

Anatomical features of *Salvia potentillifolia* Boiss. & Heldr. ex Benth. and *Salvia nydeggeri* Hub.-Mor. (Lamiaceae)

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ABSTRACT

The genus *Salvia* is represented by 107 taxa in Turkey and 54 of them are endemic. The genus has been used medically since ancient times and it is known as “adaçayı”, “şalba”, “dağ çayı”, “çalba” in Turkish. Traditional uses of *Salvia potentillifolia* are reported for cold and flu in Turkey. In this study leaf, petiole and stem anatomy of two endemic species, *Salvia potentillifolia* and *S. nydeggeri*, are compared. The study found that the mesophyll type is bifacial and the leaf is of amphistomatic type in both species. In the study we observe morphologically different types of glandular hairs. There are also dense eglandular hairs. The study also observes starch grains in petioles. The vascular bundles are of the collateral type. Both species have similarities in leaf and stem anatomy. The anatomical differences and similarities of these two morphologically similar species are given in detail.

Keywords: *Salvia potentillifolia*, *Salvia nydeggeri*, anatomy, Turkey

INTRODUCTION

Lamiaceae is the third largest family of flowering plants in Turkey. The genus *Salvia* L. is represented by 107 taxa in Turkey, 54% of which are endemic (Celep and Dirmenci 2017). A project entitled “Taxonomic revision of the genus *Salvia* L. in Turkey” was carried out in 2008 by Doğan et al. (2008). As a part of this project the anatomy of some *Salvia* species was studied and the importance of anatomical studies was emphasized for the taxonomy of the genus *Salvia*. The authors of the above-mentioned study indicated that anatomical studies is a good tool for grouping the species. Recently several anatomical studies on *Salvia* species have been done (Özdemir and Şenel 1999, Kandemir 2003, Kaya et al. 2007, Özkan and Soy 2007, Baran et al. 2008, Özkan et al. 2008, Aktas et al. 2009, Özdemir et al. 2009, Kahraman and Doğan 2010, Kahraman et al. 2009a, 2009b, Koyuncu et al. 2009, Kahraman et al. 2010a, 2010b, 2010c, Bagherpour et al. 2010, Polat et al. 2010, Büyükkartal et al. 2011, Celep et al. 2014, Polat et al. 2017).

Salvia species has been used medically since ancient times and has different traditional uses such as antipyretic, antiseptic, antimicrobial, diuretic, stimulant, laxative and for abdominal pain, common cold, flatulence, rheumatism, tonsillitis, warts, stomachache, wounds (Yeşilada et al. 1993, Fujita et al. 1995, Ulubelen et al. 1997, Sezik et al. 1997, 2001, Baytop 1999, Topçu and Gören 2007, Gürdal and Kültür 2013, Tan et al. 2016 and 2017, Yeşil and İnal 2019). Traditional uses of *S. potentillifolia* Boiss. & Heldr. ex Benth are reported for cold and flu (Baser et al. 2006). In Turkey *Salvia* species is known as “adaçayı”, “şalba”, “dağ çayı”, “çalba” (Baytop 1994, Tuzlacı 2006).

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Salvia potentillifolia and *S. nydeggeri* Hub.-Mor. grow in south-west Anatolia and have similar morphological characteristics. They differ from each other in terms of the size of terminal foliol and stems (erect or procumbent). In this paper the anatomical characteristics of endemic *Salvia potentillifolia* and *S. nydeggeri* have been given for the first time.

MATERIALS AND METHODS

Plant specimens were collected from Antalya during a field trip of the Tübitak Project (Project No. 114S734). Specimens were collected from *S. nydeggeri* - Antalya, Elmalı, Elmalı Mountain, Kışlaköy village, 29.06.2015, Sat-175, ISTE 107562; *S. potentillifolia* - Antalya, Cedar Research Forest, 28.06.2015, Sat-166, ISTE 107560. Voucher samples were kept in ISTE (Herbarium of Faculty of Pharmacy, Istanbul University).

Plants materials were fixed in 70% alcohol. Cross and surface sections of the plant parts (leaves, petiole, and stem) were taken by free-hand and stained with Sartur solution. Anatomical features of plants were studied by Olympus BX-53 light microscope. Photos were taken with Olympus E330 digital camera.

RESULTS AND DISCUSSION

Stem anatomy

Salvia potentillifolia: The stem is more or less angled-circular in transverse section. The epidermis is covered by relatively thick cuticle with eglandular and glandular trichomes. The epidermis is composed of a single layer of oval-rectangular cells. The collenchyma tissue is located under the epidermis which is 4-7 layered. The cortex tissue is paranchymatous and 3-5 layered. Sclerenchyma groups are present above the phloem. Cambium is not distinguishable. The xylem part is larger than the phloem part. The pith consists of paranchymatous cells which are large and polygonal or orbicular in shape (Figure 1a).

Salvia nydeggeri: In the transverse section of the stem, the epidermis consists of oblong- rectangular cells and is covered by cuticle with eglandular and glandular trichomes. The collenchyma tissue which is 3-5 layered is located under the epidermis. The cortex tissue is paranchymatous and 2-5 layered. Sclerenchyma are present above the phloem. Cambium is not distinguishable. The xylem part is larger than the phloem part. The pith comprises polygonal parenchyma cells (Figure 1b).

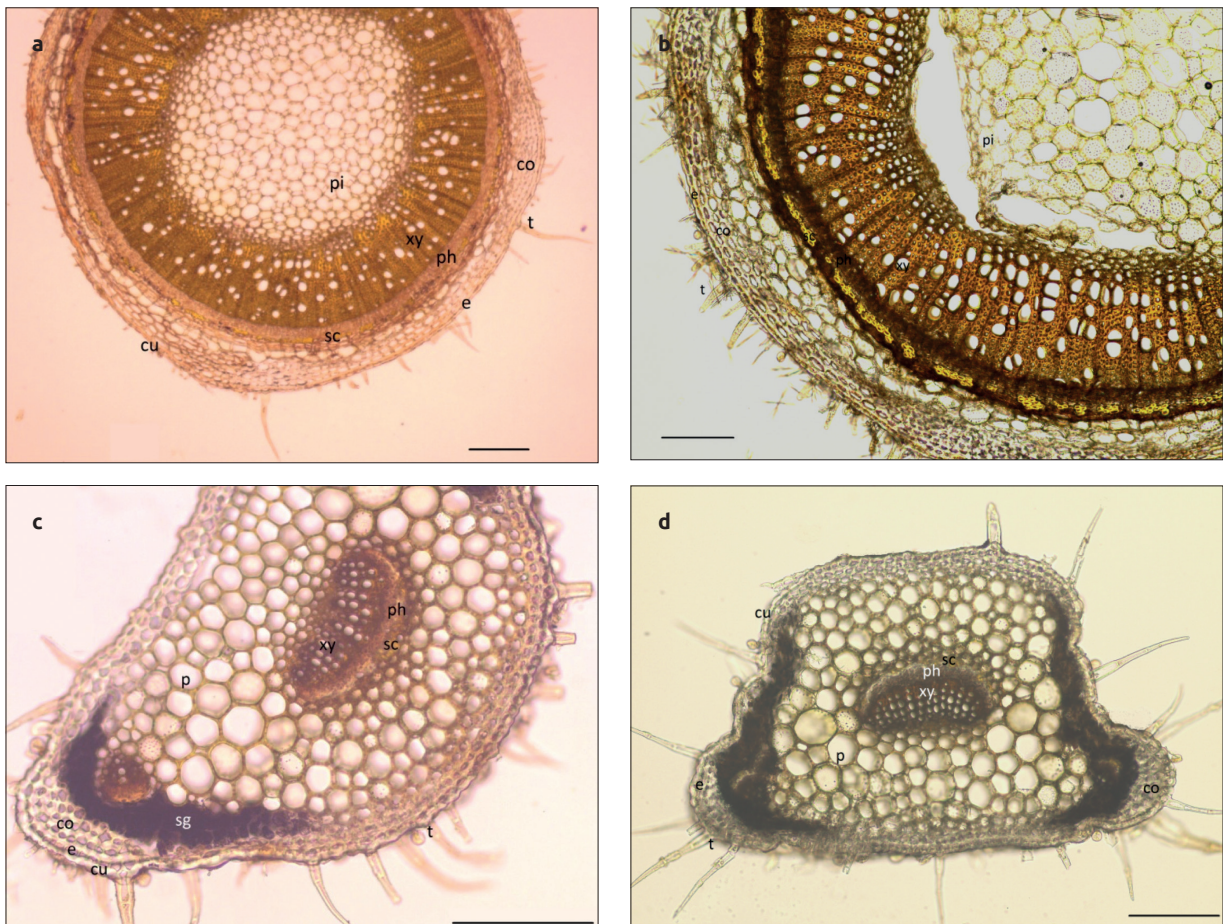


Figure 1. a-d. *Salvia potentillifolia* stem, b) *S. nydeggeri* stem, c) *S. potentillifolia* petiole, d) *S. nydeggeri* petiole.

e: epidermis, cu: cuticle, t: trichome, co: collenchyma, sc: sclerenchyma, xy: xylem, ph: phloem, pi: pith, p: parenchymatous cells, sg: starch grains. Scale: 0.2 μ m

Petiole anatomy

Salvia potentillifolia: In the transverse section of the petiole, the abaxial surface is flat and the adaxial surface is convex. The epidermis is composed of uniseriate, rectangular or oval cells. There are eglandular and glandular trichomes on the epidermis. The collenchyma cells are 3-4 layered on the

corner of the petiole and 1-2 layered under the epidermis. There is a large vascular bundle in the center with small bundles on the corners. The vascular bundle is of collateral type and surrounded by 1 layered sclerenchyma tissue. Several parenchymatous cells contain starch grains in the corners (Figure 1c).

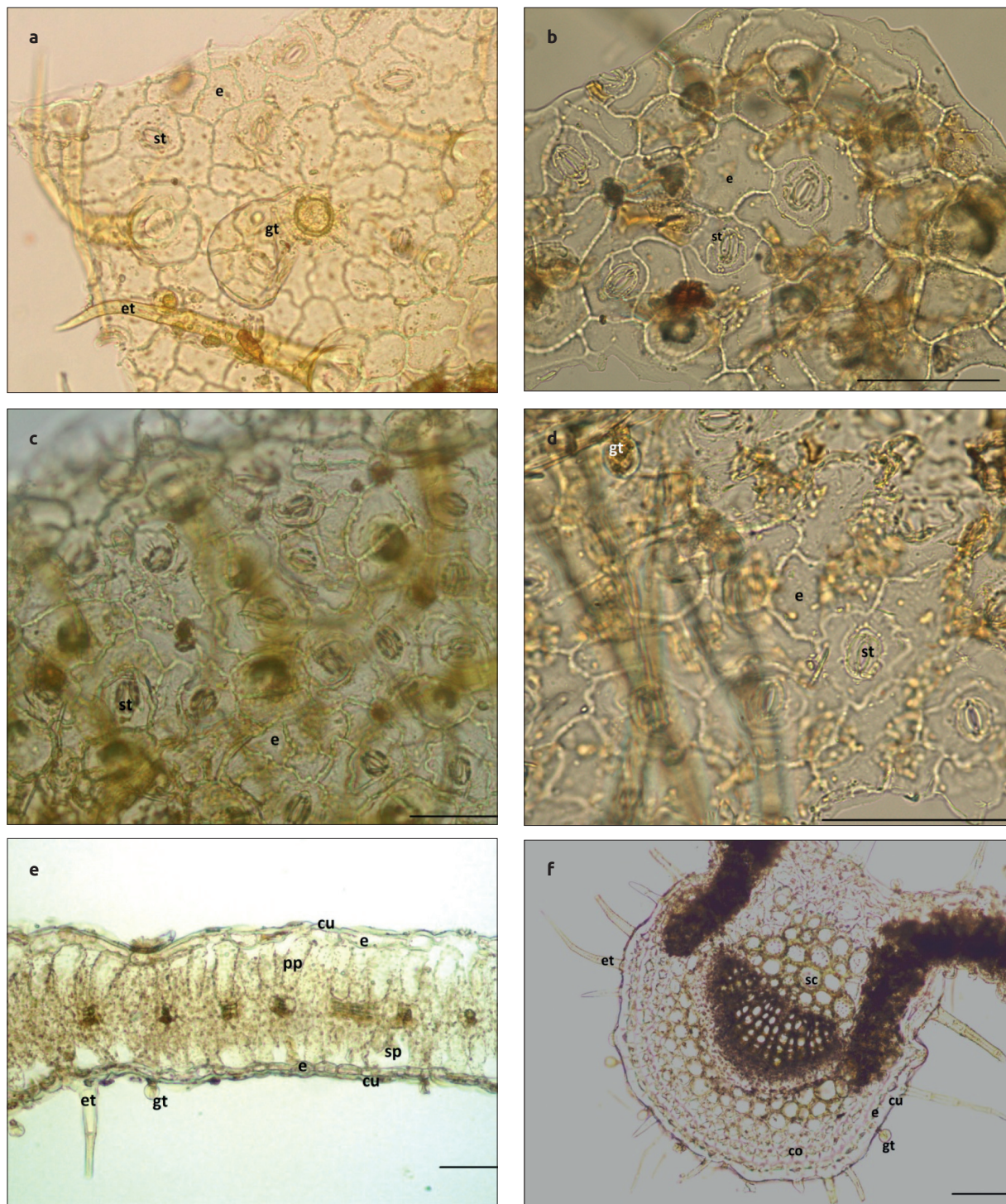


Figure 2. a-f. Leaf sections a) *Salvia potentillifolia* upper epidermis, b) *S. nydeggeri* upper epidermis, c) *S. potentillifolia* lower epidermis, d) *S. nydeggeri* lower epidermis, e) *S. potentillifolia* mesophyll tissue in leaf cross section, f) *S. nydeggeri* midrib area in leaf cross section.

e: epidermis, cu: cuticle, et: eglandular trichome, gt: glandular trichome, co: collenchyma, sc: sclerenchyma, pp: palisade parenchyma, sp: spongy parenchyma Scale: 0.1 mm

Salvia nydeggeri: In the transverse section of the petiole, the abaxial surface is almost flat and the adaxial surface is convex. The epidermis is composed of uniseriate, rectangular or oval cells with thick cuticle layer. There are eglandular and glandular trichomes on the epidermis. The collenchyma cells are 3-4 layered on corner of the petiole and 2-3 layered under the epidermis. The vascular bundles are of collateral type. There is a large vascular bundle in the center with small bundles on the corners (Figure 1d).

Leaf anatomy

Salvia potentillifolia: In the transverse section of the lamina, the upper and the lower epidermis are covered with a thick cuticle layer. There are eglandular and glandular trichomes on both sides. Both epidermis consist of a single layer, rectangular or squarish cells. The stomata cells are present on both the upper and lower epidermis. The stoma type is diacytic. The leaf is of the bifacial. The palisade cells are elongated rectangularly, 1-2 layered and the spongy parenchyma cells are 2-3 layered with large intercellular spaces. The vascular bundle is the collateral type (Figure 2).

Salvia nydeggeri: In the transverse section of the lamina, the upper and the lower epidermis are covered with a cuticle layer. There are eglandular and glandular trichomes on both sides. Both epidermis cells are of a single layer, rectangular or squarish. The stomata cells are present on the upper and lower epidermis. The stoma type is diacytic. The leaf is of the bifacial. The palisade cells are elongated rectangularly, 1-2 layered and the spongy parenchyma cells are 3-4 layered. The vascular bundle is collateral type (Figure 2).

Discussion and Conclusion

According to Metchalf and Chalk (1950), the arrangement of the collenchyma in the stem is of diagnostic value and also the vascular structure of the petiole is of taxonomic interest for the family Lamiaceae. Recently several anatomical studies have been conducted about some species of the genus *Salvia* in Turkey. Some anatomical properties show differences between the species.

Salvia potentillifolia and *S. nydeggeri*, which are our studied specimens, belong to Sect. *Salvia* Hedge. In the literature some species in the same section are studied. The leaf of *S. macrochlamys* Boiss. & Kotschy is of equifacial type and amphistomatic. The petiole of *S. macrochlamys* has one large vascular bundle in the middle and also two small vascular bundles in the petiolar wings (Kahraman et al. 2010). Petiole of *S. ballsiana* (Rech.f.) Hedge has one central vascular bundle and 4-6 small bundles in the wings (Kahraman et al. 2010c). In the petiole of *S. quezelii* Hedge & Afzal-Rafii there is a central vascular bundle and 4 small bundles in the petiolar wings (Celep et al. 2014). *S. tchihatcheffii* (Fisch. & C.A.Mey.) Boiss. Has one large vascular bundle on the median region and small vascular bundles on the end part of the petiole (Aktas et al. 2009). In our study, *S. potentillifolia* and *S. nydeggeri* also have one large vascular bundle in the center and small bundles on the corners of the petiole. When comparing the members of sect. *Salvia*, they have one central vascular bundle and in addition the number of vascular bundles in the petiolar wings varies.

Özkan and Soy (2007) mentioned that the stoma type of *Salvia blepharochlaena* Hedge & Hub.-Mor. leaf is diacytic and in

petiole one vascular bundle is on the median part and a small bundle is near these bundles. In another study conducted by Özkan et al. (2008), the petiole of *S. cadmica* Boiss. has one large vascular bundle in the center and two small bundles at both ends. *S. cadmica* and *S. euphratica* Montbret & Aucher ex Benth. are members of Sect. *Hymenosphace*.

Polat et al. (2017) compared the anatomical features of three endemic *Salvia* species (*S. euphratica*, *S. divaricata* Montbret & Aucher ex Benth. and *S. hypargeia* Fisch. & C.A.Mey.) in different sections. All three species have bifacial mesophylls. Vascular bundles in the petiole show differences between these three species. *S. divaricata* and has one median vascular bundle and a single bundle at the wings of the petiole. *S. euphratica* has 4 median bundles and one small vascular bundle in each of the petiolar wings. *S. hypargeia* has 4-5 median bundles and one small bundle in the petiolar wings. *Salvia euphratica* is in Sect. *Hymenosphace*, *S. divaricata* in sect. *Salvia*, *S. hypargeia* in Sect. *Aethiopsis*.

In the literature, the anatomical characteristics of some species in Sect. *Aethiopsis* are studied. Kandemir (2003) showed that petiole of *S. hypargeia* has two large vascular bundles on the median part and a small one is present near these. In the leaf anatomy of *S. hypargeia* stoma type is diacytic and the leaf is bifacial. There are 5 or 7 large vascular bundles of *S. argentea* L. in the center and 3-5 small ones in the ends of petiole (Baran et al. 2008). In petiole of *Salvia vermifolia* Hedge & Hub.-Mor. there are three large vascular bundles in the middle and three more small ones located in each wing (Bagherpour et al. 2010). As regards the leaf anatomy of *Salvia indica* L., stomata are diacytic and the leaf is bifacial (Kahraman et al. 2009b). For *Salvia chrysophylla* Stapf, 2-3 large vascular bundles are in the center and 2-4 small subsidiary bundles are in the petiolar wings (Kahraman et al. 2010a). Polat et al. (2010) compared *S. aethiopsis* L. and *S. argentea* in Sect. *Aethiopsis* with *S. viridis* L. in Sect. *Horminum*. They showed that the leaf anatomy of them is similar to each other.

Kaya et al. (2007) studied the anatomy of *Salvia halophila* Hedge. Their results show that the stomata are diacytic and the epidermis is amphistomatic. The leaf is of the monofacial centric type. Six vascular bundles are present in the center of the petiole and three small vascular bundles are present in each of the petiolar wings. Leaf of *Salvia verticillata* L. subsp. *verticillata* (in Sect. *Hemisphace*) is bifacial and has anisocytic type of stomata (Koyuncu et al. 2009).

According to the studies in the literature, the difference between the species is shown particularly in the size and in the number of the vascular bundles in the petiole. In many studies, cambium is indistinguishable in the stem anatomy of *Salvia* species (Bagherpour et al. 2010, Kahraman et al. 2010, Polat et al. 2010, Koyuncu et al. 2009, Aktas et al. 2009). It is also the same in our study. Büyükkartal et al. (2011) studied the mericarp anatomy of *Salvia hedgeana* Dönmez, *S. huberi* Hedge and *S. rosifolia* Sm. and showed differences in the exocarp, mesocarp, sclerenchyma region and endocarp.

In conclusion, the stem, petiole and leaf anatomy of *Salvia nydeggeri* and *S. potentillifolia* are studied in this study for the first time. These two species are closely related to each other. Both

of them have pinnate leaves and yellow flowers. *S. nydeggeri* differs from *S. potentillifolia* by its caespitose habit, size of terminal foliol and procumbent stem. According to our data and the literature, anatomy studies can be a useful tool in the taxonomy of the genus *Salvia*.

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