Morphological and Anatomical Characteristics of *Cichorium intybus* L., *Tragopogon latifolius* Boiss. and *Tussilago farfara* L. (*Asteraceae*)

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Abstract

Edible and medicinal parts of *Cichorium intybus* L. *Tragopogon latifolius* Boiss. and *Tussilago farfara* L. (*Asteraceae*) were investigated morphologically and anatomically. These plants are used as food and folk medicines. Plant samples were collected from different locations in the West and Central Black Sea regions. The stem and leaf of *C. intybus,* the leaf of *T. latifolius* and the leaf and petiole of *T. farfara* were used for anatomical investigation. The stomata index and stomata index rate of three species were calculated. *C. intybus* had secretory structure in the cortex of stem and little glandular hairs on the upper and lower epidermis of leaves. *T. latifolius* and *C. intybus* had equifacial and *T. farfara* had bifacial mesophyll. *T. latifolius* had anomocytic and anisocytic stomata. *C. intybus* and *T. farfara* had anomocytic stomata.

Key words: Anatomy, *Cichorium intybus,* Morphology, *Tragopogon latifolius, Tussilago farfara.*

INTRODUCTION

The *Asteraceae* family consists of approximately 1100 genus and 25000 species in the World [1]. This family is represented by 152 genera and 1230 species in Turkey [2]. *Cichorium intybus* L. *Tragopogon latifolius* Boiss. and *Tussilago farfara* L. are the members of the family *Astereceae* [3].

The fresh leaves and stems of *C. intybus* are consumed as vegetables in the Black Sea region and different parts of Turkey. Doğan et al. [4] reported that above- ground parts of *C. intybus* are eaten in salad and meal. This plant is used for melting gallstone. The tea which is prepared with this plant is used for an appetizing [5, 6]. This plant is rich in insulin, glucose, mucilage, carbohydrate and vitamin C [7].

Only fresh leaves of *T. latifolius* are eaten raw or cooked with oil and eggs. Its local names are "Teke sakalı and Yakı otu" [8]. Shoot and leaves of *T. porrifolius* Web. are consumed as salad and stew with yogurt [4].

The young leaves of *T. farfara* are consumed as vegetable [4]. A tea is made by boiling leaves and flowers are used in the treatment of cough and respiratory problems [6, 7]. They are rich in mucilage, tannins, inulin [7].

Plants are generally identified with morphological characters. But in many cases anatomical, micromorphological, karyological and palynological characters show diagnostic differences. So, morphological and anatomical studies are significant for recognizing plants. *Asteraceae* family species have a great importance in human nutrition, cosmetics and pharmacy related to their essential oil production [9]. There are a lot of studies on anatomical properties of taxa of family *Asteraceae* [9-11]. In spite of the importance of studied species as medicinal plants, there are limited information about their leaf and stem anatomy. These organs are used for medicinal and edible purposes. Therefore, the aim of this article was to investigate the anatomical features of eaten and used parts of the *C. intybus, T. latifolius* and *T. farfara.*

MATERIALS AND METHODS

Plant samples of *C. intybus, T. latifolius* and *T. farfara* were collected from different locations in the West and Central Black Sea regions in the A4-A6 squares.

The taxonomical description of the plants was carried out according to Davis [3]. Samples were fixed in 70% alcohol for anatomical studies. The stem and leaf of *C. intybus,* the leaf of *T. latifolius* and the leaf and petiole of *T. farfara* were used for anatomical investigation. Their photographs were taken with a Nikon FDX-35 microscope. The length and width of the stoma were measured by an ocular micrometer using the surface section from the upper and lower parts of the leaf epidermis. The stomatal index was calculated according to the method described by Meidner & Mansfield [12].

RESULTS

Cichorium intybus L.

Morphological properties

This plant was roughly hairy or glabrous perennial herb with a stout tap root. Stems were 15-105 cm. Basal leaves were shortly petiolate, oblanceolate, toothed to runcinate. Cauline leaves were sessile. Capitula was 2.5- 3.5 cm broad, axillary. Outer phyllaries were ovate, inner phyllaries were lanceolate, 2-3x longer than outer (Figure 1).

Anatomical properties

Stem

A transverse section taken from the stem was observed (Fig. 2, 3). A single layered epidermis was located on the

stem. Epidermis cells were 7.5-12.5x 10-20µ. Three or four collenchyma cell layers were found at the corners. One or two layers of chlorenchymatic cells were present between the corners. Distinguisable endodermis (one- two layers) was seen between cortex and vascular tissue. The vascular tissues were collateral type. Bundles were in different sizes. The small bundles were located under the collenchyma. There was distinguishable cambium between phloem and xylem of large bundles. Secretory structure was found in the cortex. Pith cells were large and cylindrical. The pith cavity was present in the centre of stem (Fig. 2).

Leaf

A transverse section of the lamina and both epidermises was studied (Fig. 4, 5). Both epidermises were covered with cuticle. There were multilayered eglandular hairs and little glandular hairs on the upper and lower epidermis. Mesophyll contained two- three layers of parenchymatic cells with dense chloroplast on the upper and lower epidermis and 4-6 layers of isodiametric spongy parenchmatic cells. Mid-rib region was triangular. There were three large vascular bundles. One-three layered collenchyma was located at the both upper and lower epidermis (Fig. 4). Leaf was equifacial. Stomata type was anomocytic. Stomata was determined on both epidermal surfaces. But stomata cells were more common on the lower epidermis. The number of stomata was 14 ± 2 on the upper epidermis and 42 ± 2 on the lower epidermis of the leaf. Stomata index was 13.46 for the upper epidermis and 24.13 for the lower epidermis (Table 1).

Table 1. Stoma features on the upper and lower epidermis of leaves of *C. intybus, T. latifolius,* and *T. farfara.*

	C. intybus		***T. latifolius***		***T. farfara***	
	U. surface	**L. surface**	**U. surface**	**L. surface**	**U. surface**	**L. surface**
Number of stomata (1 mm^2)	56	48	40± 2	60 ± 2	20± 2	20± 2
Number of epidermis cells (1 mm^2)	160	160	270 ± 2	270 ± 2	250± 2	260± 3
Stomata index	25.9	23	12.9	18.1	7.40	7.14
Stomata length (µ)	16.5-18.5	17.5-20	25-26.5	22..5-25	17.5-18.5	17.5-18.5
Stomata width (µ)	22.5-25	22.5-25	22.5-25	22.5-25	22.5-25	20-22.5
Stomata index rate		1.12		0.71		1.036

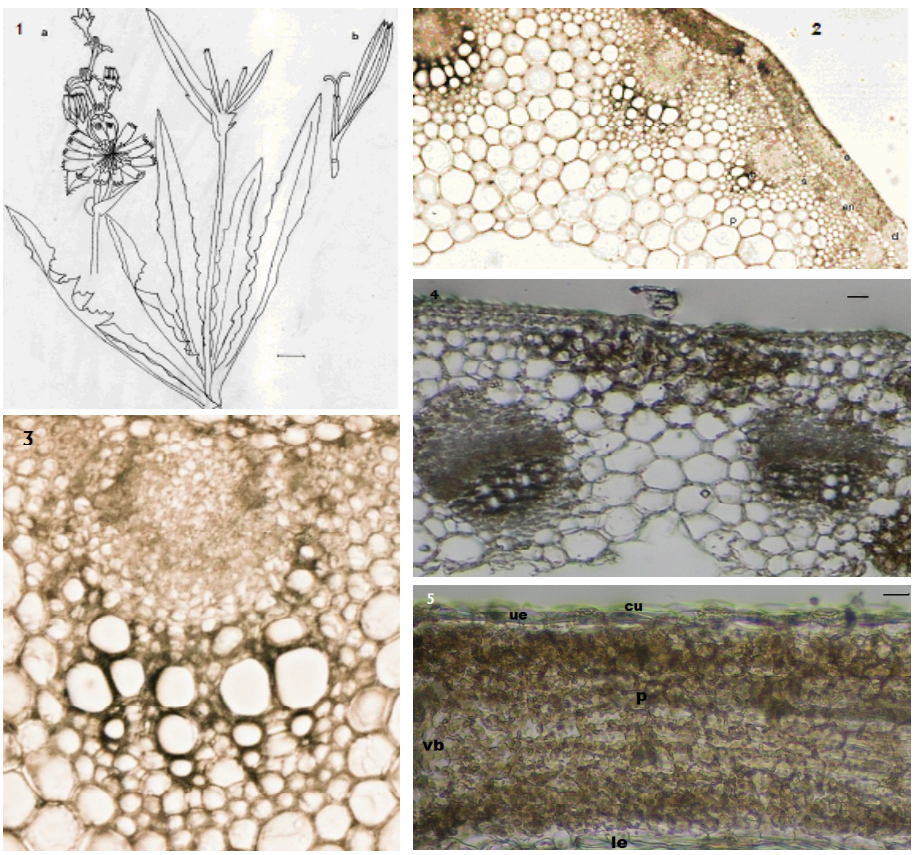

Figure 1-4. *C. intybus.* **Fig 1.** a) General appearance b) flower. **Figs 2-3.** Cross-section of stem. **Fig 4-5.** Cross-section of leaf. Cu) cuticle, e) epidermis, ue) upper epidermis, cl) collenchyma, p) parenchyma, en) endodermis, s) sclerenchyma, vb) vascular bundle, le) lower epidermis. Bar: 2.5 cm (1a), 3mm (1b), 80 µ (2,4,5), 40 µ (3).

***Tragopogon latifolius* Boiss.**

Morphological properties

This plant was annual to perennial and 8-80 cm. Stems were unbranched. Leaves were lanceolate to broadly oblong. Peduncles were very slightly thickened below fruiting capitula. Phyllaries were 8-13 cm lanceolate, tomentose. They were sometimes with black hairs, shorter than flowers. Flowers were yellow. Achenes were 20-25 mm. Pappus was 25-30 mm, brown, annulus very sparsely hairy (Figure 6).

Anatomical Properties

Leaf

A transverse section of the mid-rib, lamina and both epidermises was studied (Fig.7-10) A single layered epidermis located on the upper and lower surface of the leaf. Upper epidermis cells were larger than lower ones. There were little eglandular hairs on the epidermis. The equifacial mesophyll was composed by two (three) layers of parenchymatic cells with dense chloroplast on the both epidermises and 2-3 layers of isodiametric spongy parenchmatic cells. Large and small vascular bundles located in the mesophyll. There were collenchymatic cells on the upper and lower part of big vascular bundles. Mid-rib was very large. There were large and small six vascular bundles in the mid-rib. A very large air cavity was present in the centre of mid-rib (Figs. 7-8). Stomata type was anomocytic and anisocytic. The number of stomata was 40 ± 2 on the upper epidermis and 42 ± 2 on the lower epidermis of the leaf. Stomata index was 12.9 for the upper epidermis and 18.1 for the lower epidermis (Table 1).

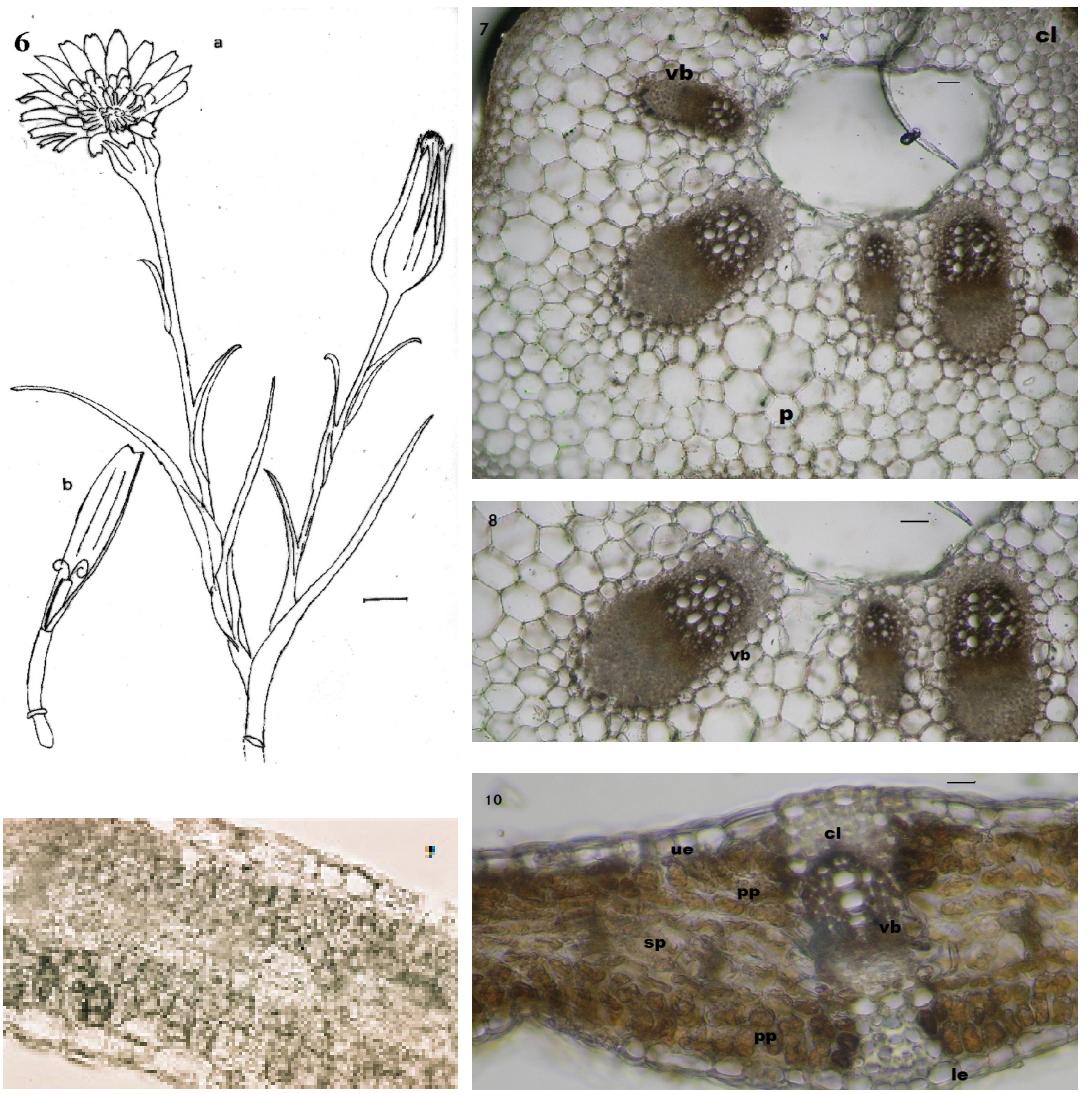

Figure 6-10. *T. latifolius.* **Fig 6.** a) General appearance b) flower. **Figs 7-8.** Cross-section of midrib of leaf. **Figs 9-10.** Cross-section of leaf: ue) upper epidermis, cl) collenchyma, p) parenchyma, le) lower epidermis, vb) vascular bundle. Bar: 2.5 cm (6a), 3.5 mm (6b), 100 µ (7,8), 50 µ (10).

***Tussilago farfara* L.**

Morphological properties

The plant was perennial rhizomatous. Leaves were petiolate. Lamina was 10-22 (-30) diam, acute lobes and margins irregularly toothed. Scapes were 4-15 cm, with numerous purplish scale-leaves. Capitula were in the range of 1.6-2.5 cm broad. Phyllaries were linear, obtuse. Achenes were 3-4 mm. Pappus was 10-16 mm (Figure 11).

Anatomical Properties

Petiole

Petiole was narrowly winged, half oval with the adaxial side flat. Multicellular hairs were present on the epidermis. Multilayered collenchyma located at the corners and abaxial surface. One or two layers of chlorenchymatic cells were present between the corners. Apart from the large central vascular bundle, the petiole contained four large lateral bundles, eight bundles half as large as the latter and six small bundles. Except the small bundles, all the bundles had a layer of cambium. Vascular bundles were surrounded by orbicular parenchymatous cells with starch (Fig. 12, 13). Mechanical tissue was formed on the xylem and phloem. A very large air cavity was present in the centre of petiole.

Leaf

A transverse section of the lamina and both epidermises was studied (Fig. 14, 15). Both epidermises had cuticle. A single layered epidermis was located on the upper and lower surface of the leaf. Upper epidermis cells were larger than lower ones and 7-15 x 10-35µ. Leaf was bifacial. Mesophyll contained one- (two) layers of elongated palisade cells and 4-5 layers of isodiametric spongy parenchmatic cells. Air cavity was present in the centre of mid-rib. The leaf was amphistomatic with anomocytic stomata. Stomata cells were more common on the lower epidermis. The number of stomata was 20 ± 1 on the upper epidermis and 20 ± 1 on the lower epidermis of the leaf. Stomata index was 7.4 for the upper epidermis and 7.1 for the lower epidermis (Table 1).

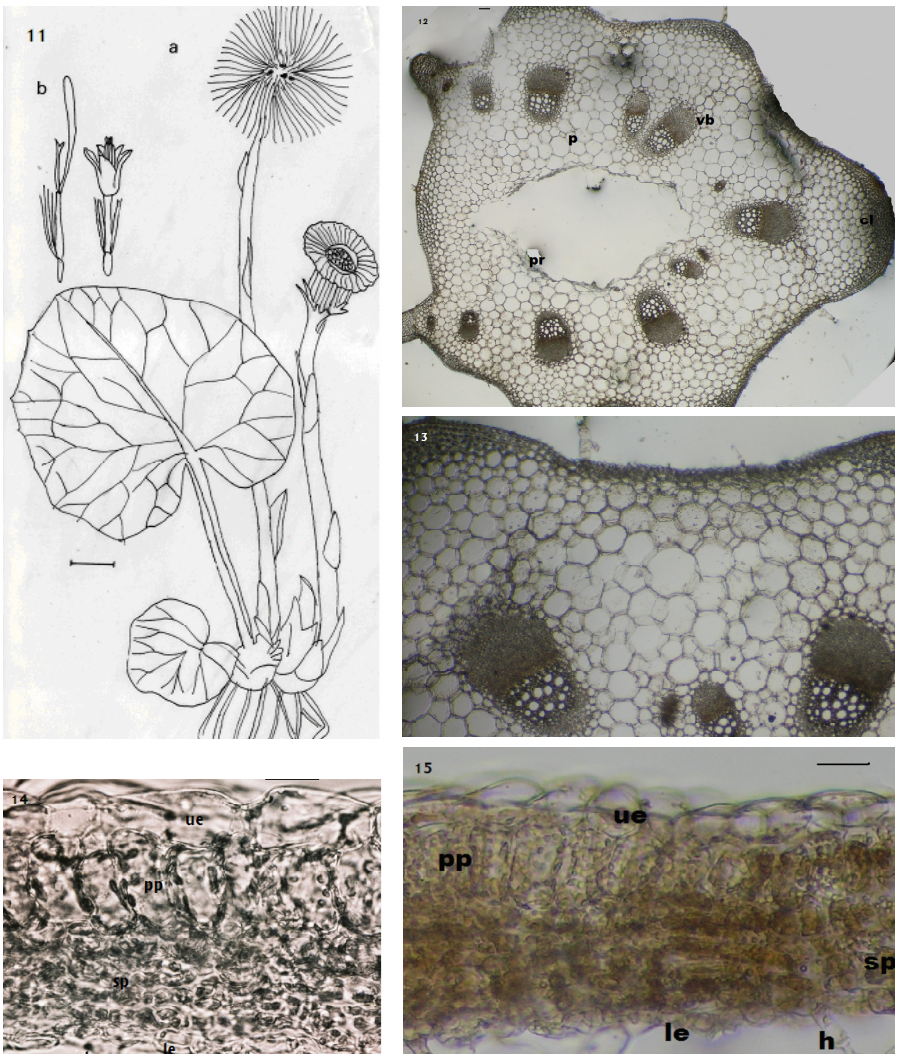

Figure 11-15. *T. farfara*.. **Fig 11.** a) General appearance b) flower. **Figs 12-13.** Cross-section of petiole. **Figs 14-15.** Cross-section of leaf: e) epidermis, ue) upper epidermis, cl) collenchyma, p) parenchyma, pp) palisade parenchyma, sp) spongy parenchyma, le) lower epidermis, vb) vascular bundle, h) hair. Bar: 2 cm (11a), 7.5 mm (11b), 100 µ (12), 40 µ (14,15).

DISCUSSION

In this study, the morphological and anatomical characteristics of used parts of *C. intybus, T. latifolius* and *T. farfara* were examined. The stem and leaf of *C. intybus,* the leaf of *T. latifolius and* leaf and petiole of *T. farfara* are used as food and traditional medicine.

The anatomical properties of these plants present the general features of Dicotyledons [13]. Metcalfe & Chalk [14] gave information about the general anatomical characteristics of the family *Asteraceae*. According to Metcalfe & Chalk [14] anatomical diversity is commonly observed in the structure of leaves of taxa of *Asteraceae*. In stem of *C. intybus,* three or four collenchyma cell layers were found at the corners. One or two layers of chlorenchymatic cells were present between the corners. Distinguisable endodermis (one- two layers) was seen between cortex and vascular tissue. Özörgücü et al. [15] reported that endodermis is usually and completely distinguishable in *Asteraceae*. There was a pith cavity in the centre of stem of *C. intybus*. Melo-de-Pinna & Menezes [10] stated that a pith cavity was seen in the stem of *Ianthopappus corymbosus* Roque &Hind (Asteraceae). The mesophyll of the studied species varied according to the number of cell layers. *T. latifolius* and *C. intybus* had equifacial and *T. farfara* had bifacial mesophyll. Metcalfe & Chalk [14] pointed out that there were homogeneous and equifacial mesophyll in the family Asterac*eae.* Milan et al. [9] observed that *Mikania glomerata* Spreng had anomocytic stomata. In this research it was found that *T. latifolius* had anomocytic and anisocytic stomata. *C. intybus* and *T. farfara* had anomocytic stomata. Metcalfe & Chalk [14] reported that there were both anomocytic and anisocytic stomata in the family *Asteraceae.*

In this study, it was seen that the vascular bundles were surrounded by orbicular parenchymatous cells (endodermis) with starch petiole of *T. farfara.* Melo-de-Pinna & Menezes [10] observed that the endodermis clearly involves the vascular unit at the central vascular unit region of petiole of *I. corymbosus.* Lotocka and Geszprych [11] stated that very large air cavity was formed on the adaxial flat side of petiole of *Rhaponticum carthamoides* (Willd.) Iljin (*Asteraceae*). Same results were found in petiole of *T. farfara.* These species had a very large air cavity in the centre of petiole and mid-rib. Also, there was air cavity in the mid-rib of *T. latifolius.*

The secretory structures are important in *Asteraceae*. Secretory structures are used as taxonomic properties for identification of some genera of *Asteraceae*. In studied species, *C. intybus* had secretory structure in the cortex of stem and little glandular hairs on the upper and lower epidermis of leaves. Milan et al. [9] observed that *M. glomerata* had secretory ducts and glandular hairs; *Porophyllum ruderale* Cass. had secretory cavities and hydathodes.

Consequently, it has been aimed that study of anatomical and morphological properties of edible and used parts of *C. intybus, T. latifolius* and *T. farfara.* Plants are valuable sources of food because they are widely available and easily procured. It is important to be able to recognize the wild edible plants. The studies of plants would provide significant data about plants and their using field.

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