Original Article

Anatomical Features of *Scutellaria tonkinensis* Doan in Vietnam

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**Abstract:** *Scutellaria* L. is a genus of flowering plant in the Lamiaceae. The genus includes about 350 species commonly known as skullcaps. *Scutellaria* is widespread in temperate regions and tropical mountains including Europe, North America and East Asia [1]. 15 species belonging to *Scutellaria* genus were recorded in Vietnam [2, 3]. Two species of *Scutellaria* are endemic in Vietnam [2]. Some *Scutellaria* species has been used in traditional medicine in many cultures [4]. Although *Scutellaria* species are potential gene sources for biologically active substances, researches on them are not many. One of the endemic species in Vietnam as *S. tonkinensis* Doan, which is distributed in Lao Cai (Sa Pa) and Vinh Phuc (Tam Dao). It has been recorded to grow in sunny and moist areas, forest edge or roadside, at altitude more than 1,000 meters. The study is an effort to understand the anatomical delimitation of *Scutellaria tonkinensis* Doan in a better way.

**Keywords:** *Scutellaria*, *Scutellaria tonkinensis* Doan, Lamiaceae, Vietnam, anatomy.

1. Introduction

*Scutellaria* L. is a genus of flowering plant in the Lamiaceae. *Scutellaria* is called by Thuan or Hoang cam in Vietnamese. The genus includes about 350 species commonly known as skullcaps. *Scutellaria* is widespread in temperate regions and tropical mountains including Europe, North America and East Asia [1]. 15 species belonging to *Scutellaria* genus were recorded in Vietnam [2, 3]. Two species of *Scutellaria* are endemic in Vietnam [2]. Some *Scutellaria* species has been used in traditional medicine in many cultures [4]. Although *Scutellaria* species are potential gene sources for biologically active substances, researches on them are not many. One of the endemic species in Vietnam as *S. tonkinensis* Doan, which is distributed in Lao Cai (Sa Pa) and Vinh Phuc (Tam Dao). It has been recorded to grow in sunny and moist areas, forest edge or roadside, at altitude more than 1,000 meters. The study is an effort to understand the anatomical delimitation of *Scutellaria tonkinensis* Doan in a better way.

2. Material and Methods

The research materials were obtained specimens of *S. tonkinensis* Doan which was collected in Tam Dao National Park, in Vinh Phuc province located the North of Vietnam. Efforts were made to collect both flowering and fruiting specimens for studying morphological characteristics. The samples were collected in
2017, 2018, 2019. Collecting samples according to Nguyen Nghia Thin [5]. No. of specimens studied as TX361 that have been keeping in Herbaria of Hanoi University.

Using anatomical research method, double-staining method to study root, stem and leave structures, according to F. David Cutler, Ted Botha, and Wm. Dennis Stevenson [6] and Nguyen Khoa Lan [7].

3. Results

3.1. Root

The cross section is circular. The outermost is epidermis with long hirsute that possess efficient in absorption (Fig.1: 1, 3, 4). More root absorbent hair increases the contact area between the roots and soil, increases the ability to absorb water and nutrients. Radial vascular bundle has polyarch protoxylem and is located in the middle of the root (Fig. 1: 1, 2). Xylem develops from the outside inwards towards the center (exarch). Parenchyma consists of polygonal cells with large intercellular space allowing water to be absorbed fluently. Casparian strip is developing to play the role in regulatory of water absorption (Fig. 1: 6).

Comparing secondary root to primary root, transport system has developed completely. From outside to inside, there are epidermis, parenchyma, sclerenchyma, endodermis, phloem and xylem (Fig. 1: 5, 6). Parenchyma consists of multi-layer of big polymorphism cells with large intercellular space. Vascular bundle is concentric, periphloematic. Endodermis is impregnated with casparian strip to restrict apoplastic flow of water to the inside. Sclerenchyma gather perpendicularly to some spots outside the phloem, plays the role of mechanical support.

![Figure 1. The transverse section of the root of S. tonkinensis.](image)

Ca: Casparian strip; E: epidermis; En: endodermis; P: parenchyma; Ph: phloem; Rh: root hirsute; S: sclerenchyma; Vb: Vascular bundle; X: xylem. Bar = 100 µm.L

3.2. Stem

The cross section of primary stem is square, with a parallel convex side pair (Fig. 2: 1, 5). This is the most recognizable feature of Lamiaceae species. Epidermis contains needle-shaped multicellular trichomes and glandular trichomes and is covered by a thin layer of cuticle (Fig. 2: 3, 4, 8). The epidermis includes of uniseriate small polygonal cells arranged
regularly, single layer (Fig. 2: 7). Collenchyma cells concentrate in 4 corners, contribute to the rigidity of stem (Fig. 2: 5). It’s nearly the same stem structure of *S. barbata* (Do Thi Lan Huong) [8]. Vascular bundles are collateral open and located at 4 corners. Parenchyma in the center consists of big polygonal cells (Fig. 2: 2, 6).

*Secondary stem* with xylem is arranged around the stem. Vascular cambium is located between xylem and phloem. Cortex parenchyma has relatively large intercellular space. That allow the plant to adapt to wet environment (Fig. 2: 7, 8) (Nguyen Khoa Lan; Nguyen Ba) [7, 9]. Besides, sclerenchyma has been formed and arranged exteriorly along phloem at 4 corners and in convex sides, contributes to rigidity of the stem.

In many cases, parenchyma matures very early and stops growing. In contrast, the surrounding has the properties of nascent tissue, which further expand horizontally and vertically. So the middle part of the plant may expand gradually and form a hollow plant. The cross section of primary stem is square, with a parallel convex side pair (Fig. 2: 1, 5). This is the most recognizable feature of Lamiaceae species. Epidermis contains needle-shaped multicellular trichomes and glandular trichomes and is covered by a thin layer of cuticle (Fig. 2: 3, 4, 8). The epidermis includes of uniseriate small polygonal cells arranged regularly, single layer (Fig. 2: 7). Collenchyma cells concentrate in 4 corners, contribute to the rigidity of stem (Fig. 2: 5). It’s nearly the same stem structure of *S. barbata* (Do Thi Lan Huong) [8]. Vascular bundles are collateral open and located at 4 corners. Parenchyma in the center consists of big polygonal cells (Fig. 2: 2, 6).

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Figure 2. The transverse section of the stem of *S. tonkinensis*.
C: collenchyma; E: epidermis; Gt: glandular trichome; P: parenchyma; Ph: phloem; S: sclerenchyma; Vb: Vascular bundle; T: trichome; X: xylem. Bar = 100 μm.
3.3. Leaf

- Leaf blade: Leaf surface is covered by a multicellular needle-shape trichomes and glandular trichomes (Fig. 3: 2, 4). Leaf trichomes are similar to stem trichomes. Cuticle is thick, restricts the evaporation to adapt to extensive insolation (Nguyen Khoa Lan, 1996; Nguyen Ba; C. William Dickson; T. William Penfound) [7, 9, 10, 11]. Upper epidermis consists of large cells arranged regularly (Fig. 3: 1, 3). Mesophyll region is composed of 2 layers of elongated rectangular palisade cells and 3-6 layers of irregular spongy cells with large intercellular space (Fig. 3: 3). That indicate that the plant is a heliophyte (William C. Dickson; William T. Penfound) [10, 11]. Lower epidermis consists of small cells. (Fig. 3: 1, 3, 4)

- Leaf vein: Leaf vein is convex in the underside and slightly convex or straight in the upper side. Outermost layer is epidermis covered by trichomes. Below epidermis in underside, there are 1-2 layers of collenchyma, contributing the rigidity. Next is parenchyma with polygonal cells and large intercellular space. There is an open vascular bundle in the center of the vein that plays the role of transportation (Fig. 3: 1, 2).

S. tonkinensis have anatomical characteristics that allow them to adapt to a habitat with intensive insolation. Trichomes cover all surface of stem and leaf along with thick cuticle in leaf that prevents evaporation of water from the epidermal surface under the sunlight. In addition, relatively developed intercellular space system provides them ability to grow in habitat with abundance of water condition.

Usually the humid and heliophyte plants usually grow in moist grasslands, mostly herb species (Nguyen Khoa Lan) [7]. When investigating the distribution of S. tonkinensis in the nature, individuals of S. tonkinensis were recorded often along the forest path, where there is a lot of light, near water sources.

Figure 3. The transverse section of the leaf of S. tonkinensis.
Cu: Cuticle; Gt: glandular trichome; Le: lower epidermis; P: parenchyma; Ph: phloem; Pm: palisade mesophyll; Sm: spongy mesophyll; T: trichome; Ue: Upper epidermis; V: Vascular bundle; X: xylem. Bar = 100 µm.

4. Conclusion

- S. tonkinensis Doan has squared stem cross-section. Stem vascular bundles are collateral open and locate in 4 corners. Secondary root cross-section is radial and has a radial vascular bundle locates in the center. Xylem in root develops from the outside inwards towards the center (exarch). Leaf has 2 layers of elongated rectangular palisade cells and 3-6 layers of irregular spongy cells with large intercellular space. Collateral open vascular bundle is located in the center of the leaf vein.

- S. tonkinensis Doan adapt to a habitat with high moisture and intensive insolation.

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