ANATOMICAL STUDY OF THE STEMS OF SOME WILD SPECIES OF POACEAE FAMILY IN THE WESTERN DESERT

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ABSTRACT

The research included anatomical study of cross sections of stems of eight species belonging to six genera, namely Aristida adscensionis, Avena barbata, Avena fatua, Eragrostis ciliensis, Polyggon monspelisinsis, Schismus arabicus, Setaria glauca, Setaria verticillata from plants of the Poaceae family growing in the Western Desert of Iraq. The results showed that the quantitative and qualitative characteristics have greatly contributed to isolating the species depending on the cross-sectional diameter of the stem, which ranged between 1112-2185 μm. The sections also varied in terms of the presence of the core region (solid section) or the absence of it (hollow section). As for the sclerenchymal tissue, its cell numbers ranged between 2 - 9 rows, as well as the variation in thickness of this tissue between species. The same is the case with the Parenchyma tissue, which differed greatly between the types in terms of thickness and the type of tissue, which ranged between the ordinary Parenchymal tissue and the Chlorenchyma tissue, as well as the variation in the nature of the tissue between the regular annular and semi-annular or in the form of small, medium or large clusters. Most types contained two or three rows of bundles except for Avena barbata and Avena fatua, which contained only one row. The number of vascular bundles varied greatly between species, as well as their different in sizes and the different diameter of a single vessel.

Keyword: Anatomical, Stems, wild species, Poaceae, Western desert.

1. Introduction

Plant Anatomy played an important role in classifying the plant kingdom in general. As it was divided into two groups, they are the Thallophytic (non-vascular), and the vascular system, depending on the presence of a developed vascular system in the second group, and its absence in the first [1]. Many researchers have mentioned that plant anatomy has a prominent role, no less important than morphology, in isolating taxonomic orders. [2], indicated that anatomical traits have been used in taxonomic studies for more than a hundred years. Stuessy [3], also indicated that the internal body structure of the plant’s is one of the scientific facts that are used in the classification of plants. These facts are very crucial in giving the necessary solutions to many problems between the taxonomic ranks and the species level, and subspecies sometimes. An ancient anatomical study [4], of monocotyledons families. Among them is the Gramineae family, which was recently known by the name Poaceae according to the legal designation that was derived from one of its largest genera, the genus Poa L., which includes about 500 species worldwide [5]. The Poaceae family (Gramineae) is the fourth largest plant family in the world, as it includes more than 300 genera, and about 10,000 species [6]. In Iraq, according to the Flora of Iraq, this broad plant family, which has a unique volume of its own (Volume nine) has the largest share in terms of the number of plant species that reach 301 species, belonging to 107 genera [7]. The plants of this family were distinguished by the ecological dominance of most of the ecological habitats, as they cover about 10% of wild and farmed lands [8]. Therefore, interest in it began, as it is one of the economic Plant families that provides us with about 80% of the total annual global food [9]. Especially since our country has extensive natural plant wealth, we had to go to study it from all aspects, such as taxonomic, anatomical, environmental, nutritional, chemical content, genetic studies, pathogens and their control, and organ functions [10].

The source of the anatomical characters in plants in general is summarized through two types of characteristics that can be adopted taxonomically, namely: the first type, which can be derived through the transverse sections of the stems, which are the most complex and stable organ in the nature of the characteristics compared to other organs such as roots and leaves. Whereas,
the second type, it is represented by all the external characteristics that can be adopted, such as the nature of epidermal cells, stomatal complexes, and indumentum, and other characteristics that can be subject to measurement or qualitative description [11]. One of the studies that concerned this family is the study of Meney and Meo [12], where they were able to isolate the four species belonging to the genus *Elytrigia* Desv. Depending on both anatomical and phenotypic exact features. In Iraq, research trends began recently aimed at employing anatomical characters in support of plant taxonomy, including the study [13], of six species belonging to the genus *Poa* L., in which the anatomical characters were accurately adopted to isolate the species, followed by another study of three genera of the family Poaceae, the anatomical, chemical and molecular characteristics used in it in order to give a clear picture and precise limits for each of the species belonging to the three genera [14].

Due to the lack of taxonomic studies in general and anatomical studies in particular, this preliminary study used 8 wild plant species belonging to 6 genera of the Poaceae family (Gramineae), aim to studying the cross sections of the stems by revealing the distributions and contrast of tissues. As well as adopting the quantitative characteristics of the tissues that can be measured, such as xylem and other tissues, in order to employ them as constant evidence, and approved traits that are easy to deal with in order to set clear limits for each type under study to give an anatomical imprint that can be used as classification approval in isolating the species.

### 2. Material and Methods

For this anatomical study of the stem through cross-sectional sections, 8 wild plant species of the Poaceae family, belonging to 6 genera, belonging to 6 different tribes growing in the Western Desert of Iraq (Table 1) were used for this study. The fresh plant samples that were collected during the spring of 2019 were relied on during field trips in the Rutba, Nukhayb and 160 km west of Ramadi, in the Western Sahara Province. The eight species were diagnosed in the Herbarium of the University of Anbar - Center for Desert Studies, based on [7], and dry samples were preserved and deposited in the Herbarium, and others for the study, where the study relied on the dissection of the dried stems in preparing the slices after soaking them in warm water for one hour, and after it regained its moderate tenderness that allow the blade to be cut without the tissue being crushed or being soft and difficult to cut, as it relied on manual cutting, the soft stem was held by the index finger and thumb and in a vertical position, then a sharp blade was used to cut, by repeating the cutting process for several times, typical slices in terms of thickness were obtained, some slides were cut using the Komax anatomical microscope after placing the stem on the microscope base in a horizontal position, where the cutting was done by examining the stem microscopically, in order to obtain the finest sections for perfection and clarity. Then the good sections were transferred to a glass slide, then two drops of safranin dye were added to it for a period of 3-5 minutes, with the dye being diluted with very few drops of 70% ethyl alcohol when needed, and after confirming the staining process, the dyed slides were transferred to another clean glass slide. After that, 3-5 drops of Glycerin were added until the slides were completely covered. Then the glass slide was placed on a hot plate in order to get rid of the air bubbles that are inside the intersections of the tissues for a period of approximately two hours. Finally, the samples were examined under

| Scientific names | Common names | Tribe       |
|------------------|--------------|-------------|
| *Aristida adscensionis* Desf. | SAFWH | Danthonieae |
| *Avena barbata* Pott ex Link | SHOOFAN | Aveneae |
| *Avena fatua* L. | DOOSR | Aveneae |
| *Eragrostis cilinensis* (All.) Vign. -*Lutut* | SUNASALH | Eragrostideae |
| *Polypogon monspelialis* (L.) Desf. | THUAL ALQAT | Agrostideae |
| *Schismus arabicus* Nees | AUHNATH | Danthonieae |
| *Setaria glauca* (L.) P. Beauv. | DAKHAAN | Paniceae |
| *Setaria verticillata* (L.) Beauv. | SHAAR ALFAAR | Paniceae |
a compound light microscope, Olympus type of Japanese origin, at a magnification power of 100 X for the entire section, then at a magnification power of 400 X for a part of the section, and the required measurements were taken for a number of sections of the same species (8-12 sections), taking into account their averages. The samples were imaged using a Canon microscope camera, with the use of the Ocular micrometer to perform all measurements of the tissue section according to [15], with some necessary adjustments.

3. Results and Discussion

Anatomical study of the cross sections of the stems of the eight species showed significant variation in both quantitative and qualitative traits. At the forefront of these characteristics is the nature of the section in terms of the presence or absence of the core region, which resulted in isolating the species into two groups, at the forefront of these characteristics is the nature of the section in terms of the presence or absence of the core (region, which resulted in isolating the species into two groups, four of which were characterized by solid stems, while the other four were hollow (figure 1-8). Many scientific sources [1,16], have indicated that the characteristic of hollow stems is the most common among plants of the monocotyledones species, including the plant family Poaceae. The average diameter of the sections in general ranged from 1112 μm in the type *Avena fatua* to 2185 μm in the type *Avena barbata*. Depending on this, the species were divided into two groups. The first group included five species that approached in cross-sectional diameters of the first type, while the other three species were closer to the second type (Table 2). The study did not give importance to epiderm cells in terms of shapes and dimensions because they are very similar in characteristics, as well as the lack of stable cell sizes within individuals of the same type developing in environments of varying factors. As the sizes of epidermal cells often increase in the stems of plant species growing in temperate environments, on the contrary, we find in dry environments, and this was indicated by [17]. Whereas, the ground tissue, it consisted of two types of tissues:

![Figure 1](image1.png)

*Figure 1. stem transverse sections of Arisida adscensionis: 1:phloem 2:sclerenchyma 3:parenchyma 4:metaxylem 5:lysigenous cavity 6:pith.*
**Figure 2.** Stem transverse sections of *Avena barbata*: 1: phloem  2: sclerenchyma  3: parenchyma  4: metaxylem  7: chlorenchyma  8: bundle sheath  9: protoxylem.

**Figure 3.** Stem transverse sections of *Avena fatua*: 1: phloem  2: sclerenchyma  3: parenchyma  4: metaxylem  9: protoxylem.
Figure 4. stem transverse sections of *Eragrostis cilinensis*  
2:sclerenchyma  3:parenchyma  
4:metaxylem  11:ground tissue.

Figure 5. stem transverse sections of *Polypogon monseplinsis*  
1:phloem  2:sclerenchyma  3:parenchyma  
4:metaxylem  5:lysigenous cavity  7:chlorenchyma
Figure 6. stem transverse sections of Schismus arabicus 2:sclerenchyma 3:parenchyma
4:metaxylem 5:lysigenous cavity 6:pith.

Figure 7. stem transverse sections of Setaria glauca 2:sclerenchyma 3:parenchyma
4:metaxylem 5:lysigenous cavity 6:pith 9:protoxylem.
Figure 8. Stem transverse sections of Setaria verticillata 2: sclerenchyma 3: parenchyma
10: vascular bundle 11: ground tissues.

Table 2. Some quantitative and qualitative characteristics of cross-sectional stems of species measured in micrometers.

| N  | Species                  | Section diameter | Thickness of sclerenchyma tissue under epidermis (average) | His rows numbers (average) | Type of parenchymal tissue under epidermis | His thickness (average) | His nature | Pith thickness (average) | His nature |
|----|--------------------------|------------------|------------------------------------------------------------|----------------------------|------------------------------------------|------------------------|------------|--------------------------|------------|
| 1  | Aristida adscensionis    | 1315             | 138(116)125                                                | 9                          | Chlorenchyma                            | 73                     | Small      | 708                      | Hollow     |
| 2  | Avena barbata            | 2185             | 115(108)102                                                | 7                          | Chlorenchyma                            | 215                    | Large      | 825                      | Hollow     |
| 3  | Avena fatua              | 1112             | 89(78)71                                                   | 5                          | Chlorenchyma                            | 143                    | Medium     | 487                      | Hollow     |
| 4  | Eragrostis cilinensis    | 2164             | 92(75)66                                                   | 4                          | ordinary                                | 270                    | Continuous  | 1135                     | Solid      |
| 5  | Polypogon monseplinsis   | 2025             | 120(110)95                                                 | 5                          | Chlorenchyma                            | 135                    | annular    | 775                      | Solid      |
| 6  | Schismus arabicus        | 1250             | 98(83)77                                                   | 4                          | Chlorenchyma                            | 65                     | Small      | 730                      | Hollow     |
| 7  | Setaria glauca           | 1480             | 62(53)50                                                   | 3                          | Chlorenchyma                            | 45                     | annular    | 874                      | Solid      |
| 8  | Setaria verticillata     | 1165             | 44(41)37                                                   | 2                          | ordinary                                | 38                     | Continuous  | 670                      | Solid      |

3.1. Sclerenchyma tissue
Sclerenchyma tissue generally forms a smaller proportion of the parenchymal tissue in stem sections, as it is located directly under the epiderm cells in the form of continuous rows surrounding the entire section. The thickness of this tissue varied from 41 μm as an average in Setaria verticillata (with two rows) to 116 μm as an average in Aristida adscensionis and by 9 rows. Some species converged a lot (4 species) in terms of numbers of rows of tissue, while the other four types diverged greatly. It seems that the apparent increase in the number of rows has been closely related with the length of the stems in a direct relationship, since this tissue performs a support function that strengthens the stem against environmental factors such as winds, as well as strengthening
the stem in order to enable it to carry the inflorescences represented by the spikes without bending these stems and this was confirmed by [18].

3.2. Parenchyma tissue

This tissue occupies the largest part of the area of the section in general, and its cells are organized in several rows distributed into two main areas:

The First region: It is represented by two types of parenchymal cells, the Ordinary parenchyma, which is located directly below the sclerenchyma tissue and in the form of a continuous ring of cells along the circumference of the section. It was unique to *Eragrostis cilinensis* and *Setaria verticillata*. Whereas, the other type of Bronchyma cells, is the green parenchymal tissue (Chlorenchyma), which is located directly below the epidermis layer in the form of clumps of green cells, which were evident in most of the types except for the two previous types that were distinguished by the presence of ordinary parenchyma tissue without the presence Chlorenchyma. The thickness of Chlorenchyma and its nature differed greatly between species, as it appeared in the form of small clusters with a thickness of 65-75 μm as an average in the two types Schismus arabicus and Aristida adscensionis, or in the form of medium thicknesses (143 μm) or high thickness (215 μm) as in the two types Avena Fatua and Avena barbata, respectively, while other species differed in the nature of this tissue, as it appeared in an irregularly shaped annular thickness in *Polypogon monseplinsis*, or in an irregular semi-annular thickness in the type *Setaria glauca*.

The Second region: It is represented by ordinary parenchyma cells, which are wider than the first region as they start from under the sclerenchymal layer located under the epidermis and continue towards the center of the section where the (large) deep vascular bundles are distributed. The cells of this region vary in their sizes and shapes, as their sizes increase as we head towards the center of the section and in many-sided or circular shapes, until they become irregular in shape at the center of the core (pith) region or around the stem cavity. As for the vascular bundles, they consist of the two tissues xylem and the phloem, and they are of the collateral vascular bundles, as the xylem is located inward (the center) and the phloem towards the outside (the periphery), it is considered one of the types of closed bundels, that is free of cambium. Each bundle is surrounded by a chain of sclerenchyma cells called the bundle sheath, which appears most pronounced in large bundles. Through the transverse sections, the vascular bundles appear almost scattered, but they are arranged in two groups:

Peripheral or Minor Vascular bundles: It is the annulus in which the vascular bundles are arranged near the circumference of the stem section, it is embedded within the sclerenchyma tissue and under the epidermis, or its time is connected to the epiderms by means of sclerenchym bundles, and it is absent in the genus *Avena*, while the type *Setaria verticillata* is unique in that the bundles are similar in shape and size as well as being scattered within the ground tissue looking as if they were three rows. The numbers of peripheral vascular bundles in the species varied a lot, as their numbers ranged from 9 bundles in the *Setaria glauca* to 16 bundles in the two species Aristida adscensionis and Schismus arabicus, and the species came between them (Table 3). It is noticeable that the lengths of the diameters of these bundle increase in length a lot as the number of bundle decreases, and their diameters decrease as the number of bundle increases, and the reason for this is in order to increase the efficiency of the vascular system represented by xylem and phloem, according to [19], through their study of species of the grass family growing in the Nile Delta.

| N. | Species             | number of rows of vascular bundles | number of vascular bundles Peripheral (small) | length of its diameters | The number of vascular bundles Deep (large) | length of its diameters | One vascular diameter |
|----|---------------------|------------------------------------|---------------------------------------------|------------------------|---------------------------------------------|------------------------|----------------------|
| 1  | Aristida adscensionis | 2                                  | 16                                          | 50                     | 16                                          | 175                    | 28                   |
| 2  | Avena barbata       | 1                                  | 0                                           | 320                    | 7                                           | 258                    | 45                   |
| 3  | Avena fatua         | 1                                  | 0                                           | 165                    | 7                                           | 162                    | 31                   |
| 4  | Eragrostis cilinensis | 2                                  | 10                                          | 115                    | 11                                          | 141                    | 47                   |
| 5  | Polypogon monseplinsis | 2                                  | 12                                          | 93                     | 13                                          | 200                    | 67                   |
the type of bundles in a single section, so the smaller the number of bundles, the greater the diameter of one bundle and vice versa. It has been evident during this study that the average diameter of a single vascular bundle is often inversely proportional to the number of bundles in a single section, so the smaller the number of bundles, the greater the diameter of one bundle and vice versa. Whereas, the diameter of the vessel, it varied greatly between species, ranging from 18 μm in the type of the stems in the form of two regular or irregular rings with the presence of the hollow stem, while the vascular bundles are scattered irregularly within the ground tissue with solid stem. All of these traits can be used to classify to isolate species from each other. Some researchers in this field were able to adopt anatomical features with pollen grains and their characteristics in isolating two species of the genus Celtis L., as well as isolating two strains of C. australis depending on these traits [20]. It has been evident during this study that the average diameter of a single vascular bundle is often inversely proportional to the number of bundles in a single section, so the smaller the number of bundles, the greater the diameter of one bundle and vice versa. Whereas, the diameter of the vessel, it varied greatly between species, ranging from 18 μm in the type Setaria glauca to 67 μm in the type Polypogon monspeliensis. It has been observed that the average diameter of a single vessel is directly proportional to the cross-sectional diameter of the stem, and this is evident from, and according to [21].

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