

A Study on Determination of Anatomical and Micromorphological Properties of *Capsella bursa-pastoris* (L.) Medik. (Brassicaceae) in Turkey

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Abstract

In this study, we aimed to reveal the anatomical features of *Capsella bursa-pastoris* (L.) Medik., a medicinal plant. Samples of *C. pastoris* taxon were collected from Tokat and its environs in June 2018. The collected samples were placed in 70% alcohol and fixed. Transversal section sections were taken from the root, stem and petiole of the plant for anatomical research. Both transversal section and superficial sections were taken of the leaves by hand. There were 2-3 rows of periderm cells on the outermost part of the root transversal section section of the plant. In the stem transversal section, the collenchyma was in the form of a continuous ring of 7-8 rows, just below epidermis. Sclerenchyma forms an intervacular ring. The epidermis cells on the lower and upper surfaces of the leaf were single-row. The leaves were bifacial type. Palisade parenchyma cells were in 1-2 rows. The sponge parenchyma was 3-4 stratified. The epidermal cell edges of the lower surface of the leaf of *C. bursa-pastoris* were wavier than the upper surface cell edges. Stomata were anisocytic. The vascular bundle in the petiole mid-vessel region of the taxon was large and 4-5 of them. The vascular bundles were surrounded by a sclerenchymatic scabbard. The petiole epidermis was monolayer and had cuticle on the surfaces. The fruit of the taxon was heart-shaped and had a striate pattern. Seed shape was elliptical, striate- undulate cell shaped, cell wall thickening was very pronounced. Ornamentations were reticulate. Wax was observed on the abaxial and adaxial surface of the leaf. Corolla surface showed very intense longitudinal cuticular folds. Sepal surface had plenty of sail-shaped papillae. As a result, the root, stem, leaf anatomical features, and fruit, seed, leaf sepal and petal micromorphological features of *C. bursa-pastoris* had been revealed in detail.

Keywords: *Capsella bursa-pastoris*, Anatomy, Micromorphology, Medicinal plant.

Capsella bursa-pastoris (L.) Medik'in (Brassicaceae) Anatomik ve Mikromorfolojik Özelliklerinin Belirlenmesi Üzerine Bir Çalışma

Öz

Bu çalışmada, tıbbi bir bitki olan *Capsella bursa-pastoris* (L.) Medik'in anatomik özelliklerini ortaya konulması amaçlanmıştır. *C. bursa-pastoris* taksonuna ait örnekler Haziran 2018 tarihinde Tokat ve çevresinden toplanmıştır. Toplanan örnekler % 70 alkol içerisine yerleştirilmiş ve sabitlenmiştir. Anatomik araştırma için bitkinin kök, gövde ve yaprak sapından (petiyol) kesitler alınmıştır. Yaprakların hem enine hem de yüzeysel kesitleri elle alınmıştır. Bitkinin kök enine kesitinin en dış kısmındaki peridermis hücreleri 2-3 sıradır. Gövde kesitinde, kollenkima epidermisin hemen altında, 7-8 sıradan oluşan sürekli bir halka biçimindedir. Sklerenkima, intervasküler bir halka oluşturmaktadır. Yaprığın alt ve üst yüzeylerindeki epidermis hücreleri tek sıra halindedir. Yapraklar bifasial tiptedir. Palizat parankima hücreleri 1-2 sıradır. Sünger parankiması 3-4 tabakalıdır. *C. bursa-pastoris*'in yaprağının alt yüzeydeki epidermal hücre kenarları, üst yüzey hücre kenarlarına göre daha dalgalıdır. Stomalar anizositiktir. Taksonun petiyol orta damar bölgesindeki vasküler demet büyük olup vasküler demet sayısı 4-5'dir. Vasküler demetler sklerenkimatik bir kınla çevrelenmiştir. Petiyol epidermisi tek tabakalı olup kutikula tabakası bulunmaktadır. Taksonun meyvesi kalp şeklinde olup striate (çizgili) desenlidir. Tohum şekli eliptik, çizgili şekilli, hücre şeklinde, hücre duvarı kalınlaşması çok belirgindir. Süslemeler retikülate (ağsı)'dır. Yaprak abaksiyal ve adaksiyal yüzeyinde vaks gözlenmiştir. Korolla yüzeyi çok yoğun boyuna kutikular kıvrımlar göstermektedir. Sepal yüzeyde bol miktarda yelken papilla bulunmaktadır. Sonuç olarak, *C. pastoris*'in kök, gövde, yaprak anatomik özellikleri ile meyve, tohum, yaprak, sepal ve petal mikromorfolojik özellikleri ayrıntılı olarak ortaya konulmuştur.

Anahtar Kelimeler: *Capsella bursa-pastoris*, Anatomi, Mikromorfoloji, Tıbbi bitki.

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1. Introduction

The family Brassicaceae (Cruciferae) contains 365 genera and 3250 species worldwide and contains many economically important taxa. About 61 genera, 653 species, 39 subspecies, was equipped with 18 varieties in Turkey (Mutlu and Karakus 2015; Karaismailoğlu, 2016). Two species belonging to *Capsella* were distributed in Turkey. *Capsella bursa-pastoris* (L.) Medik. was used in traditional medicine for many different purposes. For example, fruits and leaves of taxa were utilized to lower kidney stones, in Iran (Delfan et al., 2015). From this plant were benefited as diuretics and nosebleed in Turkey (Güler et al., 2016). It also shows antimicrobial, antioxidant, reproductive, anti-inflammatory, anticancer, hepatoprotective, cardiovascular, sedative and other pharmacological effects. It is very rich in chemical content. *C. bursa-pastoris* contains flavonoid, polypeptide, choline, acetylcholine, histamine, tyramine, fatty acid, sterol, organic acid amino acid, sulforaphane, trace elements, vitamins and many different compounds (Al-Snafi, 2015).

Anatomical and micromorphological studies were used to unravel some taxonomic problems. Anatomical and micromorphological features were distinctive especially in cases where morphological findings are insufficient (Yiğit, 2017). In this study, it was aimed to determine the anatomical and micromorphological features of *C. bursa-pastoris* plant which is ethnobotanical and medically important. The results of our study will help the studies on this taxon. About the last status of my manuscript

2. Materials and Methods

Samples of *Capsella bursa-pastoris* plant, which constitute the research subject, were collected from Tokat province and its environs in June 2018. The specimens were identified according to "The Flora of Turkey" (Davis; 1965) then these were placed in 70% alcohol and fixed. Root, stem, petiole of the plant was transversal section -sectioned for anatomical research. Both transversal section and superficial sections of the leaves were taken by hand. The sections were made into a permanent preparation using the glycerin-gelatin method (Vardar, 1997). The preparations were examined with a Zeiss Axio Lab A1 microscope and Zeiss Axiocam 105 imaging system (Table 3.2). Photographs were taken from these preparations. In addition, cells of various tissue types seen in the prepared sections were measured. The averages were based on 30 measurements. Materials and methodology used in the conducting of the research need to be described in detail in this section.

3. Findings and Discussion

Periderm cells in the outermost part of the root transversal section section of the plant were in 2-3 row. The cortex parenchyma was consisted of cells There were gaps between these cells. In the central cylinder of the root, xylem was located (Table 1, figure 1A). There is no study in the literature on the root anatomy of the plant.

In the stem transversal section section, the outermost single-row epidermis cells were circular-rectangular, thick-walled. Just below the epidermis layer, there was a continuous ring-shaped collenchyma layer of 7-8 rows. The cortex was very narrow and consisted of oval or polygonal cells and several layered. Sclerenchyma cells form an intervascular ring. The vascular bundles formed two rings. Large vascular bundles were closer to the pith. Kyslychenko et al. (2016) stated that large vascular bundles were located towards the pith. Xylem consisted of thick-walled trachea. The phloem was prominent around the sclerenchyma. Sclerenchyma cells seen from phloem. Parenchyma cells occurred the pith and circular or oval shaped. (Table 1, figure 1B).

The upper and lower surface of the leaf was surrounded by a single-row layer of the epidermis. Epidermis cells on both surfaces were rectangular or irregular in shape. Leaves were bifacial type. Trichomes were observed on the abaxial epidermis. Stellate hairs were present on the lower epidermis. Mesophyll differentiated. The leaf of the taxon was bifacial (dorsiventrals). The palisade parenchyma was 1-2 layered. (Table 1, figure 1C). In *Ricotia* species (Brassicaceae) mesophyll was bifacial and equivalent (Selvi and Paksoy, 2013). According to the light microscope images of the superficial sections taken from the leaves of *C. bursa-pastoris* plant, the epidermal walls were flat on the abaxial surface of the leaf (Table 1, figure 1D) and the epidermal cells on the lower surface were highly wavy. It was surrounded by the sclerenchyma ring of the vascular bundles. Stomata were anisocytic (Table 1, figure 1E). Metcalfe and Chalk (1957) stated that the presence of sclerenchymatic cells around vascular bundles of leaves, epidermal cell type, and stomata type are characteristic of Brassicaceae family.

In the transversal section section of the petiole, epidermis was single layered and cuticle was present on surfaces. Cortex cells consisted of orbicular parenchymatic cells, was intercellular space between them. The middle vessel region was wide. The vascular bundles were large in the middle vessel region, the number of bundles was 4-5, surrounded by a sclerenchymatic scabbard (Table 1, figure 1F).

Table 1. Anatomical measurements of *Capsella bursa-pastoris* (Mean values of the measurement)

| | | Width (μm) \pm Standard error | Length (μm) \pm Standard error |
|---------|--------------------------------|--|---|
| Root | Periderm | 0.50 \pm 2.60 | 0.54 \pm 2.81 |
| | Diameter of cortex cells | 0.77 \pm 4.12 | |
| | Diameter of trachea | 0.78 \pm 4.18 | |
| Stem | Epidermis cells | 12.24 \pm 3.64 | 12.60 \pm 2.70 |
| | Cuticle | 6.32 \pm 1.05 | |
| | Diameter of collenchyma cells | 8.75 \pm 1.86 | |
| | Diameter of cortex cells | 17.98 \pm 4.13 | |
| | Diameter of pith cells | 36.24 \pm 9.99 | |
| | Diameter sclerenchyma cells | 10.73 \pm 2.03 | |
| | Diameter of trachea | 19.81 \pm 6.72 | |
| Leaf | Upper epidermis | 28.49 \pm 12.45 | 94.74 \pm 63.33 |
| | Lower epidermis | 22.05 \pm 6.11 | 28.14 \pm 12.76 |
| | Palisade parenchyma | 21.89 \pm 3.88 | 28.62 \pm 5.40 |
| | Spongy parenchyma | 8.13 \pm 2.79 | |
| | Diameter of trachea | 8.47 \pm 1.57 | |
| | Sclerenchyma cells | 19.54 \pm 7.07 | |
| Petiole | Epidermis cells | 20.23 \pm 4.49 | 22.362 \pm 6.32 |
| | Cuticle | 8.55 \pm 1.94 | |
| | Parenchyma cells | 65.60 \pm 15.71 | |
| | Diameter of trachea | 11.54 \pm 2.42 | |
| | Diameter of sclerenchyma cells | 8.16 \pm 1.87 | |

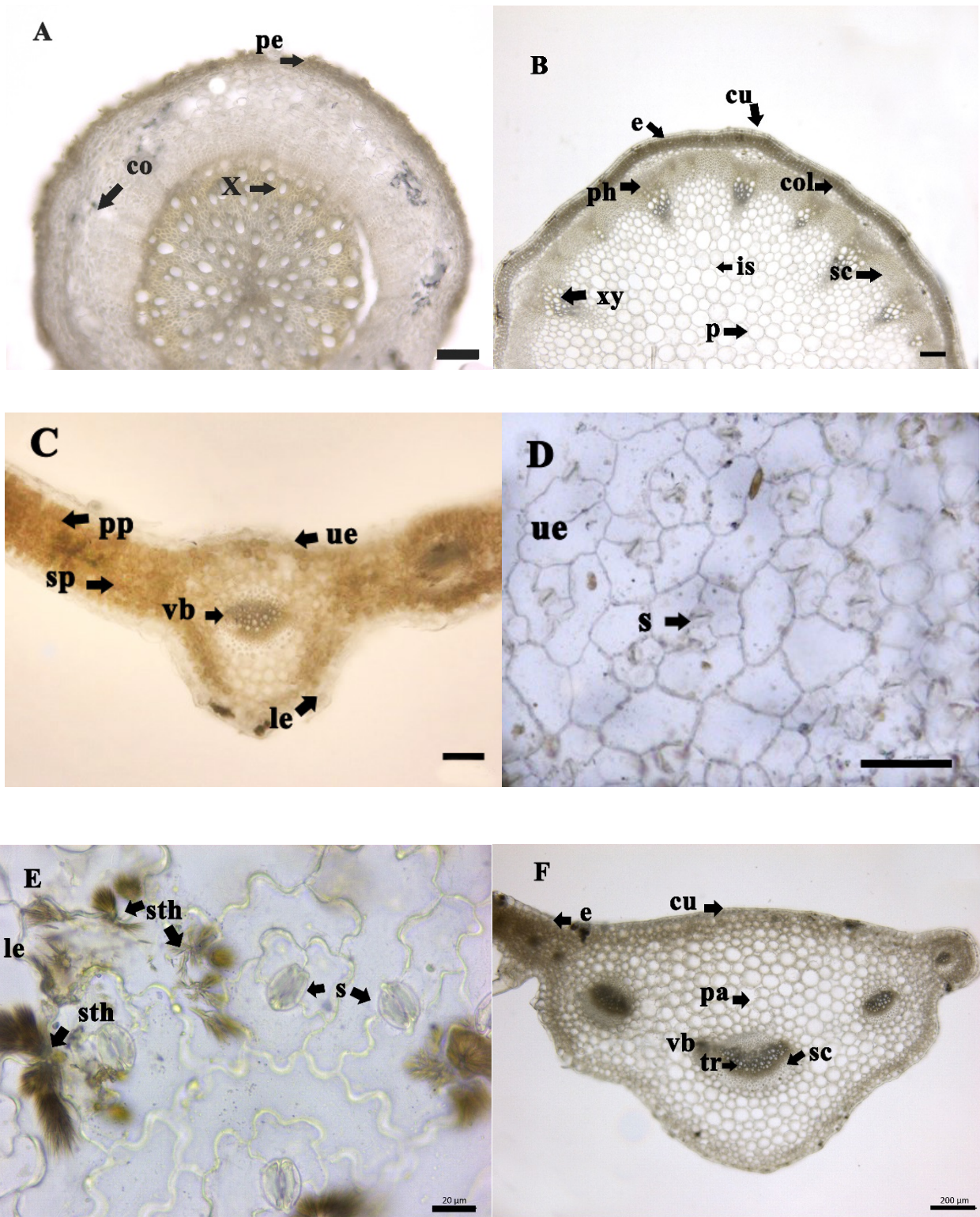


Figure 1. Transversal section and surface section of *C. bursa-pastoris* (A–F), A root, B stem, C cross-section of the leaf, D leaf surface (upper surface), E leaf surface (lower surface), F petiole. pe periderm, co cortex, ph phloem, xy xylem, e epidermis, p pith, pa parenchyma, co cortex, cu cuticle, col collenchyma, sc sclerenchyma, is intercellular space, xy xylem, ue upper epidermis, le lower epidermis pp palisade tr trachea parenchyma, sp sponge parenchyma, vb vascular bundle, s stomata, sth stellate hair, vb vascular bundle (Scala bar 100 μ m)

The fruit of *Capsella bursa-pastoris* taxon was heart shaped (cordate) and green in color. The surface had abundant veins and stomata. Ornamentation was striate (Table 2, figure 2 G-H). The seeds

of were *C. bursa-pastoris* elliptical and slightly flattened. The epidermal cells were square or rectangular in shape, the anticline cell wall was very thick. The cells surface was striate-undulate (Table 2, figure 2 I-J). The seed surface had reticulate ornamentation. Karaismailoğlu (2019) identified the surface ornamentation as tuberculate-reticulate in *C. bursa-pastoris* seed. Satil et al. (2018) stated that the surface ornaments of some species belonging to the genus *Chorispora* (Brassicaceae) were irregular reticulate. According to SEM images taken from the leaves of *C. bursa-pastoris* plant, the epidermis cells on the lower of the leaf had wavy walls, they didn't have a certain shape and dense wax formation was observed on the surface. Cell edges were threaded. The periclinal wall on the lower surface of the leaf was sulcate, occasionally thickening occurs on the anticline walls (Table 2, figure 2 K-L).

Table 2. The micromorphological measurements of *Capsella bursa-pastoris*

| | Shape | Ornamentati | Cell shape | Thickness of anticlinal walls | Vax | Cell edge | Stomata |
|----------------------|----------|-------------|-----------------------|-------------------------------|-------------|-------------|-------------|
| Fruit | Cordate | Striate | Not evident | Not evident | Many | Not evident | Available |
| Seed | Elliptic | Reticulate | Square or rectangular | Very evident | Unavailable | Undulate | Unavailable |
| Leaf upper epidermis | | Undulate | Not evident | Unavailable | Powerful | Undulate | Available |
| Leaf lower epidermis | | Undulate | Not evident | Not evident | Many | Threaded | Available |

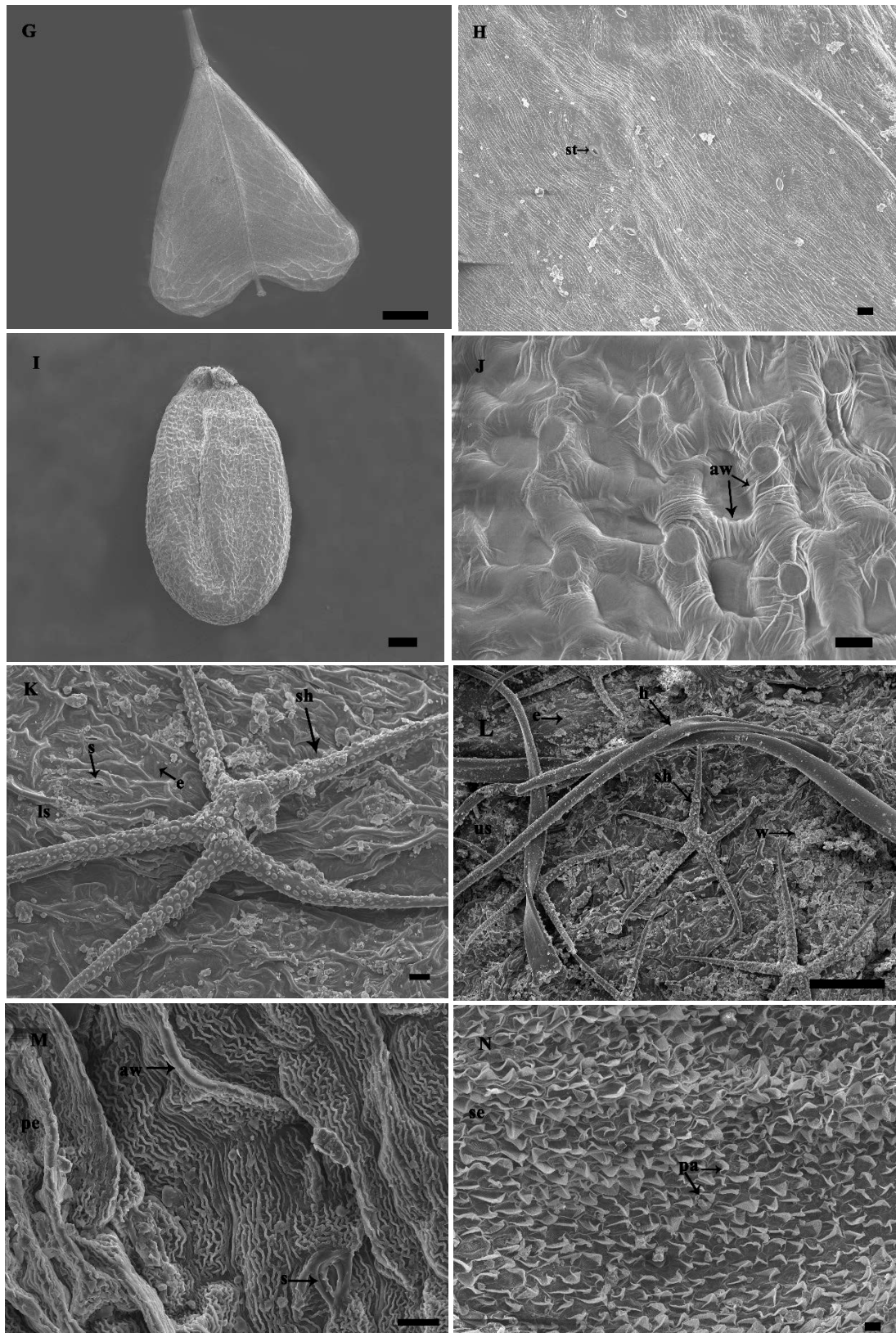


Figure 2. Micromorphology of *C. bursa-pastoris* SEM, (G-H) fruit s stomata (I-J) seed anticlinal cell wall, (K) leaf lower surface (ls) e epidermis s stomata sh stellate hair, (L) leaf upper surface (us) e epidermis h hair w wax, (M) petal surface aw anticlinal cell wall (N) sepal surface pa papilla (Scala bar 100 μ m)

Surface ornamentation was undulate, stomata were available and stellate trichomes were available. On these hairs, tuberculate ornamentation was seen. The other trichome was pusticulate. The epidermal cells of the abaxial surfaces didn't have a specific shape. Thickening of cell walls was not apparent. Again, there were stellate trichomes on the abaxial surface of the leaf as on the lower surface. The stomata were located higher than the epidermal cells. The dorsal walls of the stomata were thicker. The ornamentation on the abaxial surface of the leaf was undulate (Table 2, figure 2 M).

Corolla surface showed very intense longitudinal cuticular folds. Due to these folds, cell shapes were not clear. The anticlinal walls collateral to the long axis were very thick. Stomata were found on the petal surface and the outer walls of these stomata were thickened. Surface ornamentation was striate. Since the calyx surface consists of abundant sail-shaped papillae, surface cell shapes were not certain. Striate ornaments were observed on the papillae (Table 2, figure 2 N).

4. Conclusions and Recommendations

In this study, anatomical and micromorphological features of *C. bursa-pastoris* species were investigated in detail. The plant had secondary root structure. The cortex region of the root was remarkably wide. No study had been found about the root anatomy of the plant in literature. Metcalfe and Chalk (1957) investigated the general anatomical characters of the Brassicaceae family. In their study, they revealed that the types of stoma were anisocytic, and vascular bundles in the stems were surrounded by sclerenchyma cells. These two features are common to all members of the family. In our studies, stoma types were determined as anisocytic. The leaf of the taxon was bifacial (dorsiventrals). Stellate trichome on the lower and upper surface was noticeable. Vascular bundles of petiole were great in the middle of the vessel, the number of bundle was 4-5 and was surrounded by sclerenchymatous scabbard.

Fruit surface patterning was striate according to SEM images. Stomata were located on the surface. The seed surface had reticulate ornamentation. Abundant wax formed on the abaxial surface of the leaf. The anticlinal walls that collateral to the long axis were thickened in the petal. Sepal surface had plenty of sail-shaped papillae.

Consequently, features such as the presence of sclerenchyma, collenchyma, and hairs, their location, the structure of the leaf and the type of stoma, the structure of the petiole, and the number of conduction bundles were characteristic. In addition, the ornaments of the fruit, seed, leaf sepal, and petal surface were peculiar to species. We believe that these results will be a source for future studies.

References

- Al-Snafi, A. E. (2015). The Chemical Constituents and Pharmacological Effects of *Capsella bursa-pastoris* a review. *International Journal of Pharmacology and Toxicology*, 5(2), 76-81.
- Davis, P.H. (1965). *Flora of Turkey and the East Aegean Islands*. Edinburgh University Press, 1, 343-344.
- Delfan, B., Baharvand-Ahmadi, B., Bahmani, M., Mohseni, N., Saki, K., Rafieian-Kopaei, M., Shahsavari, S., Naghdi, N., Taherikalani, M., Ghafourian, S. (2015). An Ethnobotanical Study of Medicinal Plants Used in Treatment of Kidney Stones and Kidney Pain in Lorestan Province Iran. *Journal of Chemical and Pharmaceutical Sciences*, 8, 4.
- Güler, B., Kümüştekin, G., Uğurlu, E. (2016). Contribution to the Traditional Uses of Medicinal Plants of Turgutlu (Manisa – Turkey). *Journal of Ethnopharmacology*, 176, 102–108.
- Karaismailoğlu, M. C. (2016). Addition to Characters of Endemic *Aubrieta canescens* subsp. *canescens* Bornm. (Brassicaceae) From Turkey. *Bangladesh Journal of Botany*, 45(3), 509-515.
- Karaismailoğlu, M. C. (2019). Notes on the Taxonomical, Morphological and Mucilage Features of *Capsella bursa-pastoris* Medik. and *Capsella rubella* Reuter Taxa (Brassicaceae). *Artvin Coruh University Journal of Forestry Faculty*, Vol: 20 Issue: 1.
- Kyslychenko, V. S., Kuznietsova V. Y., Kolisnyk Y. S., Sushchuk, N. A. (2016). The Anatomical Study of Shepherd's Purse Herb. *News of Pharmacy*, 3(87).
- Metcalf, CR., Chalk, L. (1950). *Anatomy of the Dicotyledons*. London: Oxford Univ. Press, Vol. 2, pp: 1041-1051.
- Metcalf CR, Chalk L 1957. *Anatomy of The Dicotyledons (Leaves, Stem and Wood in Relation to Taxonomy with Notes on Economic Uses)*. Oxford University Press, Amen House, London 1, 79-87.
- Mutlu B., Karakus, S. (2015). A New Species of *Sisymbrium* (Brassicaceae) from Turkey: Morphological and Molecular Evidence. *Turkish Journal of Botany* 39: 325-333.
- Satil, F., Kaya, A., Ünal, M. (2018). Fruit, Seed and Pollen Morphology of *Chorispora* Dc. Species (Brassicaceae) of Turkey. *Bangladesh Journal of Botany* 47(3), 459-466.
- Selvi, S., Paksoy., M. E. (2013). Comparative Anatomy of Stem and Leaf of *Ricotia* L. Growing in Turkey. *Bangladesh Journal of Botany* 42(1): 123-130.
- Vardar, Y. (1987). *Botanikte Preparasyon Teknikleri*. Ege Üniversitesi Fen Fakültesi Baskı İşleri, İzmir, No 1.
- Yigit, N. (2016). *Micromorphological Studies on Plants and Their Importance, (Developments in Science and Engineering*, R. Efe., L. Matchavariani., A. Yaldir., L. Levai (Ed.). 113-124