

Anatomical Study of Three Species of the Asteraceae Family from the Anbar Governorate, Iraq

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Abstract: This study explores the stem and leaf anatomy of three Asteraceae species *Lactuca serriola* L., *Sonchus asper* (L.) Hill, and *Sonchus oleraceus* L., collected from Anbar Governorate in Iraq, to identify diagnostic traits relevant to taxonomy. Fresh specimens were identified at the University of Anbar and handmade transverse sections were prepared, stained with safranin, and examined under a light microscope. Both qualitative and quantitative features of the dermal, ground, and vascular tissue systems were analyzed, including stomatal density, epidermal cell dimensions, and tissue thickness. A stripped epidermis technique was used for detailed leaf surface analysis. Anatomical differences were evident among the species. *S. oleraceus* exhibited a biseriate epidermis and showed greatest thickness in epidermal (67.5 µm), cortical (320 µm), and pith (1920 µm) tissues along with the highest stomatal density (131.5/mm² adaxial). Trichomes appeared only in *S. asper*, which also had the longest epidermal cells. *L. serriola* had the thickest mesophyll (154 µm) and main vascular bundles (738 µm). All species displayed anomocytic stomata but stomatal size and density varied across adaxial and abaxial surfaces. These anatomical traits provide valuable taxonomic markers for species differentiation within Asteraceae and offer insights into their structural adaptations and evolutionary significance.

Keywords: Asteraceae, anatomy, epidermis, stomata, vascular system, taxonomy.

Irak'ın Anbar İlinde Bulunan Asteraceae Familyasına Ait Üç Türün Anatomik Çalışması

Öz: Bu çalışma, Irak'ın Anbar İlinde toplanan üç Asteraceae türü – *Lactuca serriola* L., *Sonchus asper* (L.) Hill ve *Sonchus oleraceus* L. – üzerinde gövde ve yaprak anatomisini inceleyerek taksonomi açısından ayırt edici özellikleri belirlemeyi amaçlamaktadır. Taze örnekler Anbar Üniversitesi'nde teşhis edilmiş, el yapımı enine kesitler hazırlanarak safranin ile boyanmış ve ışık mikroskobu altında incelenmiştir. Epidermal, temel ve iletim dokusu sistemlerine ait nitel ve nicel özellikler analiz edilmiştir; bunlar arasında stoma yoğunluğu, epidermal hücre boyutları ve doku kalınlıkları yer almaktadır. Yaprak yüzeyinin ayrıntılı analizi için soyulmuş epidermis tekniği kullanılmıştır. Türler arasında anatomik farklılıklar belirgin şekilde gözlemlenmiştir. *S. oleraceus* çift sıralı epidermis göstermiş ve epidermis (67.5 µm), korteks (320 µm) ve öz bölgesi (1920 µm) dokularında en yüksek kalınlık değerleri ile birlikte en yüksek stoma yoğunluğunu (131.5/mm² adaksiyal) sergilemiştir. Tüy yapıları yalnızca *S. asper* türünde gözlemlenmiş ve bu tür aynı zamanda en uzun epidermal hücrelere sahip olmuştur. *L. serriola* ise en kalın mezofil (154 µm) ve ana iletim demetlerine (738 µm) sahip tür olarak öne çıkmıştır. Tüm türlerde anomositik stoma yapısı gözlemlenmiş, ancak stoma boyutu ve yoğunluğu adaksiyal ve abaksiyal yüzeyler arasında farklılık göstermiştir. Bu anatomik özellikler, Asteraceae familyası içindeki tür ayırımında değerli taksonomik belirteçler sunmakta ve yapısal adaptasyonları ile evrimsel önemlerine dair bilgiler sağlamaktadır.

Anahtar kelimeler: Asteraceae, anatomi, epidermis, stomata, vascular sistem, taksonomi.

1. Introduction

The Asteraceae (syn, Compositae) is widely distributed and the largest family of flowering plants (angiosperms) in terms of genera (1623 genera) and second in the number of species (2480 0-3500 0) when compared to the Orchidaceae (Christenhusz & Byng, 2016; Mandel et al., 2019; Atiyah & Khesraji, 2023). The family Asteraceae consists of 13-16 subfamilies and 45-51 tribes (Susanna et al., 2020). It is usually dominant in arid and temperate regions and is an important family that includes many economically significant plants (Hicks et al., 2016). It is characterized by plants with small flowers gathered in a capitulum that are composed of protective involucre bracts and achene fruits (Hurkul & Yayla, 2023). In Iraq, this family is represented by 123 genera and 433 species (with four cultivated species), four subfamilies, and 16 tribes (Ghazanfar et al., 2019). *Lactuca* (Inceer & Ozcan, 2011) and *Sonchus* (Susanna

et al., 2020) are two of the genera in the family that can be found in Iraq. (Endress, 2000).

Plant anatomy is the branch of plant science dealing with the anatomical structure of parts of plant. Anatomy is also essential to validate and understand many aspects of plant biology, including the ecological and molecular biology. This field of biology finds application in several fields such as systematics, forensics, and pharmacognosy. For example, anatomical characteristics are useful for the delimitation of taxa regardless of the influence of environmental factors. Therefore, classification have investigated such features in order to select anatomical data which may strengthen the taxonomy of the genera and provide features allowing for better identification of the species (Rivera, 2017; Inceer & Ozcan, 2011; Inceer & Garnatje, 2018; Inceer & Ozcan, 2021).

Leaves are widely used in the classification of many plant families. Appearance has been linked to variable environmental conditions such as drought, saline soils, and light conditions (Rossatto & Kolb, 2010; Faria et al., 2012; Bercu & Broască, 2012; Ferraro & Scremin-Dias, 2017). Nevertheless, the environmental influences alone do not explain the variation in leaf anatomical characters because some of these, as well as most of the leaf structural characters, can be constrained by the phylogenetic history (Faria et al., 2012). Thus, these anatomical characteristics are important in solving taxonomic and evolutionary problems of different plant groups (Alrawi et al., 2023; Atiyah & Khesraji, 2023). Therefore, the aim of this research is to describe the anatomical characters of the stems and leaves of three taxa belonging to the Asteraceae family that were found growing in the University of Anbar, Ramadi in Iraq.

2. Material and Method

Anatomy characteristics of fresh stems and leaves of three plants (*Lactuca serriola*, *Sonchus asper*, and *Sonchus oleraceus*) in the genera *Lactuca* and *Sonchus* were examined (Christenhusz & Byng, 2016; Atiyah & Khesraji, 2023). The specimens were identified at the Department of Biology, College of Education for Pure Science, University of Anbar, Iraq, in April 2024, according to the method of Ghazanfar et al. (2019). The anatomical characteristics of the stems and leaves were recorded using the following methods. Handmade transverses of fresh stems and leaves were prepared and stained with safranin and then placed on a microscope slide to distinguish plant tissue under the microscope. Measurements were taken using a micrometre (Inceer & Bal, 2019). For dermal tissue system analyses, specimens of the epidermis surface (ordinary epidermis cells and stomatal density for stems and abaxial and adaxial surfaces for leaves were studied using the stripped-off epidermis method (Atiyah & Khesraji, 2023).

All micrographs were taken using an Olympus light microscope with a Sony digital camera.

3. Results

3.1. Stem Anatomy

The results of the anatomical study of the studied taxa showed variations in some of the studied characteristics of stems. For the stem shape the *S. asper* and *S. oleraceus* showed a circular shape, while it was grooved-circular for the *L. serriola*.

3.1.1. Dermal tissue system (DTS)

A uniseriate epidermis was observed in *L. serriola* and *S. asper*, while the *S. oleraceus* had a biseriate epidermis. The ordinary epidermis cells were polygonal in all three species. The *S. oleraceus* had the thickest ordinary epidermis cells (67.5 µm), while *L. serriola* and *S. asper* had thinner epidermis cells at 23 and 15 µm, respectively. *S. asper* had the longest epidermis cells at 127.5 µm, while *S. oleraceus* had the shortest epidermis cells at 45 µm. However, *S. oleraceus* had the widest epidermis cells at 50 µm, while *S. asper* was the narrowest at 29 µm. The stomata were anomocytic in all three species. *S. oleraceus* had the longest (35 µm) and widest (26 µm) stomata compared to other species. As for the stomata density, *L. serriola* had the highest density at 95 stomata per mm². Trichomes were present in the *S. asper*. (Table 1, Figs. 1-2).

3.1.2. Ground tissue system (GTS)

The ground tissue system consists of the cortex and pith. Cross sections of all three species showed that they all had a narrow cortex, with *S. oleraceus* having the thickest cortex at 320 µm, whereas *L. serriola* was the narrowest at 90 µm. Meanwhile, the pith was the thickest in *S. oleraceus* at 1920 µm, while the thinnest was in *L. serriola* at 1190 µm. Chlorenchyma tissue was present only in *L. serriola* and not in the other two species (Table 2, Fig. 2).

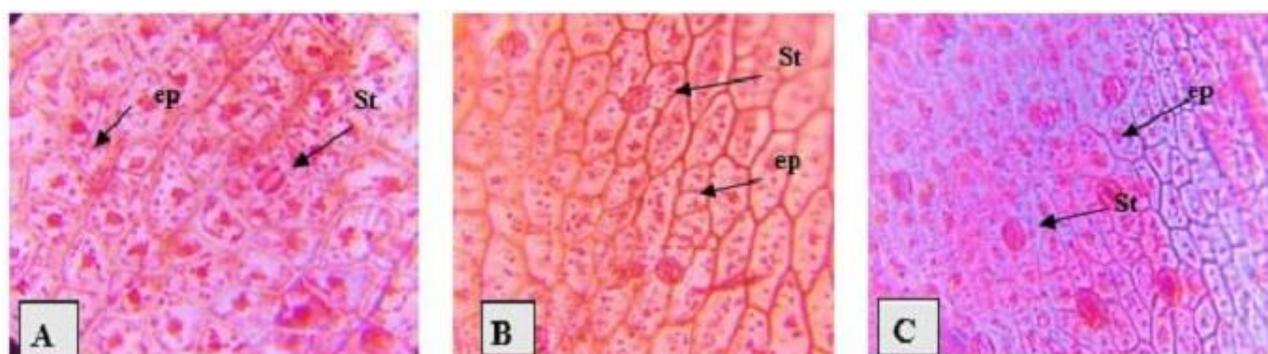


Figure 1. Stem epidermis of the species studied (A: *Lactuca serriola*, B: *Sonchus asper*, C: *Sonchus oleraceus*). ep: epidermal cells, St: stomata cells.

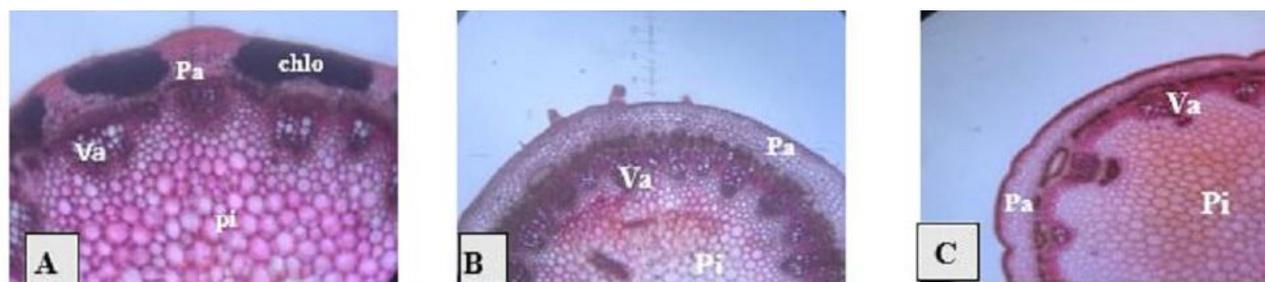


Figure 2. Stem cross section of the species studied (A: *Lactuca serriola*, B: *Sonchus asper*, C: *Sonchus oleraceus*). Pa: paranchyma cells, Chlo: chlorenchyma cells, Va: Vascular bundle, Pi: Pith.

Table 1. Stem surface feature in the three species studied (µm).

Taxa	Characters	Stomata			Ordinary epidermis cells	
		Length	Width	Density++	Length	Width
<i>Lactuca serriola</i>		(25-30) \ 27.5+	(17.5-22.5) \ 19	95	(37.5-60) \ 45	(25-37.5) \ 34.5
<i>Sonchus asper</i>		(27.5-30) \ 27.5	(17.5-22.5) \ 20	39	(90-175) \ 127.5	(25-32.5) \ 29
<i>Sonchus oleraceus</i>		(30-37.5) \ 35	(25-27.5) \ 26	15	(30-50) \ 42	(37.5-75) \ 50

+Out the brackets = mean of 7 replicates, (++) density of stomata \ mm²

Table 2. Stem cross section of the three species studied (µm).

Taxa	Character	Ordinary E.C thickness	Cortex thickness	Pith thickness	Paranchyma tissue layer	Va. No	Trichomes
<i>Lactuca serriola</i>		(20-30)/23+	(80-100)/90	(1180-1200)/1190	(6-7)	(15-18)	Absent
<i>Sonchus asper</i>		(10-20)/15	(110-120)/110	(1200-1400)/1300	Absent	(27-29)	Present
<i>Sonchus oleraceus</i>		(50-75)/67.5	(300-350)/320	(1875-1950)/1920	Absent	(22-25)	Absent

+Out of the brackets = mean of 7 replicates.

3.1.3. Vascular tissue system (VTS)

The vascular bundle was embedded in the pith cells and protected like narrow cap cells by pericyclic sclerenchymatous tissue in all three species. However, *S. oleraceus* also has an endodermis layer (Fig.1).

3.2. The Leaf

3.2.1. Dermal tissue system

Adaxial surface: uniseriate in *L. serriola*, *S. asper* species while *S. oleraceus* had a biseriate undulating epidermis. Anomocytic stomata were observed in all three species in this study, with *S. oleraceus* having the longest stomata at 27.5 µm, while *S. asper* had the widest at 20µm. Meanwhile, *S. oleraceus* had the highest stomata density at 131.5 per\mm². Moreover, *S. asper* had longest ordinary

epidermis cells at 71.5 µm, while *L. serriola* had the shortest, at 71.5 µm. In terms of ordinary epidermis cell width, *S. oleraceus* was the widest at 56 µm, while *L. serriola* was the narrowest at 39 µm (Table 1).

Abaxial surface: uniseriate in *L. serriola* and *S. asper*, while *S. oleraceus* had biseriate undulating epidermis. Anomocytic stomata were observed in all three species in this study, with *S. asper* having the longest stomata at 20 µm. The widest stomata were observed in *S. oleraceus* 17.5 µm. In terms of stomata density, *L. serriola* had the highest density 117.8 per\mm². Meanwhile *S. asper* had the longest ordinary epidermis cell 69.5µm, while *L. serriola* had the shortest 60 µm. Similarly, *S. asper* also had the widest stomata at 46. µm, while *L. serriola* had the narrowest at 46.5 µm (Table 3).

Table 3. Adaxial and abaxial characters for the species studied (µm)

Taxa	surface	Stomata data			Epidermis cells data		
		Length	Width	Density++	Thickness	Length	Width
<i>Lactuca serriola</i>	Adaxial	(22.5-27.5) \ 25+	(17.5-20) \ 19	100	(5-10)6.5	(42.5-80) \ 61.5	(30-57.5) \ 39
	Abaxial	(25-30) \ 28	(20-22.5) \ 21	117.8	(7.5-15) \ 11	(55-62.5) \ 60	(25-57.5) \ 46.5
<i>Sonchus asper</i>	Adaxial	(22.5-27.5) \ 25	(17.5-22.5) \ 20	79	(5-7.5) \ 6	(62.5-82.5) \ 71.5	(10.5-60) \ 45
	Abaxial	(17.5-22.5) \ 20	(22.5-27.5) \ 24	94	(7.5-10) \ 8	(37.5-112.5) \ 69.5	(37.5-75) \ 56
<i>Sonchus oleraceus</i>	Adaxial	(25-30) \ 27.5	(15-20) \ 17.5	131.5	(12.5-20) \ 17	(45-75) \ 62.5	(50-62.5) \ 56
	Abaxial	(20-27.5) \ 24	(15-20) \ 17.5	86.8	(7.5-15) \ 12.5	(57.5-70) \ 64	(45-50) \ 47.5

+Out of the brackets = mean of 7 replicates, (++) density of stomata \ mm²

3.2.2. Ground and vascular tissue system

All species in this study had deltoid vines and unifacial mesophyll. *L. serriola* showed the thickest mesophyll 154 µm, while *S. oleraceus* had the thinnest 60µm as for the thickness of vines. *L. serriola* had the thickest 738µm, while *S. asper* had the thinnest 520µm. (Table 4, Fig. 4).

Table 4. Leaf characters of the three species studied (µm)

Species	Mesophyll thickness	Vein thickness	No. of vascular bundles
<i>Lactuca serriola</i>	(150-180) \ 154+	(730-750) \ 738	3
<i>Sonchus asper</i>	(100-120) \ 110	(500-530) \ 520	3
<i>Sonchus oleraceus</i>	(50-70) \ 60	(700-750) \ 730	3

+Out of the brackets = mean of 7 replicates.

4. Discussion

The comparative study of plant shape together with plant anatomy has always been the basis for determining plant systematics. The anatomical characters of the three species in this study are typical of the Asteraceae family. The observed stem and leaf variation in the family and within each tribe is consistent with some previous reports. Anatomical characters such as the stem and leaf were used as taxonomic characters to identify the species. The shape of stem is an important characteristic to distinguish between taxa. Corner collenchyma was clearly seen in the stem of *L. serriola*; thus, this character can be used to identify the species. Meanwhile anomocytic stomata is prevalent in most species of this family. Therefore, the presence of the collenchyma is a distinctive feature for separating taxonomic ranks at the species level (Atiyah &

Khesraji, 2023). In the Asteraceae family the mesophyll tissue is either completely palisade or spongy parenchyma (Metcalf & Chalk, 1950). Regarding the frequency of the stomata on the adaxial and abaxial part of the plant varied

between species and this proves that it is not necessary for the stomata to be distributed more on the abaxial. Most Asteraceae species have leaves with three main veins in the middle of the leaf.

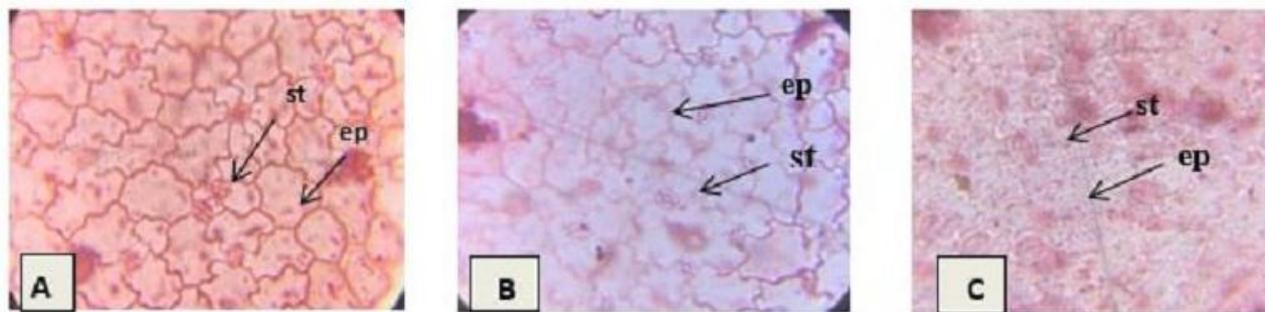


Figure 3. Adaxial characters of the species studied (A: *Lactuca serriola*, B: *Sonchus asper*, C: *Sonchus oleraceus*). St: stomata, epi: epidermis.

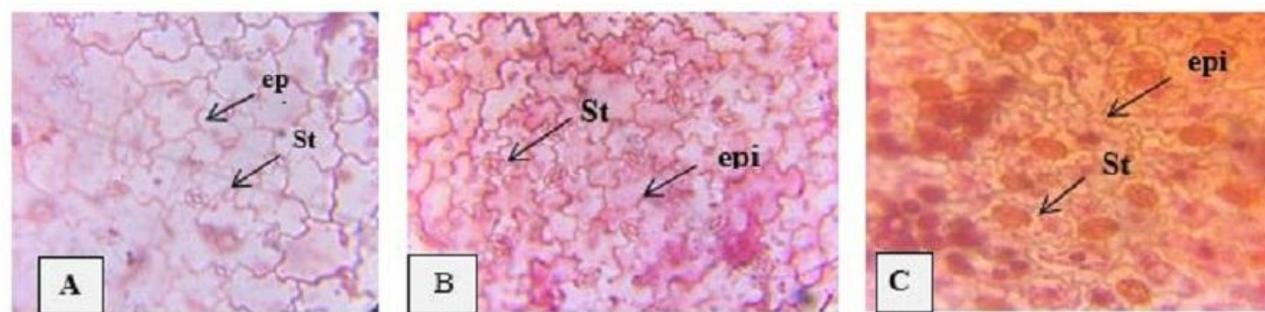


Figure 4. Abaxial characters of the species studied (A: *Lactuca serriola*, B: *Sonchus asper*, C: *Sonchus oleraceus*). St: stomata, epi: epidermis.

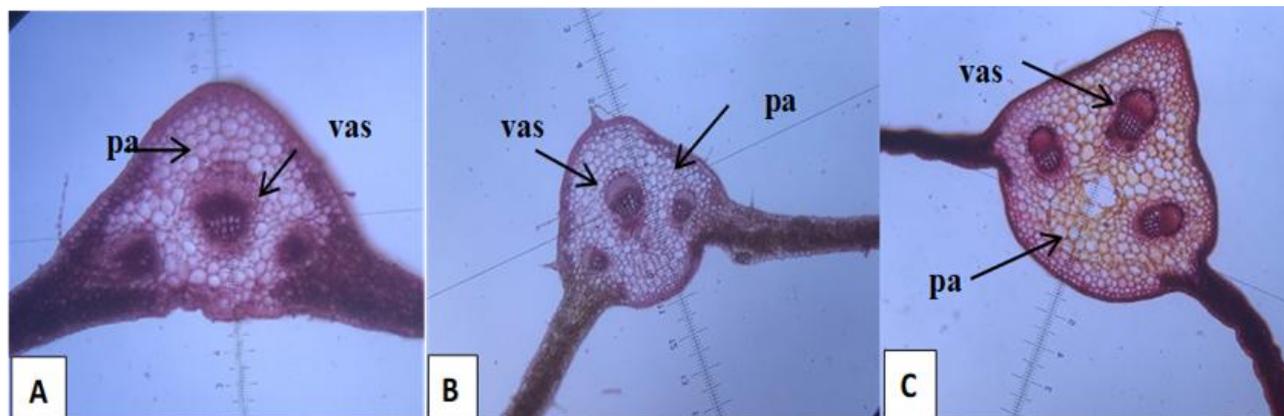


Figure 5. Leaf cross section of the three species in the study (A: *Lactuca serriola*, B: *Sonchus asper*, C: *Sonchus oleraceus*). pa: parenchyma cells, vas: vascular bundle.

5. Conclusion

Anatomical characters such as the stem and leaf were used as classified characters to identify the three Asteraceae species. Although our results are generally in line with the literature, anatomical descriptions are a fundamental part of the evolutionary, physiological, and ecological studies of the Asteraceae. The results of this descriptive study can allow the testing of hypotheses about the factors causing stem and leaf diversity in this plant group. More leaf anatomical studies of the family are important to confirm the patterns proposed for the tribes and the family.

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