

Morphological and Anatomical Observations on Seeds of Some *Iris* L. Taxa from Turkey

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ABSTRACT: This study includes on the taxonomic evaluation of morphological and anatomical features of seeds belonging to *Iris* taxa, which are *I. suaveolens*, *I. sintenisii*, *I. foetidissima* and *I. germanica* scattered in Turkey. Morphological features like dimension, shape, colour, and surface ornamentation types of seeds have studied by light and scanning electron microscopes. The structure and thicknesses of testa and parenchyma layers in seeds have examined anatomically. The obtained results show that the color, shape, testa structure and thickness of the seeds of the examined taxa are different in some respects. Furthermore, the surface ornamentations are somewhat diverse for the studied taxa at the interspecific level. As a result, it has been determined that the examined morphological and anatomical characteristics of the seeds show variations with some exceptions, and this situation has a taxonomic importance.

Keywords: Anatomy, Morphology, SEM, Seed, Turkey

Türkiye'den Bazı *Iris* L. Taksonlarının Tohumları Üzerinde Morfolojik ve Anatomik Gözlemler

ÖZET: Bu çalışma Türkiye'de dağılım gösteren bazı *Iris* taksonlarına ait (*I. suaveolens*, *I. sintenisii*, *I. foetidissima* ve *I. germanica*) tohumların morfolojik ve anatomik özelliklerinin taksonomik değerlendirmesini içerir. Tohumların boyutu, şekli, rengi ve yüzey ornamentasyonları ışık ve taramalı elektron mikroskopu ile çalışılmıştır. Testa ve parankima tabakalarının yapı ve kalınlığı anatomik olarak incelenmiştir. Elde edilen bulgular, incelenen taksonlara ait tohumların renk, şekil, testa yapısı ve kalınlığına ait özelliklerin bazı açılardan farklı olduğunu göstermektedir. Ayrıca, yüzey ornamentasyonları türler arası seviyede incelenilen taksonlar için kısmen farklıdır. Sonuç olarak, incelenen tohum morfolojik ve anatomik karakterlerinin bazı istisnalar ile varyasyonlar gösterdiği ve bu durumun taksonomik öneme sahip olduğu tespit edilmiştir.

Anahtar kelimeler: Anatomi, Morfoloji, SEM, Tohum, Türkiye

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INTRODUCTION

Iris L. (Iridaceae), which has extensively dispersed through the Northern Temperate Area, includes over 300 taxa of flowering plants with attractive flowers mentioning to the extensive diversity of flower colors found in the various species (Jaenicke and Marnier, 1990; Baser et al., 2011). Taxonomical researches on *Iris* genus in Turkey has been performed by Mathew (1989). According to this researcher, genus included circa 44 taxa in four subgenera as *Limniris* Spach, *Iris* L, *Hermadactyloides* Spach and *Scorpiris* Spach, respectively (Dönmez and Pınar, 2001).

Seeds and fruits present characteristic features in terms of shape, colour, dimension, seed surface micro structures, which can offer valuable contributions in classification of taxa. These features are not affected by habitat conditions and display a great variety from species to family categories (Barthlott, 1981). In addition, anatomical structures are generally as beneficial as other characters in plant classification, and they are valuable in separation of the closely related taxa (Karamian et al., 2012; Karaismailoğlu, 2015).

Morphological works of the Iridaceae taxa have been performed by many researchers (Artyushenko, 1990; Rudall, 1991; Pınar and Dönmez, 2000; Kandemir, 2009; Mitic et al., 2013; Guo, 2015; Karaismailoğlu, 2015; Zhygalova et al., 2015). However, the studied data relating to the anatomical and micromorphological structures of the seed of Turkish *Iris* taxa are not available. Accordingly, the aim of this work is to examine morphological and anatomical characters of seeds of *Iris* taxa, which are *I. suaveolens*, *I. sintenisii*, *I. foetidissima* and *I. germanica* with light and scanning electron microscopes in order to realize variances. Detailed descriptions of seed of the studied taxa have presented in this study for the first time.

MATERIAL AND METHODS

Seeds of the studied 4 species, which were collected from natural inhabitants in Turkey and cultivated at the Alfred Heilbronn Botanical Garden, were used in morphological and anatomical studies (*I. suaveolens*: Amasya, Boraboy, stony areas, 950 m, 17.04.2018, Karaismailoğlu 381; *I. sintenisii*: Kütahya, Gediz, Murat mountain, stony areas, 1302 m, 26.05.2014, Karaismailoğlu 37; *I. foetidissima*: Bolu, Abant, inclined slopes, 1700 m, 10.04.2018, Karaismailoğlu 380, *I. germanica*: cultivated material). Researches were done with 10 ripe seeds for each taxon.

Macromorphological characters like the shape, size, and color of seeds were observed with utilizing a stereomicroscope (Olympus ZS51) and Kameram Imaging Software (Karaismailoğlu, 2015). In micromorphological observations, samples were prepared for scanning electron microscopy by gluing with silver paste on stubb, covered with gold-platinum, and analyzed (Karaismailoğlu, 2015).

The cross sections were obtained by a microtome (Thermo Shonda Met Finesse) from the middle of the seeds for anatomical structures such as testa thickness and shape of epidermal cells. Later, they were stained with haematoxylin (Harris-RRSP67-E) and enclosed with entellan to examine anatomical features. Anatomical characters were observed with a light microscope (Olympus CX21FS1) and Kameram Imaging Software (Karaismailoğlu, 2015).

The terminologies of morphological and anatomical characteristics were performed by Stearn (1985).

RESULTS AND DISCUSSION

In macromorphological, seed dimension, colour and shape characteristics of taxa were assessed, and variances among examined species were detected (Table 1). In seed sizes, *I. suaveolens* and *I. germanica* had the most

significant variances among the studied species. Their values varied between 6.58 mm and 8.24 mm for length, and between 4.32 and to 6.13 mm for width, respectively. Colours of seeds were yellow, brown and tones. Colours of seeds were defined to be significant in separation of the studied *Iris* taxa. The seed shapes of the

studied taxa displayed high variations. Also, the ratio values of seed dimensions had variances, which ranged from 1.20 to 1.52. Seeds were ellipticus in *I. suaveolens* (1.52), ellipticus-late in *I. sintenisii* (1.20), *I. foetidissima* (1.26), and ovatus in *I. germanica* (1.34) (Table 1 and Figure 1).

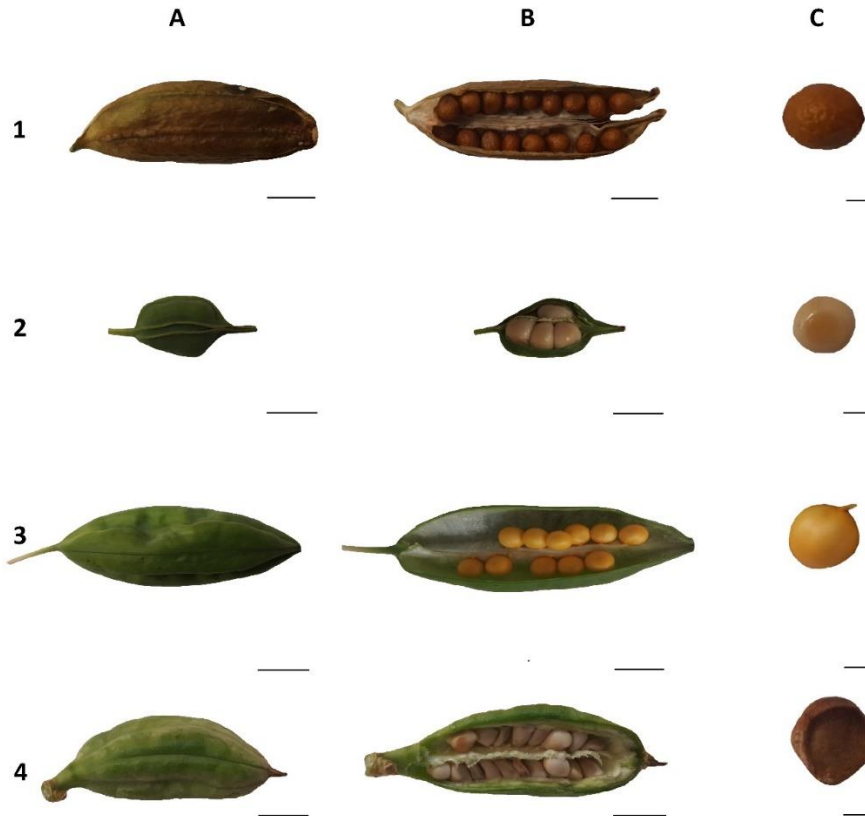


Figure 1. The examined taxa: **1:** *I. suaveolens*, **2:** *I. sintenisii*, **3:** *I. foetidissima*, **4:** *I. germanica* (**A:** Fruit, **B:** Seeds in loculus, **C:** Seeds, Scale Bars in A and B: 2 cm, Scale Bars in C: 1 cm).

The morphological and anatomical characters of seeds are of the main variations among taxa in various taxonomic groups. These variations present an ease in distribution of taxa at various taxonomic levels, in association of taxonomic features. Although seed characters such as micromorphological and anatomical features are available for taxonomic use (Grilli Caiola et al., 2010; Karaismailoğlu, 2015), a study including seed morphology and anatomy of *Iris* taxa from Turkey has not been performed until now.

In this study, macromorphological characteristics like color, shape, and size of seeds of the examined *Iris* taxa from Turkey

were shown variations. These variations in macromorphological characters were suitable with the diagnostic features in Flora of Turkey (Davis, 1984) for the *Iris* species.

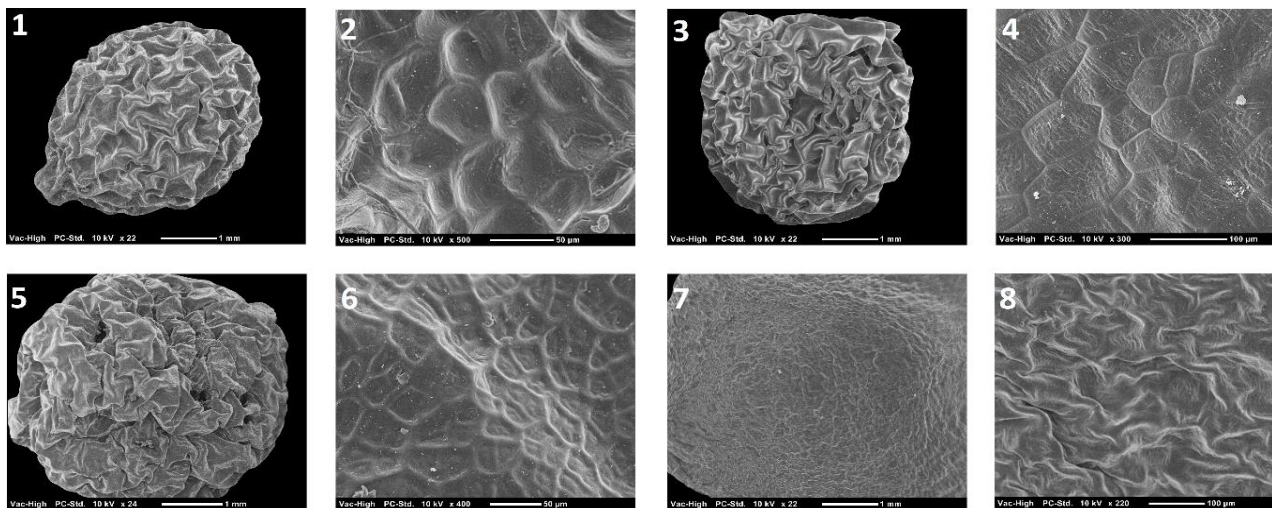
Seed surface ornamentations of the examined taxa showed diversity (Fig. 2 and Tab. 1). They were areolate (*I. suaveolens*), reticulate (*I. foetidissima*), reticulate-areolate (*I. sintenisii*) and ruminant (*I. germanica*) (Tab. 1). Moreover, cell shapes on the seed surfaces were variable, and they were composed of oval cells (*I. suaveolens* and *I. sintenisii*), polygonal cells (*I. sintenisii* and *I. foetidissima*) or undefined cells (*I. germanica*).

Table 1. Morphological and anatomical characters in seeds of the examined *Iris* taxa. Outcomes represent mean values \pm standard deviation; means with different letters are significant at $p = 0.05$ level (Duncan's multiple-range test); L: length, W: width, oe: outer epidermis, ie: inner epidermis.

Taxa	Colour	Shape	Seed Dimensions		Ratio (L/W)	Seed Surface	
			L (mm)	W (mm)		Ornamentation	Epidermal Structure
<i>I. suaveolens</i> Boiss. & Reut.	Brown	Ellipticus	6.58 \pm 0.18 ^d	4.32 \pm 0.21 ^c	1.52	Areolate	Oval cells
<i>I. sintenisii</i> Janka	Clear Brown	Ellipticus-Late	7.15 \pm 0.25 ^c	5.95 \pm 0.35 ^{ab}	1.20	Reticulate-Areolate	Polygonal or Oval cells
<i>I. foetidissima</i> L.	Yellow	Ellipticus-Late	7.63 \pm 0.13 ^b	6.04 \pm 0.21 ^a	1.26	Reticulate	Polygonal cells
<i>I. germanica</i> L.	Dark Brown	Ovatus	8.24 \pm 0.27 ^a	6.13 \pm 0.30 ^a	1.34	Ruminate	Undefined

Table 1 continued

Taxa	Testa	Parenchyma Layer		
	Structure	Thickness (μ m)	Structure	Thickness
<i>I. suaveolens</i>	6-8-layer, Flat or Crushed cells	86.29 \pm 12.25 ^{bc}	2-3-layer, Crushed cells	29.35 \pm 5.86 ^{ab}
<i>I. sintenisii</i>	oe: 7-8-layer Crushed scleranchymatic cells, ie: 5-6-layer Flat cells	94.54 \pm 10.63 ^b	1-2-layer, Flat cells	10.38 \pm 4.72 ^c
<i>I. foetidissima</i>	1-2-layer, Flat cells	25.89 \pm 6.14 ^d	1-2-layer, Flat cells	30.29 \pm 4.81 ^{ab}
<i>I. germanica</i>	oe: 1-layer Cubic cells, ie: 6-9-layer Polygonal cells	201.19 \pm 5.16 ^a	2-3-layer, Polygonal or Flat cells	35.83 \pm 2.96 ^a

**Figure 2.** The micromorphological structures of the examined taxa: **1-2:** *I. suaveolens*, **3-4:** *I. sintenisii*, **5-6:** *I. foetidissima*, **7-8:** *I. germanica*.

Seed surface features have been commonly utilized in the explanation of taxonomic problems, in the clarification of evolutionary relations, and in the association of the adaptive structures of the seed surface (Heywood, 1971; Sulaiman, 1995; Karaismailoğlu, 2015). The

surface ornamentations in the examined taxa have shown variations as areolate, reticulate-areolate, reticulate and ruminate. The surface ornamentations of seeds are useful characters in classification of the examined *Iris* taxa.

The seed surface types assist in the utilized characteristics in systematics of the genus (Davis, 1984). These results are also compatible with studies conducted with various genera such as *Crocus* (Grilli Caiola et al., 2010; Harpke et al., 2014; Carta et al., 2015; Kerndorff et al., 2015 and 2016), *Romulea* (Karaismailoğlu, 2015), *Gladiolus* (Zhygalova et al., 2015) within the family.

The anatomical characters of the seeds of four Turkish *Iris* were presented in Table 1 and Figure 3. Accordingly, the mean values of testa thickness varied between 25.89 µm and 201.19 µm, and this characteristic ranged meaningfully among the studied taxa. A thick testa was recorded in *I. germanica*, while the testa in *I. foetidissima* is thin (Tab. 1). In other aspects,

shapes and layer number of epidermal cells of testa were differed in the examined taxa (Tab. 1), which had flat, crushed, cubic and polygonal cells in unequal or equal forms, and thick or thin walls with 1-14 layer in cross sections (Figure 3). In addition to these outcomes, testa in *I. sintenisii* and *I. germanica* were occurred from two layers as outer and inner. The outer epidermis cells of *I. sintenisii* were scleranchymatic structure unlike other taxa examined. Parenchyma layer of the seeds was shown to range from 10.38 to 35.83 µm, and it was occurred from flat (*I. sintenisii*, *I. germanica* and *I. foetidissima*), crushed (*I. suaveolens*) and polygonal cells (*I. germanica*) in shapes (Figure 3).

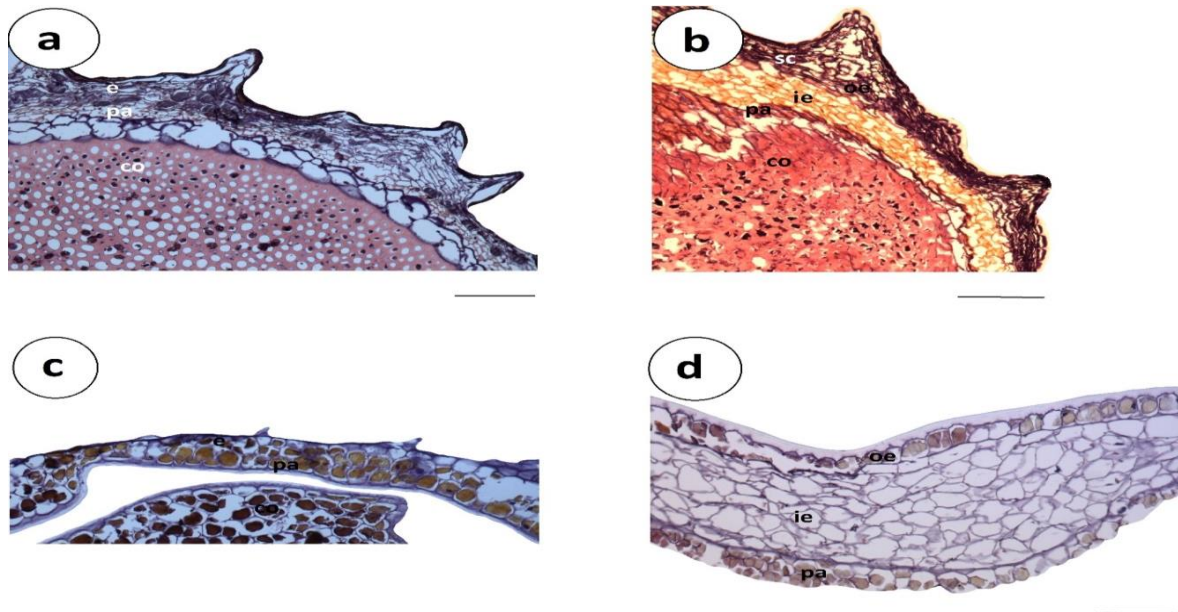


Figure 3. The anatomical structures of seeds of the examined taxa: **a:** *I. suaveolens*, **b:** *I. sintenisii*, **c:** *I. foetidissima*, **d:** *I. germanica* (**e:** epidermis, **sc:** scleranchyma, **oe:** outer epidermis, **ie:** inner epidermis, **pa:** parenchyma, **co:** cotyledon, Scale bars: 100 µm).

The anatomical structures of the testa and epidermal cells of the seeds may offer valuable information for phylogenetic classification of angiosperm taxa (Corner, 1976). In this study, the variations in the examined anatomical characters such as testa structure and thickness, parenchyma layer structure and thickness of the

examined *Iris* taxa have been recognized. The anatomical characters used in this preliminary study may contribute to the systematic of genus. These outcomes are consistent with earlier works in Iridaceae (Grilli Caiola et al., 2010; Karaismailoğlu, 2015).

CONCLUSION

This work supports the use of the morphological and anatomical features of the seeds as the distinctive characters in the classification within the *Iris* taxa in Turkey. This is a preliminary work to define the applicability of the examined characteristics, and further investigations covering all taxa of the genus are required for determining the complete differences and better understanding systematic of genus.

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