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The anatomical features of *Cirsium caucasicum* (Adams) Petr. (Asteraceae): root, stem, leaf and phyllary

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ABSTRACT: In this study, the anatomical structures of the leaf, stem, root and phyllary of *Cirsium caucasicum* (Adams) Petr. were clarified. The plant material was collected from Şavşat-Ardahan (Türkiye). The cross and surface sections were cut by hand with a razor blade into microscopic preparation form. The Sartur solution was used in microscopic examinations. According to the results, the leaf is dorsiventral and the epidermal layers contain stomata on both surfaces. In the midrib, besides the main vein, lateral veins are also observed. The upper epidermal layer of the leaf lamina is furnished with setae. The leaf surface is various in terms of cover hairs. The glandular hairs appear on both surfaces of the leaf. The flowering stem is grooved-circular. The non-glandular hairs, glandular hairs and stomata were observed on the epidermis layer of the stem. The vascular bundles are embedded in the pith cells and protected like a cap by pericyclic sclerenchymatous tissue. The root consists of periderm, sclerenchymatous pericycle, secretory canals and vascular tissues. The pith region is composed of completely lignified cells. The secretory canals are arranged regularly in the periphery the root. The cells in the outer and inner epidermis layers of the phyllary are lignified and the secretory canal is located under the sclerenchyma at the outward protrusion, it is accompanied by the vascular bundle.

KEYWORDS: Asteraceae; *Cirsium caucasicum*; plant anatomy; leaf; stem; root; phyllary

1. INTRODUCTION

The Asteraceae (Syn.: Compositae) family is characterized by small flowers gathered in a capitulum composed of protective involucral bracts and achene fruits [1-3]. The medicinal importance of the family is determined by the bioactive compounds it contains such as essential oil, inulin and latex, and the family members also contain alkaloids, sesquiterpene lactones, esters, saponosides, flavonols and coumarins [4]. *Cirsium* Mill. species contain flavonoids, phenolic acids, alkaloids, guaniolides, sterols, triterpenes, polyacetylenes, hydrocarbons and aliphatic aldehydes, the species show antioxidant, antidiabetic, analgesic, anti-inflammatory, hepatoprotective, anticancer, antimicrobial and antifungal activities [5-21]. *Cirsium* species are traditionally used worldwide against peptic ulcer, epitasis, liver disease, metrorrhagia, haemorrhaging, syphilis, eye infections, skin sores, gonorrhoea, diabetes and leukaemia [8-10]. In Mexico, the flowers and roots of *C. ehrenbergii* Sch.Bip. are used to treat vaginal flow, vaginal haemorrhage, cough and chest pain [7]. In Romania, the root and stem of *C. oleraceum* (L.) Scop. and the aerial parts and roots of *C. arvense* (L.) Scop. are added to children's bath water and used as a tonic and in the treatment of athrepsia [22]. In Anatolian folk medicine, the seeds and roots of *Cirsium* species are used to treat hemorrhoids, the flowers to treat peptic ulcer, and the stems to treat cough and bronchitis [18]. In Türkiye, the roots or the whole plant of *C. creticum* (Lam.) d'Urv. are used against mushroom poisoning [10], in addition, the flowers of *C. arvense* are used as an appetizer and tonic [23].

Cirsium caucasicum (Adams) Petr. is a perennial plant, can grow up to 50-100 cm., spreads in the northeast of Türkiye and in the Caucasus naturally and it is known as "*kobuk*" in Türkiye [1,3,24].

This study aimed to elucidate the anatomical characteristics of *C. caucasicum*, which belongs to Asteraceae, a medically important family. It is very important to correctly describe and determine the plants that are used as folk medicine and can be candidates for herbal medicine raw materials [25,26]. The light microscopy analysis is a very effective and common method, furthermore explain of anatomical characters can be benefit for taxonomic classification [27,28]. For this purpose, the anatomical structures of the leaf, stem, root and phyllary of *C. caucasicum* were examined and clarified.

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2. RESULTS

2.1. Root anatomy

The cross-section of the root consists of periderm, sclerenchymatous pericycle, secretory canals and vascular tissues (Figure 1). The phellem layer consists of 3-5 rows of flattened cells, followed by two rows of phellogen cells and slightly dorsal-ventral flattened phelloderm cells completed the periderm layer. The pith region is composed of completely lignified cells. The rays occur regularly between the vascular bundles. Secretory canals are arranged regularly in the periphery of the root section.

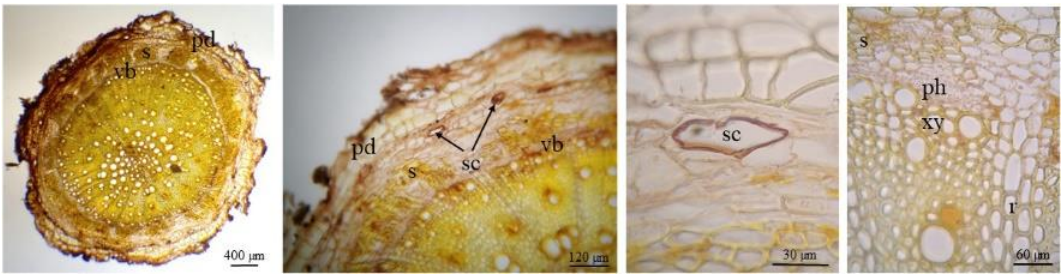

Figure 1. Root cross-section; pd: periderm, ph: phloem, r: ray, s: sclerenchyma, sc: secretory canal, vb: vascular bundle, xy: xylem

2.2. Stem anatomy

The cross-section of stem was observed as in Figure 2. The flowering stem is grooved-circular. The epidermis cells, which are square-rectangular and sometimes oval in shape, are covered with a thin cuticle. The non-glandular hairs, glandular hairs and stomata were observed on the epidermis layer. The non-glandular hairs consist of uniseriate, multicellular long hair, the glandular hairs consist of uniseriate or multiseriate stalk with a unicellular or multicellular head. The stem is supported by collenchymatous tissue in inwardly recessed parts. The vascular bundles are embedded in the pith cells and protected like a cap by pericyclic sclerenchymatous tissue.

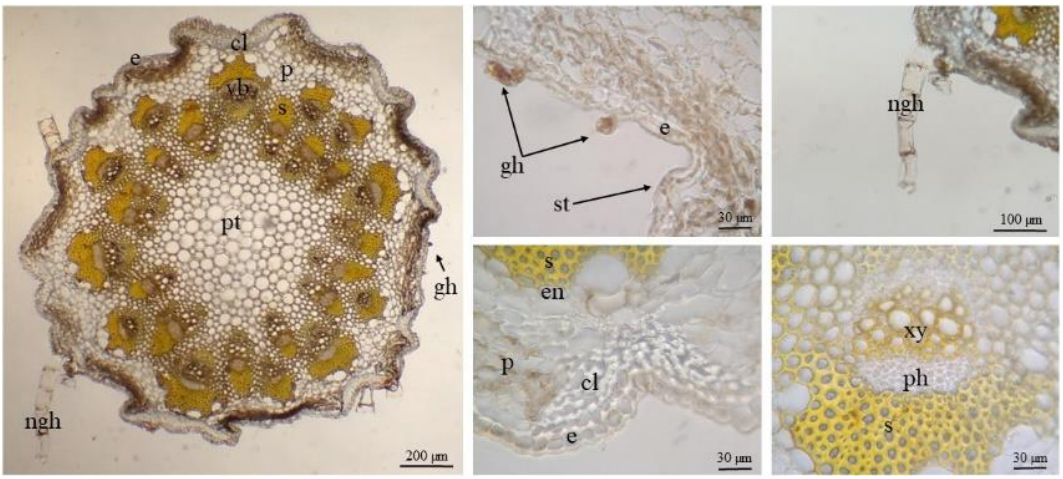

Figure 2. Stem cross-section; cl: collenchyma, e: epidermis, en: endodermis, gh: glandular hair, ngh: non-glandular hair, p: cortex parenchyma, ph: phloem, pt: pith, s: sclerenchyma, st: stomata, vb: vascular bundle, xy: xylem

2.3. Leaf anatomy

The cross-section of the leaf showed that a dorsiventral leaf (Figure 3). The distal ends of the leaf lamina are curved towards the underside. The midrib is highly protruding in the abaxial side. The upper epidermis cells are square-rectangular, the lower epidermis, although the same, consists of relatively smaller cells. Both epidermal layers are exhibited with a thin cuticle layer. In the midrib, besides the main vein, lateral veins are also observed. In the midrib, the collenchymatous tissue supports the upper and lower epidermal layers. The vascular bundles are embedded in the parenchymatous tissue. Parenchyma cells in the margin of the midrib contain abundant starch, while those in the periphery of the vascular bundles are cells

with lignified walls (Figure 4). The upper epidermal layer of the leaf lamina is furnished with setae. The lower epidermis does not contain setae. Palisade parenchyma consists of 2 rows of elongated cells. Spongy parenchyma with rounded cells arranged in 3-5 rows. Both epidermal layers contain ranunculaceous type stomata (Figure 5). The mesophyll and midrib does not contain crystals. However, the leaf surface is various in terms of cover hairs (Figure 6). The lower surface of the leaf is densely covered with whip-like hairs. These hairs are in the form of uniseriate pedestal with a long, whip-like terminal cell. In addition, sparse uniseriate, multicellular short hairs and uniseriate, multicellular long hairs are observed on both surfaces of the leaf. The glandular hairs appear on both surfaces of the leaf. The glandular hairs have a uniseriate or multiseriate stalk with a unicellular or multicellular head.

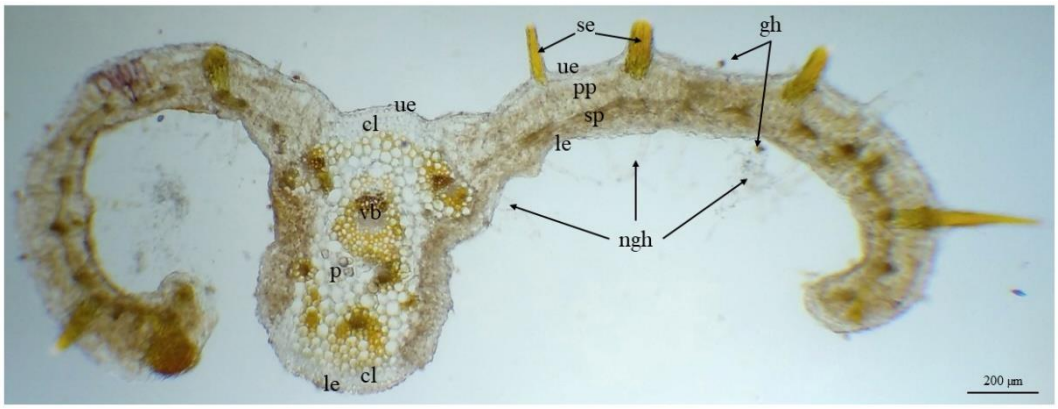

Figure 3. Leaf cross-section; cl: collenchyma, gh: glandular hair, le: lower epidermis, ngh: non-glandular hair, p: parenchyma, pp: palisade parenchyma, se: setae, sp: spongy parenchyma, ue: upper epidermis, vb: vascular bundle

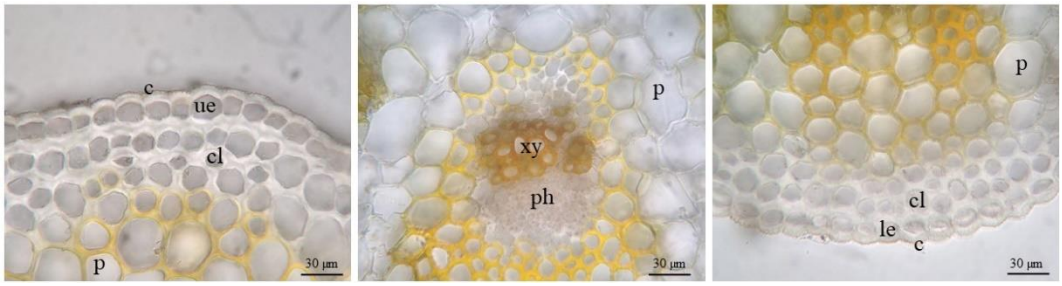

Figure 4. Midrib cross-section; c: cuticle, cl: collenchyma, le: lower epidermis, p: parenchyma, ph: phloem, ue: upper epidermis, xy: xylem

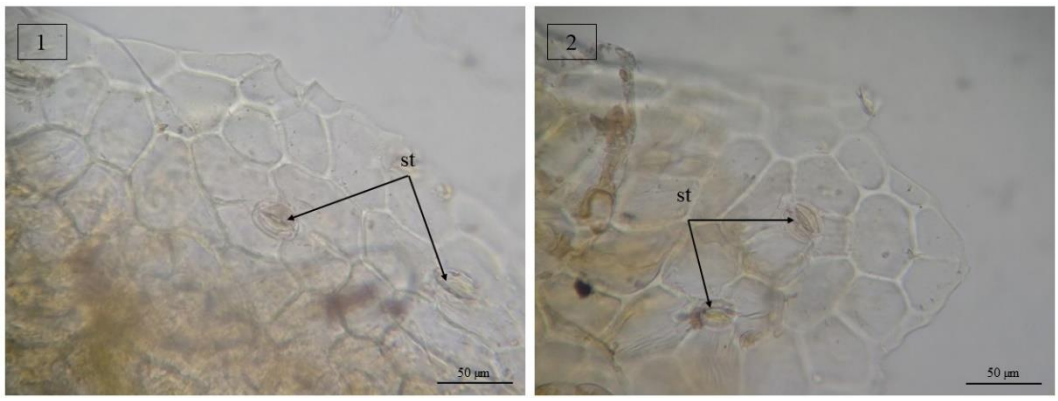

Figure 5. Leaf surface sections; 1: upper epidermis, 2: lower epidermis, st: stoma

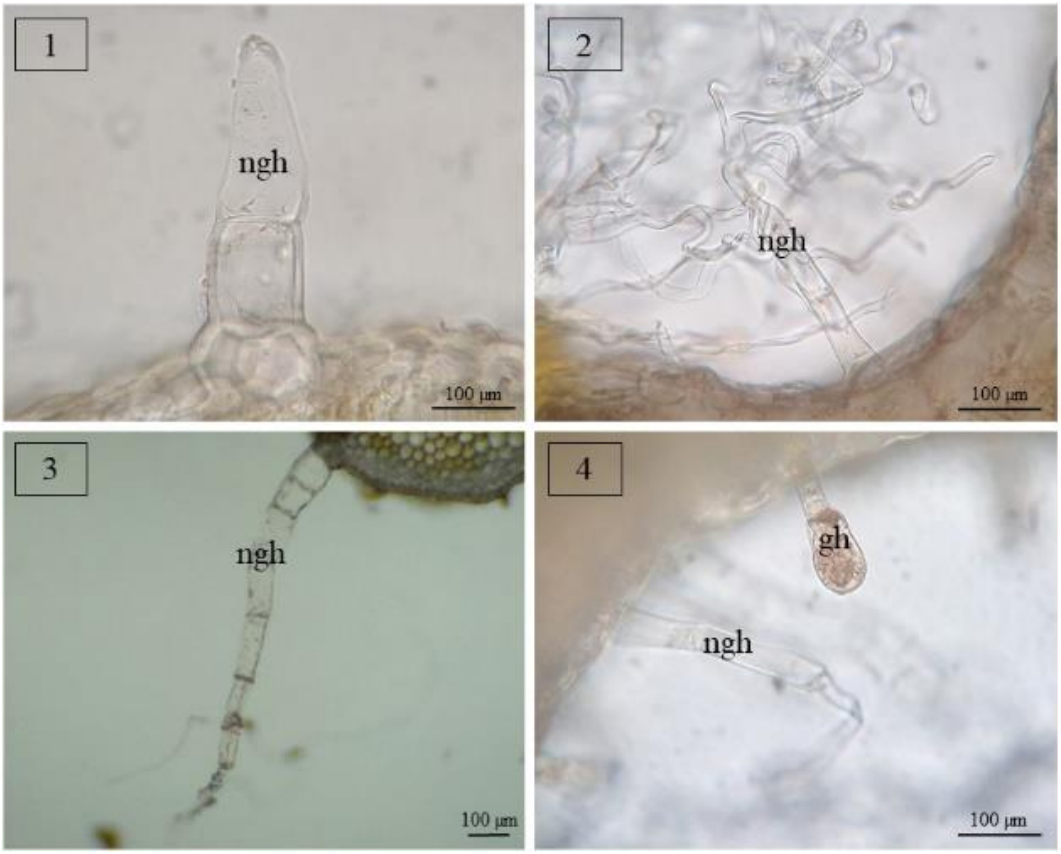

Figure 6. Leaf surface hairs features; 1: uniseriate, multicellular short hair, 2: uniseriate pedestal with a long, whip-like terminal cell, 3: uniseriate, multicellular long hair, 4: glandular hair; uniseriate or multiseriate stalk with a unicellular or multicellular head, gh: glandular hair, ngh: non-glandular hair

2.4. Phyllary anatomy

The phyllary cross-section was observed as a triangle (Figure 7). The cells in the outer and inner epidermis layers of the phyllary are lignified. The epidermal cells are oval-shaped and the outer epidermis cells are larger than the inner. The outer epidermis layer is powered by 3-8 rows of sclerenchymatous tissue. The secretory canal is located under the sclerenchyma at the outward protrusion, it is accompanied by the vascular bundle.

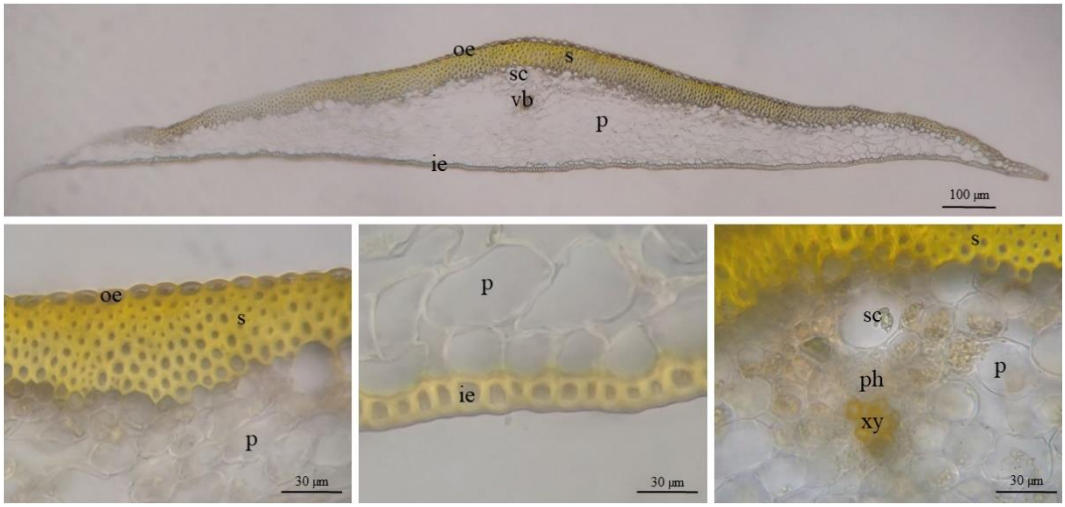

Figure 7. Phyllary cross-section; ie: inner epidermis, oe: outer epidermis, p: parenchyma, ph: phloem, s: sclerenchyma, sc: secretory canal, vb: vascular bundle, xy: xylem

3. DISCUSSION

In this study, important characters were exhibited for *C. caucasicum*, which has limited anatomical data, compared with the findings of some previous studies. Özcan et al. [29] reported that the leaf of *C. caucasicum* was dorsiventral and stomata were located on both epidermal surfaces, in addition, 2-3 rows of palisade parenchyma and 3-8 rows of sponge parenchyma and the presence of collenchymatous tissue in the midrib were also mentioned. Previous studies have mentioned the dorsiventral leaf type and the presence of ranunculaceous type stomata on both epidermal surfaces among the general anatomical characters [30,31]. Moreover, previous studies have reported the presence of cover hairs and glandular hairs on leaf surface: uniseriate, multicellular short hair; uniseriate pedestal with a long, whip-like terminal cell; uniseriate, multicellular long hair and glandular hair as uniseriate or multiseriate stalk with a unicellular or multicellular head on leaf surface [29,30]. According to the Metcalfe and Chalk [30], in the stem the vascular bundles are supported by crescent-shaped sclerenchyma and the ribbed regions in the stem contain sclerenchyma. The results of this study showed that the ribbed regions contain collenchyma not sclerenchyma [33]. Consistent with the data of this study, previous studies reported that the roots of *Cirsium* species contain secretory canals [29,30,32].

4. CONCLUSION

In this study, the anatomical structure of *Cirsium caucasicum* belonging to the Asteraceae family, which has medical importance, was clarified. Determination of anatomical characters is an effective and safe method used in the correct diagnosis of traditionally used medicinal plants. The findings obtained as a result of this study and the anatomical diagnostic values may be useful for the diagnosing of *C. caucasicum*.

5. MATERIALS AND METHODS

The plant material was collected from Şavşat-Ardahan (Türkiye). A voucher specimen was deposited in the Ankara University Faculty of Pharmacy Herbarium (AEF 30926). The samples were protected in 70% alcohol. The cross and surface sections were cut by hand with a razor blade into microscopic preparation form. The Sartur solution [34] was used in microscopic examinations. A Leica DM 4000B microscope was used for anatomical analysis and micro photographs.

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