


## MORPHOLOGY AND ANATOMY OF *Cardopatum corymbosum* (L.) Pers. (ASTERACEAE)

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### Abstract

*Cardopatum* Juss. is a genus of the Asteraceae family and this genus include only one species called *Cardopatum corymbosum* (L.) Pers. There are no studies on the anatomical features of the *Cardopatum corymbosum* (L.) Pers. The purpose of this research is to describe the anatomy and morphology of *Cardopatum corymbosum*. The plant materials used in the study were collected from the provinces of Alaşehir (Manisa), Nazilli (Aydın), Iğın (Konya), Çeşme, Bergama, Güzelbahçe, Urla, Karaburun (İzmir) and Milas (Muğla) between 2016-2017. Morphological data obtained in this study showed that there are differences between the findings reported in Flora of Turkey and our results. The best plant measurements were obtained from the locality of Alaşehir. Samples of root, stem and leaves of this species were collected, fixed and dyed using appropriate methods. In addition, anatomical measurements of species were made. The anatomical investigations are similar to the members of Asteraceae family. This species is glabrous perennial herb. Florets are blue and hermaphrodite. The leaf of *Cardopatum corymbosum* is equifacial. Stomata are in abaxial and adaxial surfaces. Vascular bundles are collateral type.

**Keywords:** Asteraceae, Anatomy, *Cardopatum corymbosum*, Dyeing method, Morphology

## *Cardopatum corymbosum* (L.) Pers. (ASTERACEAE) TÜRÜNÜN MORFOLOJİSİ VE ANATOMİSİ

### Özet

*Cardopatum* Juss. Asteraceae familyasının bir cinsidir ve bu cins sadece *Cardopatum corymbosum* (L.) Pers isimli bir tür içermektedir. *Cardopatum corymbosum* (L.) Pers'in anatomik özellikleri üzerine çalışma bulunmamaktadır. Bu araştırmanın amacı *Cardopatum corymbosum*' un morfolojisini ve anatomisini tanımlamaktır. Araştırmada kullanılan bitki materyalleri 2016-2017 yılları arasında Alaşehir (Manisa), Nazilli (Aydın), Iğın (Konya), Çeşme, Bergama, Güzelbahçe, Urla, Karaburun (İzmir) ve Milas (Muğla)'dan toplanmıştır. Morfolojik araştırma sonucunda, Türkiye Florası ile çalışma verilerimiz arasında farklılıklar olduğu belirlenmiştir. En iyi bitki ölçümleri Alaşehir yöresinden elde edildi. Bu türün kök, gövde ve yaprak örnekleri toplandı, fikse edildi ve uygun boyama yöntemleri kullanıldı. Ayrıca türün anatomik ölçümleri hesaplandı. Anatomik araştırmalar Asteraceae familyasına benzerdir. Bu tür tüsüz çok yıllık bir bitkidir. Çiçekler mavi ve hermafrodittir. *Cardopatum corymbosum* yapraklarının her iki tarafı aynıdır. Stomalar yaprağın alt ve üst yüzeyinde bulunmaktadır. İletim demetleri kollateral tiptedir.

**Anahtar Kelimeler:** Asteraceae, Anatomi, *Cardopatum corymbosum*, Boyama metodu, Morfoloji

### Cite

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### 1. Introduction

The genus of *Cardopatum* Juss. is represented with 2 species in the World which are *Cardopatum amethystinum* Spach and *Cardopatum corymbosum* (L.) Pers. But as a result of our research, we did not find a key that separates these two species.

*Cardopatum corymbosum* is a perennial herb and this species belonging to Asteraceae family.

Distribution of *C. corymbosum* in the world : Italy, Sicily, Macedonia, Greece Crete, East Aegean Islands, Rhodes, Turkey, Lebanon, Syria, Cyprus [1]. According to Flora of Turkey [2] distribution of species in Turkey: Tekirdağ, Çanakkale, Kocaeli, Manisa, Konya, Denizli, Antalya, Mersin, Adana, Hatay.

Morphological and anatomical studies on *Cardopatum corymbosum* have not been carried out to date. Morphological data are limited to the properties described in Flora of Turkey [2]. For this reason, the

purpose of this article was to investigate the morfological and anatomical properties of this species.

## 2. Material and Method

*Cardopatium corymbosum* collected from 9 different localities between the years 2016-2017 and this species constitute the research material.

### 2.1. Morphology

This study has been done considering the vegetation period of the plant. Photographs were taken while plants were collected. The data of the morphological characters which are used in the research were determined in the field.

The locality of each collected plant was recorded by GPS method.

Localities are listed below:

1. Manisa- Alaşehir-Tepeköy pasture area.  
N 38°24'28.913" E 28°32'39.824" Altitude: 115 m.
2. Konya -Ilgın - Side of Selçuk University Ilgın Vocational School, pasture area. N 38°17'07.68" E 31°58'48.32" Altitude: 1022 m.
3. İzmir-Guzelbahçe. When going from Urla to Karaburun, İzmir High Technology Institute Campus area entrance, N 38°19'02.316" E 26°39'20.468" Altitude: 9 m.
4. The way to Karaburun-Çeşme from İzmir-Karaburun. Pasture area, mixed olive grove, stony areas, N 38°39'34.629" E 26°29'11.615" Altitude: 72 m.
5. İzmir: Çeşme-İlica pasture area, N 38°19'11.007" E 26°23'24.869" Altitude: 19 m.
6. 5 km after crossing the Alaçatı Center Surf Area, N 38°14'12.382" E 26°19'32.830" Altitude: 85 m.  
38°14'12.382" E 26°19'32.830" Altitude: 85 m.
7. Aydın-Nazilli-Bozdoğan road, Toygar village. N 37°49'44.39" E 28°21'28.32" Altitude: 99 m.
8. Muğla-Milas-Koru village. Milas-Bodrum Airport road, after passing the entrance of Koru village , pasture area. N 37°14'47.2" E 27°43'11.8" Altitude: 13 m.
9. İzmir-Bergama highway edge, N 39°06'27.18" E 27°09'44.38" Altitude: 73m.

### 2.2. Anatomy

Anatomical features of *Cardopatium corymbosum* were investigated using roots, stems and leaves of samples taken from Alaşehir.

These samples were first washed in tap water in the field and then kept in 70% ethanol solution until the anatomy transverse section was examined. Anatomy studies were carried out in Botany Laboratory of Biology Department of Manisa Celal Bayar University, Science and Literature Faculty.

In the anatomy studies, transverse sections were taken by hand and microtome. A new dyeing method which was described by Bozdağ et al. [3] was used in transverse sections.

Temporary slides of *Cardopatium corymbosum* was carried out in 2 stage. Sections of *Cardopatium corymbosum*'s root, stem and leaves were taken by hand, all sections were stained with safranin and fast green according to the methodology described by Bozdağ et al. [3] examined with Leica DM3000 microscope and micro-photographed.

Samples of stems, leaves and roots were fixed in 70 % ethanol for permanent slides. Then samples were dehydrated in 80 % (2,5 hours), 90 % ( 1 hour), 100 % (25 minutes) ethanol and incubated in ethanol/ xylene (1:1) for 25 minutes, and in 100 % xylene for 20 minutes. The fixed samples embedded in paraffine and blocks were sectioned thickness of 10-15 µm using Thermo Scientific Shandon Finesse 325 rotary microtome. Sections were stained with safranin and fast green and mounted in Entellan. After a month, permanent slides were examined with Leica DM3000 microscope and photographed. Anatomical structures were measured using Screen Calipers measurement program.

## 3. Results

Morphological and anatomical data are given below:

### 3.1. Morphology

Morphological data were obtained from the examination of the samples taken from 9 different localities. It has been observed that *Cardopatium corymbosum* differ in root structure in field studies. Some of the plant's root was tap root while others were tuber (Fig.1).



Figure 1. Root structure of *Cardopatium corymbosum*

In field observations of *Cardopatium corymbosum*, 4 different branching were observed on the plant (Fig.2).



Figure 2. Branching specimens of *Cardopatium corymbosum*

At the extreme branch, the number of capitulum was determined to be 25-55. It was also observed that there

was a capitulum at the junction where each branch was formed (Fig.3).



Figure 3. Flower structure at branching points and branch tip at *Cardopatium corymbosum*

*C. corymbosum* has 7-11 flowers in the capitulum and all of the flowers are hermaphrodite. The capitulum is

composed of tubular florets. Phyllaries are numerous and thorny (Fig. 4).

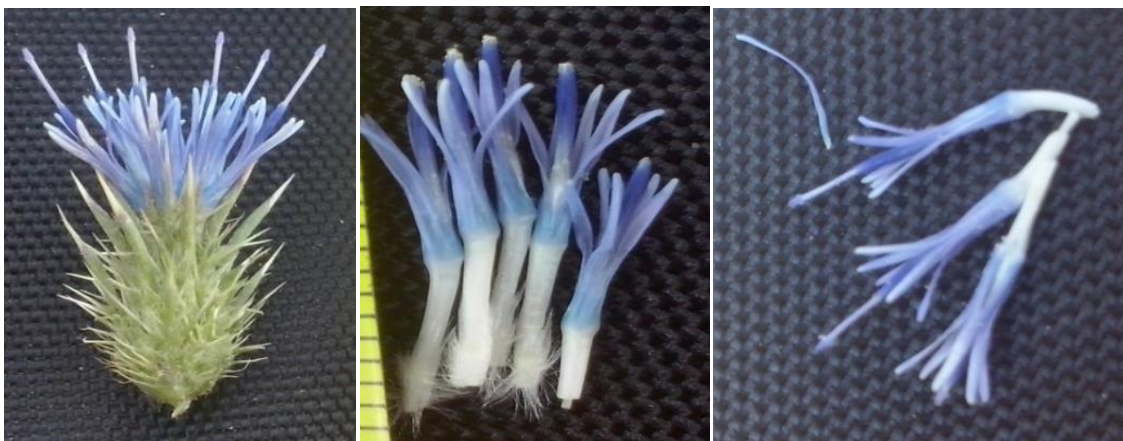


Figure 4. Flower structure of *C. corymbosum*

Morphological data of *Cardopatium corymbosum* which observed and sampled at 9 different areas are given in Table 1.

Table 1: Morphological characteristics of *Cardopatium corymbosum*

Morphological characteristics	Features
Plant type	Perennial herbs
Plant life-form	Hemicryptophyte
The appearance of plant (single or cluster)	Cluster
Lenght of the plant (cm)	10 - 65
Width of the plant (cm)	32 - 115
Root structural type	Tap or tuber
Width of root (cm)	1,4- 8,1
Length of root (cm)	10,2- 42,6
Branching patterns	Dichotomous
Stem spinose or not	Spinose
Width of stem (cm)	1,4 - 2,7
Stem hair type	Glabrous
Leaf arrangement	Decussate
Leaf type	Simple -Divided
Leaf venation	Pinnately netted
Leaf apice	Acuminate
Leaf attachment	Decurrent
Leaf margin	Spinose
Leaf hair type	Arachnoid - Sericeous or Glabrous
Width of basal leaves (cm)	8,1-10
Lenght of basal leaves (cm)	15,6 - 41
Width of cauline leaves(cm)	4,2- 11,8
Lenght of cauline leaves (cm)	6,54 - 21,2
Corolla color	Blue
Sex distribution of the flower	Monoecious
Inflorescence type	Capitulum
Number of petal which consisting corolla	5 (synpetalous)
Florets disk or ray	Disk floret
Ovary position	Epigynous (ovary inferior)
Lenght of capitulum (max) (mm)	14
Width of capitulum (mm)	5-7
Total number of capitulum in the plant	450-5940
Number of flowers in a capitulum	7-11
Capitulum shape	Ovoid
Receptacle hair type	Setose
Involucral bracts	Imbricate
Width of disk florets (mm)	1-2
Lenght of disk florets (mm)	4-8
Stamen number	5
Stamen lenght (mm)	4-6
Fruit type	Achene
Achenes lenght (mm)	1-1,8
Achene hair type	Pilose
Pappus colour	Cream
Seed size (mm)	4-6

### 3.2. Anatomy

The samples taken by hand and microtome from the root, stem and leaf were evaluated as follows:

#### 3.2.1. Transverse sections taken by hand

In order to determine the anatomical structure of *C. corymbosum* sections were taken from root, stem and leaf with hand and microtome. In the root structure, three main parts are distinguished: epidermis, cortex and vascular cylinder. Epidermis is formed from regular and tightly arranged cells composed of 1-3 layers. Beneath this, there is a cortex layer consisting of 4-9 layers of

parenchymal cells with their widths larger than their lengths which width larger than length. These two layers are more visible in the capillary root system. Underneath the cortex is the endodermis which consist of 2-4 layers rectangular shaped cells. The pericycle is underneath the endodermis layer and usually consists of single layer with surrounding vascular bundles. There is an interfascicular region consisting of sclerenchymatic cells between the vascular bundles. The phloem is 2-9 layers under the pericycle and consists of irregular cells. The cambium cells are not clear and there is xylem under the phloem tissue (Fig. 5).

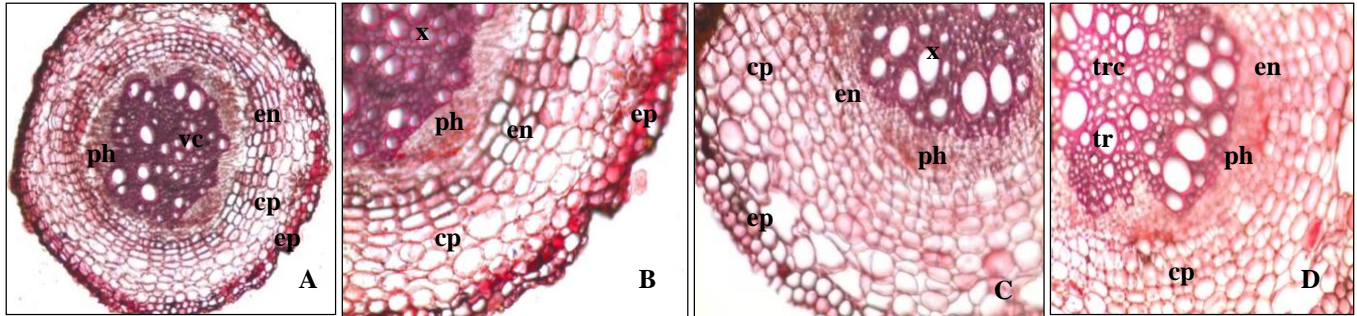


Figure 5. A and B : Mature root (10x and 20 x, respectively), C and D : Young root (20x). cp- cortex parenchyma; en- endodermis; ep- epidermis; ph- phloem; tr- trachea; trc- tracheid; vc- vascular cylinder; x- xylem.

The transverse section of the stem is circular shaped. The epidermis consists of 1-2 layers of compactly arranged orbicular or rectangular cells and is surrounded by a cuticle layer. Underneath the epidermis, there is collenchyma tissue which is composed of irregularly shaped cells. Cortex consists of oval and rectangular cells.

The vascular bundles are collateral type and surrounded by sclerenchyma fibres. The average number of vascular bundles in the stem is 30. The elements of xylem and phloem are clearly visible. In the whole centre of the stem, there is a pith filled with circular parenchymatic cells (Fig.6)

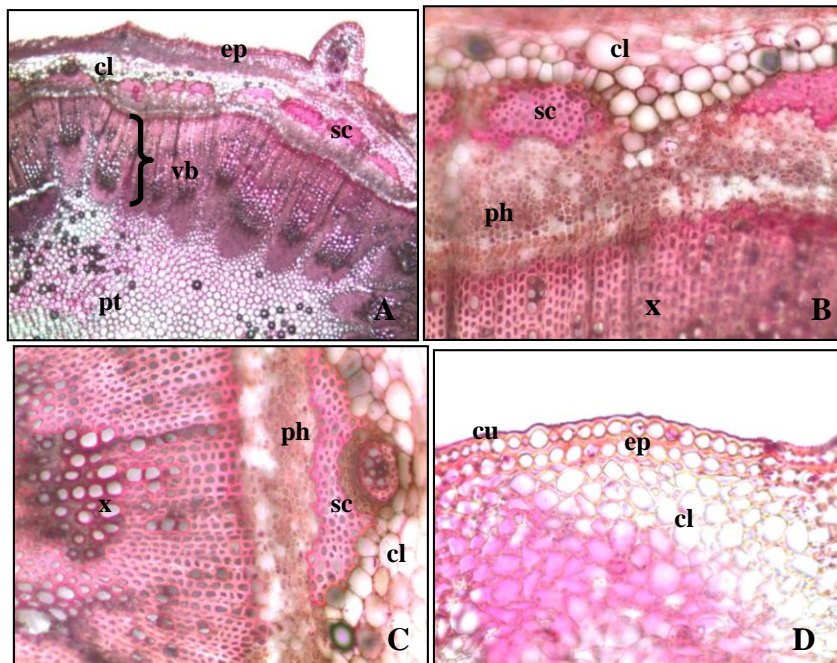


Figure 6: A: Stem transverse section (4x), B-D : (20x). cl : collenchyma; cu: cuticle; pt: pith; sc : sclerenchyma; vb: vascular bundles

In the cross sections of the leaf, equifacial leaf is observed. There is a thick cuticle on the adaxial and abaxial epidermis. Both epidermises consist of one layer quadrate, rectangular and ovoid cells. The stomata are on

both leaf surfaces. Sub-stomatal cavities are observed clearly on both sides of the leaf. The mesophyll layer consists of palisade and spongy parenchyma cells. The palisade parenchyma consists of three layers of

cylindrical parenchyma cells on each side of the leaf whereas spongy parenchyma cells are between the upper and lower palisade. The vascular bundles are surrounded by a sheath. The bundle sheath of cells are different sizes depending on the size of the vascular

bundles. Vascular bundles are collateral type. There are plenty of sclerenchyma tissue elements and well-developed vascular bundles are in the middle vein of the leaf (Fig. 7).

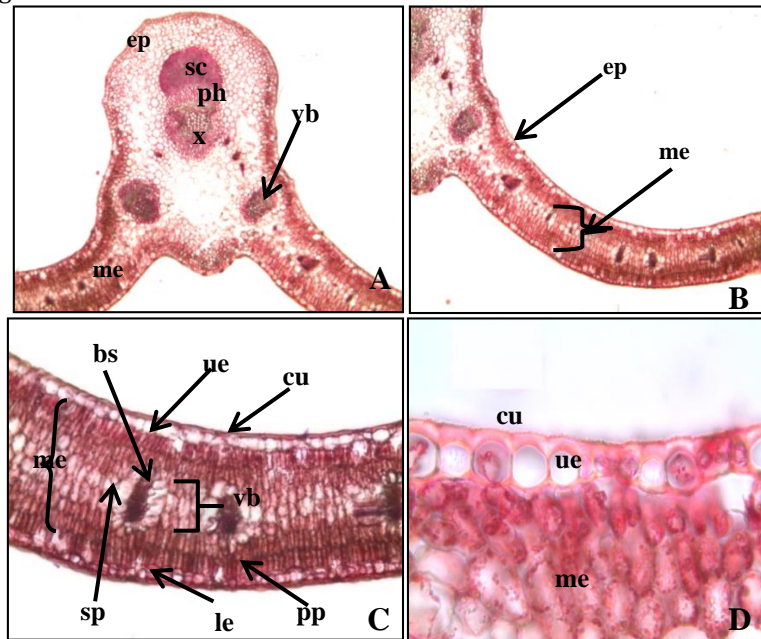


Figure 7: Leaf transverse section A-B: (4x), C: (10x), D: (40x). bs: bundle sheath, le: lower epidermis; me: mesophyll; pp: palisade parenchyma; sp: spongy parenchyma; ue: upper epidermis.

### 3.2.2. Transverse section taken by microtome

In the root transverse sections, it was determined that the separation of the different layers in the transverse

sections which taken by hand was more prominent than the sections taken with the microtome (Fig. 8).

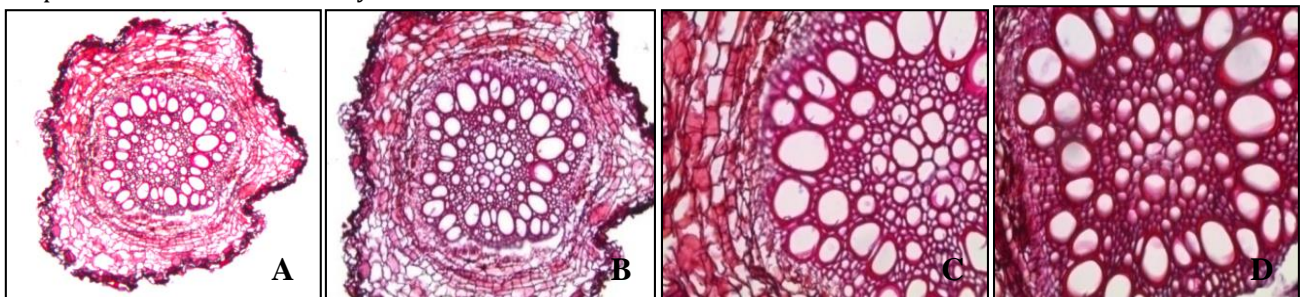


Figure 8: Root transverse section A: (4x) , B: (10x), C-D: (20x)

Both the sections which taken by hand and microtome showed good results and the sections were cut with

microtome by a reason of the sclerenchymatic cells found in the stem, causing a lot of fragmentation in the stem transverse sections (Fig. 9).

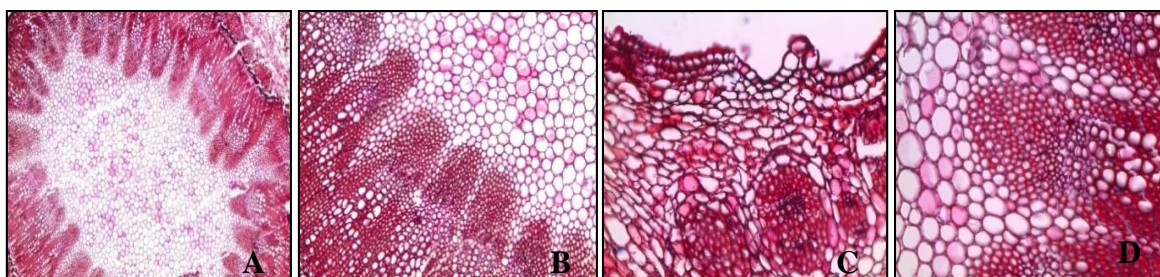


Figure 9: Stem transverse section A: (4x) , B: (10x), C-D: (20x)

In both types of slides different layers of leaf samples were well observed ( Fig. 10).

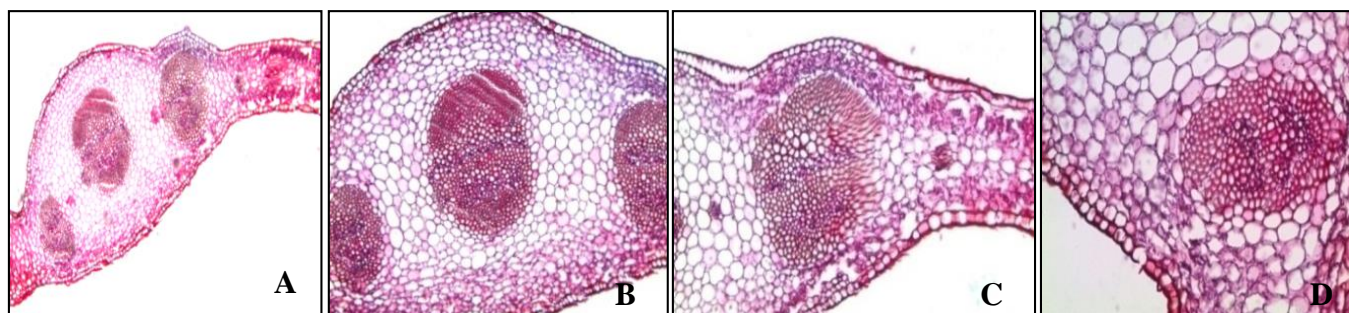


Figure 10: Leaf transverse section A: (4x) , B: (10x), C-D: (20x)

Measurements made on anatomical structures of root, stem and leaf sections of *Cardopatum corymbosum* samples are given in Table 2.

Table 2: Anatomical measurement data of sections of *Cardopatum corymbosum*

Section of plant	Width (µm)		Length (µm)	
	Minimum	Maximum	Minimum	Maximum
<b>Root</b>				
Epidermis cell	14,46	32,62	12,06	28,93
Cortex cell	36,17	100,71	25,53	50,35
Endodermis cell	32,62	82,98	15,6	29,8
Trache cells	8,76	45,77	-	-
Phloem layers	4,37	13,12	-	-
<b>Stem</b>				
Cuticle layers	3,24	6,19		
Epidermis cell	5,01	12,98	4,72	11,5
Cortex cell	6,49	26,25	6,19	14,45
Endodermis cell	9,30	30,81	-	-
Trache cells	4,72	9,44	-	-
Pith cells	17,44	58,14	19,77	68,02
<b>Leaf</b>				
Adaxial surface of cuticle	2,94	7,06	-	-
Abaxial surface of cuticle	3,24	4,71	-	-
Adaxial epidermis cells	11,18	26,18	7,94	21,47
Abaxial epidermis cells	8,24	31,47	12,06	30,88
Palisade parenchyma cells	7,65	14,41	11,41	30,29
Spongy parenchyma cells	10,29	28,53	12,35	28,24
Vascular bundles	13,24	41,76	17,35	59,41

#### 4. Discussions

In this study, the morphological and anatomical structure of *Cardopatum corymbosum* was described. There are not many studies about this species. It has been determined that more detailed morphological examinations have been made in this research compared to the "Flora of Turkey" [2] and there are differences in some measurements.

In our research, plants are 10-65 cm, leaves are simple (divided), pinnately netted and decurrent, lowermost up to 41x10 cm and spiny, capitulum are ovoid (14x7 mm) and 7-11 florets are in a capitulum whereas plant are 6-35 cm, leaves are ovate-lanceolate in outline, lowermost up to 30x13 cm and spiny-dentate, capitulum are ovoid and 10-13x5 mm in the Flora of Turkey.

In a study conducted by Kaplan et al. [4] it was reported that achenes are pilose or glabrous, achene surfaces are irregular or regular striate and palea surfaces are striate. These findings are similar to our data.

Among all *Cardopatum corymbosum* plants collected from 9 different locations, the sample collected from Alaşehir displayed the best plant growth especially in terms of root and stem growth. There are no studies on *C. corymbosum*, so the comparison will be made with other species of the Asteraceae family.

*Aspilia africana*, *Chromolaena odorata*, *Conyza sumatrensis*, *Emilia preatamisa*, *Eleutheranthe ruderalis*, *Metanthera scandens*, *Synedrella nodiflora*, *Tithonia diversifolia*, *Tridax procumbens*, *Vernonia cinarae*, *Vernonia biafrae*, *Emilia coccinea* include secretory

ducts [5], but we did not observe the secretory ducts in *C. corymbosum*.

In a study conducted by Inceer and Ozcan [6], it was stated that cuticle in leaf of 18 taxa of *Matricaria* L. and *Tripleurospermum* Sch. Bip. is not very thick, stomata are present on both surface of the leaf except in the species of *T. fissurale*. There is no difference between abaxial and adaxial surface of leaf except *T. fissurale*. There are not collechyma cells in *M. aurea* and *T. conoclinium*. Leaf of *C. corymbosum* is equifacial. There is thick cuticle in abaxial and adaxial surface. The stomata are on both leaf surface.

The anatomical features of *C. corymbosum* are found to be generally similar to those of the members of Asteraceae family [5-11].

### 5. Conclusions

The anatomical and morphological structure of *Cardopatum corymbosum* was investigated. We think that our plants can be a good material for landscaping applications in arid areas with plenty of beautiful flowers.

### 6. References

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