



Full Length Article

Anatomical And Glandular Trichome Characteristics of *Scutellaria salviifolia* (Lamiaceae) Endemic to Turkey

İlkay Öztürk Çalı*

Biology Department, Science and Art Faculty, Amasya University, Turkey

*For correspondence: ilkaycali@hotmail.com

Abstract

The anatomy and glandular trichome morphology of endemic *Scutellaria salviifolia* Benth (Lamiaceae) were examined to comprehend the important characteristics for systematic purposes. Some anatomical characters for example often 2 rarely 9–12 rowed pith rays in roots, the quadrangular stem and sclerenchymatous cells groups on the corners of stem, caryophyllaceous stoma and izobilateral leaf, one small subsidiary bundle on the corners and one big vascular bundle in petiole provide important information of taxonomical significance. Four different glandular trichome types were determined on *S. salviifolia*. The glandular trichome types were peltate (type I), type IIA, type IIB and type IIC capitate glandular. Peltate, type IIA and type IIB capitate glandular trichomes were seen nearly all organs of *S. salviifolia*, but type IIC capitate glandular trichomes were observed on only calyx. Type IIC capitate glandular trichomes are of very special type, which can be the significant taxonomic character of plant. © 2017 Friends Science Publishers

Keywords: Anatomy; Trichome; *Scutellaria salviifolia*; Endemic; Lamiaceae

Introduction

The family Lamiaceae has a number of species. This family consists of 258 genera and 3500 species on the earth (Duarte and Lopes, 2007), out of which 45 genera and 546 species are distributed in Turkey (Davis, 1982). It also has an economic value. Quite a few species belongs this family are aromatic (Werker *et al.*, 1985). Turkish people consume many species of family Lamiaceae as herbal teas. Some species are used in cosmetic industry. Many species are traditionally used to treat diseases and others are used for ornamentation (Baytop, 1984).

Scutellaria L. is very important genus in this family. This genus has approximately 300 species (Paton, 1990; Pool, 2006; Judd *et al.*, 2009). *Scutellaria* L. is seen every continent except for Antarctica. The main origin of genus diversity is Iran-Turanian region of Asia. The secondary centres of *Scutellaria* L. diversity are Eastern Mediterranean and the Andes (Paton, 1990; Bruno *et al.*, 2002). It is accepted that Turkey is center of origin of Lamiaceae family to which this genus belongs (Başer, 1993). *Scutellaria* L. genus consists of 24 species, 13 subspecies and one hybrid in the flora of Turkey; 13 out of these species are endemic to Turkey (Çiçek, 2008).

The species of *Scutellaria* L. genus are used as herb spices, fragrances, traditional and folk medicines. People in the world name this genus as “powerful medicinal herbs” which are mild relaxants that affect the neural and muscular-

skeletal systems (Werker *et al.*, 1985; Duke *et al.*, 1989; Zargari, 1990). *Scutellaria* L. species are used in different area (Ersöz *et al.*, 2002; Chou *et al.*, 2003).

In despite of the great economic importance of *Scutellaria* L., only a few studies have been reported on this genus. These studies provide general information on the morphological and anatomical structure and very brief anatomical characterization of vegetative organs. Especially no comprehensive studies are found on glandular trichome morphology in *Scutellaria* L. genus.

The glandular trichomes are very important taxonomical characters for Lamiaceae family and play an important role for pollination (Navarro and Oualidi, 2000). This genus has various glandular trichomes that secrete “scutellarin” on the abaxial epidermis. These trichomes have different number of cell. The properties of these glandular trichomes are used in taxonomy of the genus (Metcalf and Chalk, 1972). The purpose of this study was to unveil some anatomical characteristics and taxonomic usefulness of glandular trichome in *Scutellaria salviifolia*.

Materials and Methods

Plant samples of *Scutellaria salviifolia* Benth for this study were collected from Amasya, East of Karaman mountain, open forests, 500 m, June 2012. The specimens were kept as a herbarium material. Flora of Turkey was used for its taxonomical description (Davis, 1982).

The tissues of *S. salviifolia* were fixed in 70% alcohol for anatomical and trichome properties. Transverse sections for anatomical preparation of vegetative and reproductive organs were performed with commercial razor blades. Sartur reagent was applied to the sections for investigation of some anatomical tissues easily (Çelebioğlu and Baytop, 1949). A binocular light microscope, equipped with Camera and 10X to X40 objectives (Leica ICC50 HD) were used to obtain the minimum and maximum values of width and length. Preparations were photographed with the binocular light microscope and the camera mentioned above. Glandular trichomes were obtained from *S. salviifolia* by transverse and surface sections. The glandular trichome preparations were prepared under the binocular light microscope. The glandular trichome types and distributions were described. The glandular trichomes types studied in this paper were classified according to Metcalfe and Chalk (1972) and Navarro and El Oualidi (2000).

Results

Anatomy

Root: *S. salviifolia* root has periderm, which consists of multilayered cells. The cortex has 4–8 rowed cells, which are $32.5\text{--}90 \times 25\text{--}47.5$ μm thick (Table 1). Sclerenchma tissues are in front of the phloem part (Fig. 1a). The vascular bundle is collateral in the center.

Stem: A 4-angle stem has epidermis which consists of one layer of ovoidal cells. There is cuticle glandular or eglandular trichomes on epidermis. Transverse section of the stem reveals 7–8 layered collenchyma on the corners (Fig. 1b). Also there are sclerenchma cells on the corners as well. The cortex has 5–9 layered paranchyma. Beneath the phloem, there is 1–2 rowed cambium layer. The cambium cells are easy distinguishable. The pith has paranchymatous ovoidal cells. The vascular bundle is collateral.

Leaf: The surfaces of *S. salviifolia* leaf has one layered epidermis. Epidermis has glandular and eglandular trichomes. The cuticle is $2.5\text{--}7.5$ μm thick. There are 3–4 rowed palisade parenchyma cells under the epidermis. The palisade parenchyma cells are $7.5\text{--}12.5 \times 25\text{--}55$ μm thick (Table 1). Mesophyll consisting wholly of the palisade cells in *S. salviifolia* (Fig. 2c, d). The stomata are caryophyllaceous and presents on both surfaces of the leaf (Fig. 2e, f).

Petiole: The epidermis cells of petiole are one layered and rectangular in shape. Collenchyma between the corners is 2 layered. Cortex is paranchymatous. Chlorenchymatic cells are seen at each corner. There is one small subsidiary bundle on the corners and one big vascular bundle (Fig. 3g, h). Petiole has 3 vascular bundles. The median bundle is arch-shaped. The vascular bundle is collateral.

Calyx: The adaxial epidermis cells of calyx are $7.5\text{--}15 \times 10\text{--}12.5$ μm whereas the abaxial epidermal cells are $7.5\text{--}25 \times 10\text{--}15$ μm (Table 1). The cuticle on both epidermal cells

Table 1: Anatomical characteristics of *S. salviifolia*

Anatomical character	Length (μm)	Width (μm)
	Min – Max	Min – Max
The root anatomy		
Peridermis cell	7.5 – 37.5	15 – 42.5
Parenchyma cell	25 – 47.5	32.5 – 90
Trachea cell	12.5 – 50	12.5 – 37.5
The stem anatomy		
Cuticle		1.25 – 5
Epidermis cell	5 – 20	10 – 30
Parenchyma cell	12.5 – 37.5	22.5 – 65
Trachea cell	10 – 37.5	10 – 32.5
Pith cell	45 – 102.5	37.5 – 112.5
The leaf anatomy		
Cuticle		2.5 – 7.5
Adaxial epidermis cell	17.5 – 32.5	17.5 – 55
Abaxial epidermis cell	12.5 – 27.5	10 – 45
Parenchyma cell	25 – 55	7.5 – 12.5
The petiole anatomy		
Adaxial epidermis cell	7.5 – 27.5	10 – 30
Abaxial epidermis cell	2.5 – 17.5	10 – 20
Parenchyma cell	10 – 42.5	15 – 62.5
Trachea cell	7.5 – 15	10 – 17.5
The calyx anatomy		
Adaxial cuticle		1.25 – 2.5
Adaxial epidermis cell	10 – 12.5	7.5 – 15
Abaxial cuticle		1.25 – 2.5
Abaxial epidermis cell	10 – 15	7.5 – 25
Parenchyma cell	10 – 25	7.5 – 15
The corolla anatomy		
Adaxial cuticle		1.25 – 2.5
Adaxial epidermis cell	15 – 30	7.5 – 37.5
Abaxial cuticle		1.25 – 2.5
Abaxial epidermis cell	12.5 – 25	12.5 – 32.5
Parenchyma cell	10 – 22.5	10 – 30

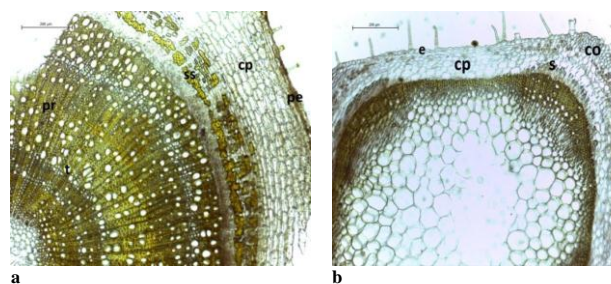


Fig. 1: Cross section of root (a) and stem (b) of *S. salviifolia* pe: periderm, cp: cortex parenchyma, ss: sclerenchmatical sheat, pr: pith rays, t: trachea, e: epidermis co: collenchyma s: sclerenchma t: trachea

is of the same dimension ($1.25\text{--}2.5$ μm). Parenchymatic cells are flat ovoidal (Fig. 4i). The surface of calyx has glandular trichomes, which are peltate (type I), type IIA and type IIC capitate trichomes.

Corolla: The dimensions of the adaxial epidermis cells are $7.5\text{--}37.5 \times 15\text{--}30$ μm whereas those of the abaxial epidermis ones are $12.5\text{--}32.5 \times 12.5\text{--}25$ μm (Table 1). There are parenchyma cells in the center (Fig. 4j). The abaxial and adaxial epidermis surfaces have both glandular and eglandular trichomes. The glandular

Table 2: Types of glandular trichomes and their localization in *Scutellaria salviifolia*

Organ	Type II capitate glands									Type I peltate	
	Type II A			Type II B			Type II C			Central cell	Peripheral cell
	Head cell	Stalk Cell	Basal Cell	Head cell	Stalk cell	Basal cell	Head cell	Stalk cell	Basal cell		
Stem	2	4	1	1	3	1	-	-	-	2	6
	2	3	1	-	-	-	-	-	-	1	4
	1	4	1	-	-	-	-	-	-	-	-
	1	3	1	-	-	-	-	-	-	-	-
Leaf	1	3	1	1	4	1	-	-	-	4	6
	1	4	1	-	-	-	-	-	-	1	6
	1	2	1	-	-	-	-	-	-	-	-
	1	4	2	-	-	-	-	-	-	-	-
Petiole	1	3	1	1	3	1	-	-	-	1	4
	2	2	1	1	1	1	-	-	-	-	-
	2	3	1	-	-	-	-	-	-	-	-
Calyx	2	4	1	-	-	-	12-16	3	2	1	4
	1	3	1	-	-	-	12-16	4	1	1	7
	2	4	1	-	-	-	6	3	1	-	-
	2	5	1	-	-	-	-	-	-	-	-
Corolla	2	4	1	1	5	1	-	-	-	1	4
	2	3	1	1	4	1	-	-	-	-	-
	1	4	1	-	-	-	-	-	-	-	-

trichomes are peltate trichomes (type I), type IIA and type IIB capitate trichomes.

Glandular Trichome Characteristics

There are four different glandular trichome types on several organs of *S. salviifolia*. These are peltate (type I) and type II capitate trichomes (Table 2). The peltate trichomes consist of a basal epidermal cell, a short stalk and round multicellular secretory head. The secretory head has different number of cells (four, six or seven) in the single shield (Fig. 5a, b). Type II capitate trichomes have a basal epidermal cell, unicellular to multicellular stalk cell and a large unicellular, bicellular or multicellular secretory head. Type II capitate trichomes are of three subtypes; type IIA, type IIB and type IIC (Fig. 5c–h). Type IIA capitate trichomes have unicelled or bicelled head and stalk of two to five cell (Fig. 5c, d). Type IIB capitate trichome is a cup-shaped unicellular head and one to five-celled stalk (Fig. 5e, f). Type IIC capitate trichome is very special trichome type with head cells radiate (Fig. 5g–h). This trichome type has 6–12 or 16-celled head like daisy shaped and three to four-celled stalk. Type IIC capitate trichomes were observed only on calyx of the plant.

Discussion

This study provided significant insight on the anatomical and glandular trichome characteristics of the plant. Measurements and observations of anatomical and glandular trichome properties of *S. salviifolia* are presented for the first time. The investigations on *Scutellaria* L. species are rather limited. The studies carried out on *Scutellaria* species shows only general characterization such as general morphological and anatomical study on varies

organs of *Scutellaria* species (Özdemir and Altan, 2005) and or very brief anatomical description on the genus species (Hatamneia *et al.*, 2008; Oliveira *et al.*, 2013).

The root anatomy of Lamiaceae family has some imported anatomical information (Metcalf and Chalk, 1972). The roots of Lamiaceae have pith rays which consist of 2–12 or more layered cells. The pith rays of *S. salviifolia* have often 2 rarely 9–12 layered cells. The results were parallel with Metcalfe and Chalk (1972) and other studies (Baran and Özdemir, 2009; Özkan and Soy, 2007). The species of Lamiaceae have quadrangular stem and there is a scleranchymatous tissue outside of the vascular bundles (Metcalf and Chalk, 1972). The stem of *S. salviifolia* was quadrangular and there were groups of sclerenchymatous cells on the corners in this study. Quadrangular stem and a scleranchymatous tissue outside of the vascular bundles are reported in other species of Lamiaceae (Baran and Özdemir, 2006; Kahraman *et al.*, 2010). It was also reported that Lamiaceae family has collenchyma on the four corners of stem (Metcalf and Chalk, 1972). Like *Salvia chrysophylla* a members of Lamiaceae family (Kahraman *et al.*, 2010), *S. salviifolia* has collenchyma in the four angles of stem. The vascular cambium was observed in *S. salviifolia*, like another species of Lamiaceae (Dinç and Öztürk, 2008). The leaf of *S. salviifolia* is izobilateral. Mesophyll consisting wholly of the 3–4 rowed palisade parenchyma cells. The stoma type of plant is caryophyllaceous (Inamder and Bhatt, 1972) and is present on both surfaces of the leaf. The vascular bundle number of petiole in Lamiaceae family is very important because it could be used as a taxonomic attribute (Metcalf and Chalk, 1972). The anatomical characteristics of petiole in species shows differences (Baran and Özdemir, 2006). Besides, the important petiole anatomical properties are determined for taxonomical purpose (Olowokudejo, 1987). Calyx and corolla of the species consisting wholly of parenchymatous cells.

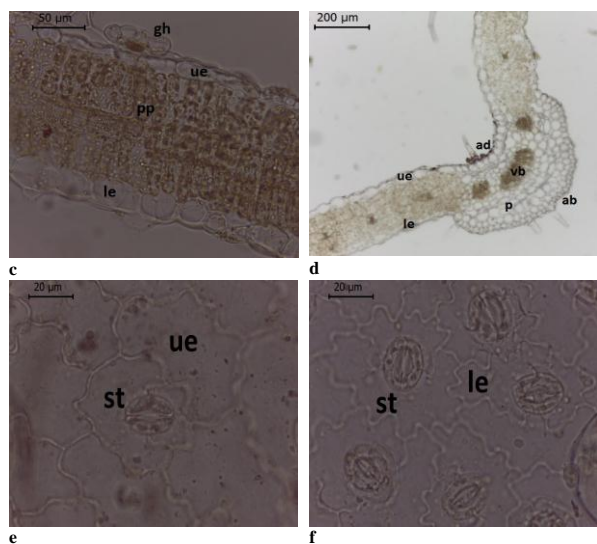


Fig. 2: Cross section of leaf blades of *S. salviifolia* (c, d) ue: upper epidermis pp: palisade parenchyma le: lower epidermis gh: glandular hair ab: abaxial epidermis of midrip ad: adaxial epidermis of midrip vb: vascular bundle p: parenchymatic cells. Surface section of *S. salviifolia* upper epidermis (e) lower epidermis (f) ue: upper epidermis le: lower epidermis st: stoma

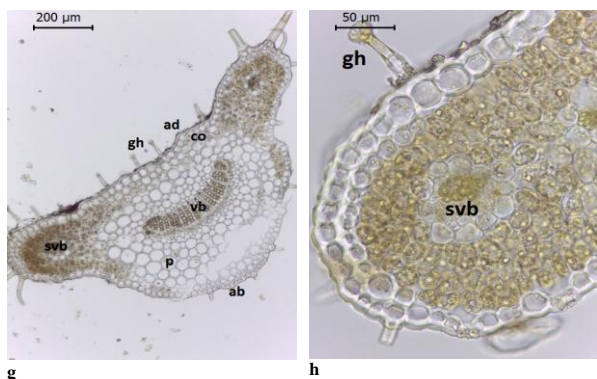


Fig. 3: Cross section of petiole (g, h) ab: abaxial epidermis ad: adaxial epidermis gh: glandular hair svb: subsidiary vascular bundle vb: vascular bundle p: parenchyma co: collenchyma

There are lots of glandular trichome on the calyx and corolla. Very special glandular trichomes as Type IIC were seen only on calyx. The morphological shapes, distribution and frequency of glandular trichomes are used as systematic properties at subfamily level in the Lamiaceae (Ascensao *et al.*, 1995). Peltate trichomes in Lamiaceae family have a large head of several secretory cells (up to 16) a wide short stalk and a basal epidermal cell (Hallahan, 2000). *S. salviifolia* has peltate trichomes comprising a basal epidermal cell, a very short monocellular stalk and a round multicellular secretory head. The head has four or six cells

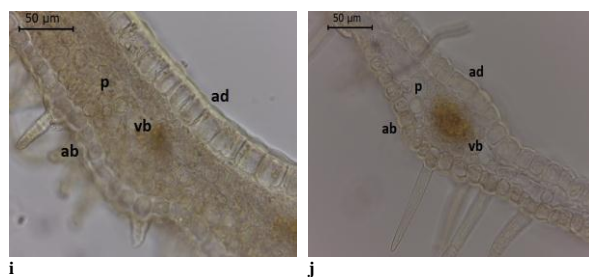


Fig. 4: Cross section of calyx (i) and corolla (j) of *S. salviifolia* ab: abaxial epidermis ad: adaxial epidermis vb: vascular bundle p: parenchyma

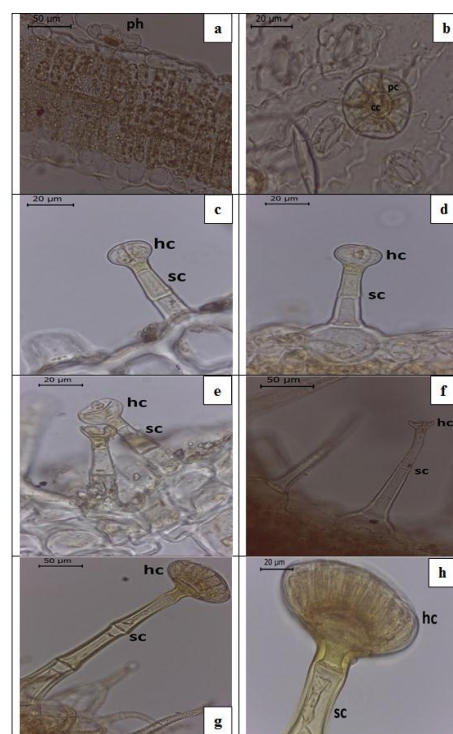


Fig. 5: Peltate glandular trichomes of *S. salviifolia* on the cross section of leaf (a) and surface section of leaf (b) cc: center cell ph: peltate hair pc: periphery cell Type II A capitate glandular trichome on petiole (c) and on leaf (d) hc: head cell sc: stalk cell Type II B capitate glandular trichome on petiole (e) and on leaf (f) Type II C capitate glandular trichome on calyx (g, h)

in the single shield. Capitate glandular trichomes are important characters in taxonomy and pollination in Lamiaceae (Navarro and El Oualidi, 2000). These trichomes vary in structure and size. In the study, there are three types of capitate glandular trichomes on the several organs of *S. salviifolia*. Type IIA and type IIB capitate glandular trichomes are seen nearly in all organs of *S. salviifolia*, but type IIC capitate glandular trichomes are noted only on calyx. Type IIC capitate glandular trichomes with 6–12 or

16-celled radiate head and three to four-celled stalk are unique to *S. salviifolia*, although type IIA and type IIB capitate glandular trichomes are met in many species of Lamiaceae (Bisio *et al.*, 1999; Baran and Özdemir, 2009; Kahraman *et al.*, 2010). Type IIC capitate glandular trichomes are a significant taxonomic character of *S. salviifolia*.

Conclusion

Anatomical and glandular trichome characters of *S. salviifolia* provided important properties for distinguishing species in *Scutellaria*. The presence of often 2 rarely 9–12 rowed pith rays in roots, the quadrangular stem and sclerenchymatous cells groups on the corners of stem, caryophyllaceous stoma and izobilateral leaf, one small subsidiary bundle in the wings and one big vascular bundle in petiole. Peltate (type I), type IIA, type IIB and type IIC capitate glandular trichomes are found on several organs of *S. salviifolia*. Peltate, type IIA and type IIB capitate glandular trichomes are seen nearly all organs of *S. salviifolia*, but type IIC capitate glandular trichomes were noted on only calyx. Type IIC capitate glandular trichomes are of very special taxonomic character of *S. salviifolia*.

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