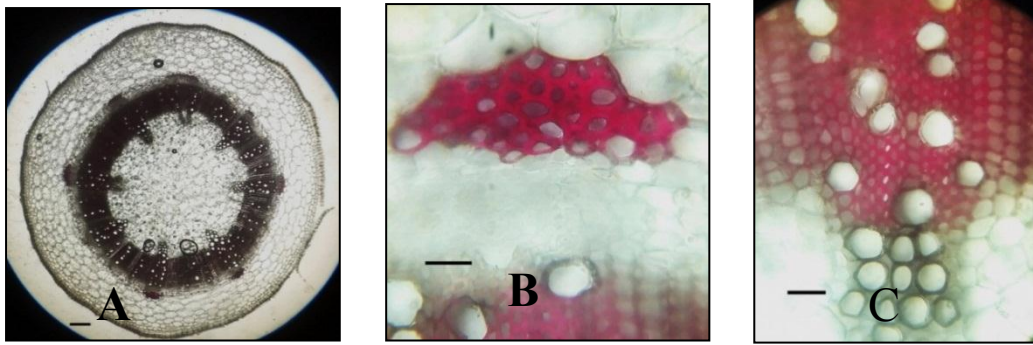


Figure 24 T.S of old stem of *T. paniculatum* (Jacq.) Gaertn., (A) Outline; Bar = 300 μm , (B) Group of pericyclic fibers, (C) Vascular bundle; Bar = 50 μm

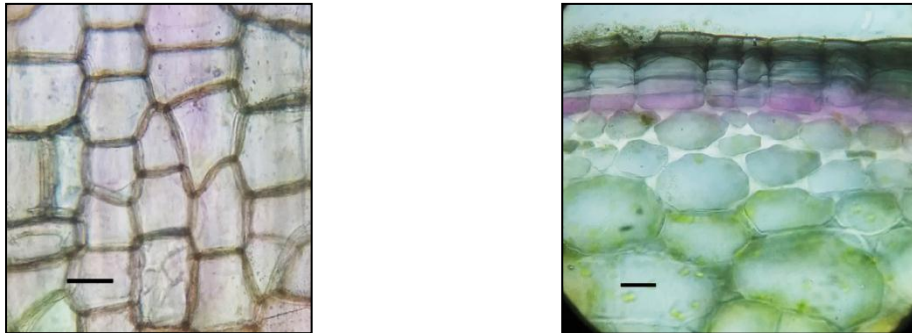


Figure 25 Periderm of old stem of *T. paniculatum* (Jacq.) Gaertn.; Bar = 50 μm

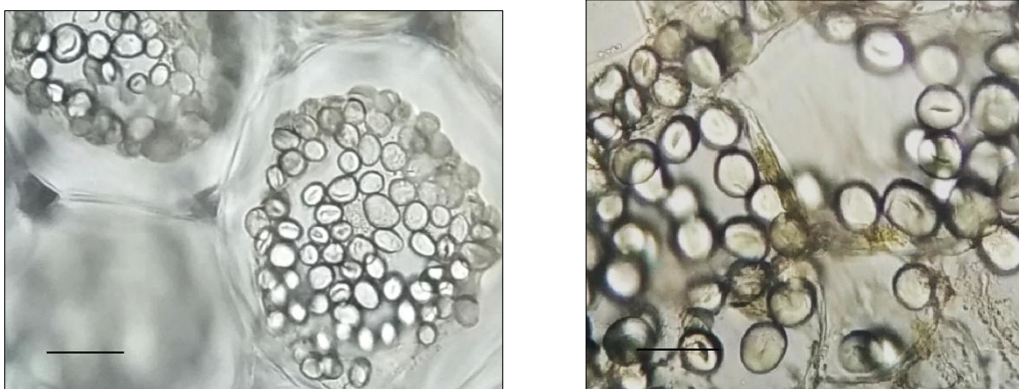


Figure 26 Starch grain found in stems of *T. triangulare* (Jacq.) Willd. And *T. paniculatum* (Jacq.) Gaertn.; Bar = 50 μm

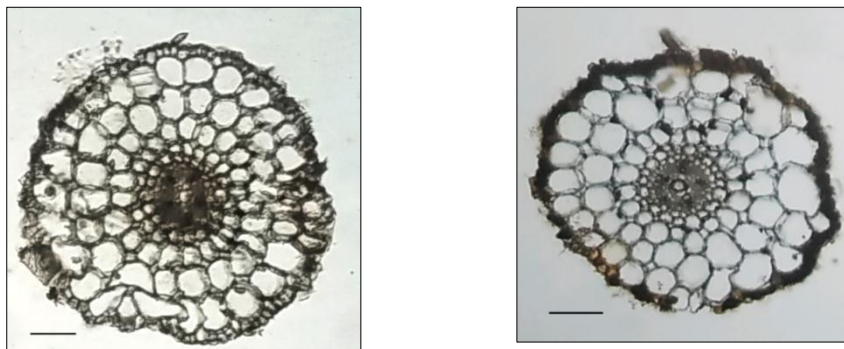


Figure 27 T.S of young root of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. Bar = 100 μm

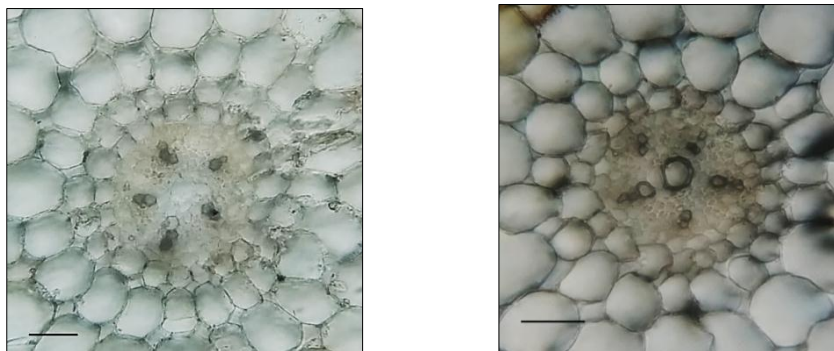


Figure 28 Vascular bundles of young root of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. Bar = 50 μ m

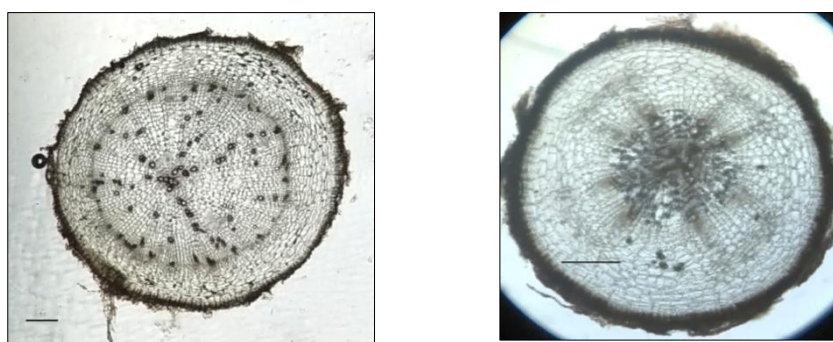


Figure 29 T.S of old root of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. Bar = 300 μ m

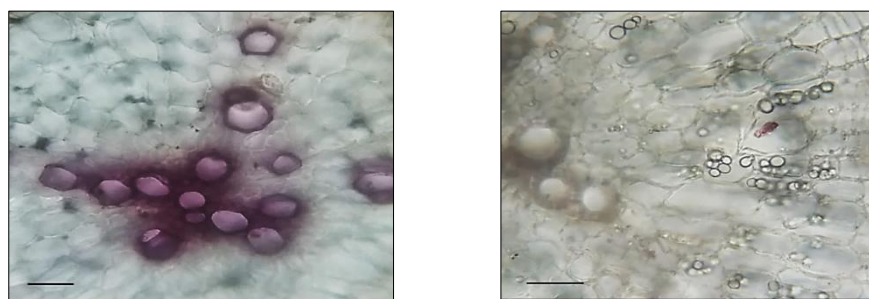


Figure 30 Vascular bundle of old root of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. Bar = 50 μ m

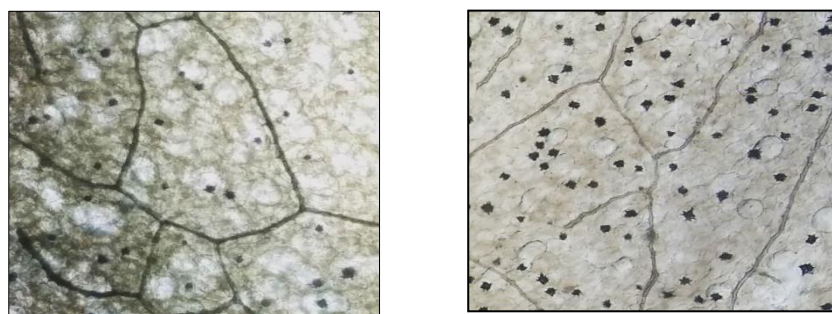


Figure 31 Veins of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn. on per square mm of leaves

Table 1 Numerical values of leaves of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

Characters	Values	
	<i>T. triangulare</i> (Jacq.) Willd.	<i>T. paniculatum</i> (Jacq.) Gaertn.
Stomatal index (upper)	13.2 – 13.8 – 16.8	9.6 – 11.3 – 12.8
Stomatal index (lower)	27.2 – 28.5 – 30.7	21.1 – 23.7 – 30.3
Palisade ratio	1.3 – 2.0 – 2.3	1.3 – 1.6 – 2.0
Vein-islets number	2.0 – 2.5 – 3.0	1.0 – 2.0 – 4.0
Vein terminations number	1.0 – 2.3 – 3.0	1.0 – 2.0 – 3.0

Table 2 Comparative morphological features of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

Features	Species	
	<i>T. triangulare</i> (Jacq.) Willd.	<i>T. paniculatum</i> (Jacq.) Gaertn.
Colour of root	Light brown	Dark brown
Leaf apex	Retuse	Acute
Inflorescence type	Cymose	Panicle cyme
Peduncle	Triangular	Terete
Sepal	Persistent, white with green prominent veins	Caducous, brown
No. of stamens	Numerous	10
Fruits	Creamy white with reddish brown spot	Yellowish green to brown

Table 3 Comparative histological features of *T. triangulare* (Jacq.) Willd. and *T. paniculatum* (Jacq.) Gaertn.

Features	Species	
	<i>T. triangulare</i> (Jacq.) Willd.	<i>T. paniculatum</i> (Jacq.) Gaertn.
Outline of young stem	Triangular	More or less rounded
Xylem vessels of young stem	Circular	Rectangular to polygonal
Papillae on stem	Presence	Absence
Starch in stem	Abundantly presence	Sparsely presence
Starch in old root	Absence	Presence

Discussion and Conclusion

According to morphological study, *T. triangulare* (Jacq.) Willd. can be distinguished from *T. paniculatum* (Jacq.) Gaertn. by its light brown color root. According to Backer (1963) and Dassanayake (1996), *T. triangulare* (Jacq.) Willd. can be differentiated from *T. paniculatum* (Jacq.) Gaertn. by its triangular flowering stem, leaves obtuse or emarginated and stamens more than 15. These characters were the same with those findings in this study.

Another differences between these two species were the shape and colour of sepals and fruits. Their flowering time was also different. Backer (1963) stated *T. triangulare* (Jacq.) Willd. as forenoon-flowering plant and *T. paniculatum* (Jacq.) Gaertn. as afternoon-flowering plant. *T. triangulare* (Jacq.) Willd. flowered around 10 am. The flowers of *T. paniculatum* (Jacq.) Gaertn. were collected at around 4 pm. These morphological characters can help in the identification and between these two related species.

In this study, the histology of both species was investigated and compared. Although the basic histological characters of these two species were relatively similar, some distinctive differences were found. *T. triangulare* (Jacq.) Willd. can be differentiated from *T. paniculatum* (Jacq.) Gaertn. by the presence of triangular outline young stem, presence of papillae and rounded xylem vessels.

Metcalf and Chalk (1950) reported that rubiaceous stomata were present on both surfaces in certain species of *Talinum*. Clustered crystals, papillae and mucilage cells were also present. Metcalf and Chalk (1950) also stated that the presence of mucilage make it very difficult to cut freehand sections of member of this family. The findings in this study were confirmed with those mentioned by Metcalf and Chalk (1950).

These distinctive histological characters can be used for species identification and differentiation. The phytochemical constituents and medicinal properties of these two species will be studied in the future.

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