

Seed morphology of some *Genista* taxa growing in Turkey

Muhittin DİNÇ¹, Ayla KAYA^{* 2}, Ahmet DURAN³

¹ Department of Biology, Ahmet Keleşoğlu Faculty of Education, Necmettin Erbakan University, Konya, Turkey

^{2*} Department of Pharmaceutical Botany, Faculty of Pharmacy, Anadolu University, 26470, Eskişehir, Turkey

³ Department of Biology, Faculty of Science and Art, Selçuk University, 42031, Konya, Turkey

Abstract

Seed macro and micromorphology have taxonomic importance in many Angiosperm families. In the present study, the seeds of some *Genista* taxa growing in Turkey are studied morphologically using stereo and scanning electron microscope (SEM). The results show that seed size and testa colour appear to have taxonomic value in classification of the sections of the genus. However the seed surface is more or less different among the taxa, it is not meaningful for the sectional classification of the genus in Turkey.

Key words: Fabaceae, *Genista*, morphology, seed, SEM

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Türkiyenin bazı *Genista* türlerinin tohum morfolojisi

Özet

Birçok Angiosperm familyasında tohum makro ve mikromorfolojisi taksonomik öneme sahiptir. Bu çalışmada, Türkiye’de yetişen bazı *Genista* tohumlarının stero ve taramalı elekton mikroskobu (SEM) kullanılarak morfolojileri çalışılmıştır. Sonuçlar göstermektedir ki, tohum boyutları ve renkleri cinsin seksiyonlarının sınıflandırılmasında taksonomik değere sahiptir. Bununla birlikte tohum yüzeyi taksonlar arasında az ya da çok farklıdır ve Türkiye’de cinsin seksiyon sınıflandırılmasında anlamlı değildir.

Anahtar kelimeler: Fabaceae, *Genista*, Morfoloji, tohum, SEM.

1. Introduction

Genista L. is a large genus of spiny and nonspiny shrubs centred in the Mediterranean region. The genus is also represented throughout most of western and central Europe, extending to the southeast of the former USSR, and to Turkey, Syria and North Africa. It includes over 90 species, and is divided into three subgenera and 10 sections (Gibbs, 1966). Subgenus *Genista* consists of the sections *Genista*, *Spartioides*, *Scorpioides*, *Erinacoides*, subgenus *Phyllobotrys* *Phyllobotrys* and *Voglera* sections, subgenus *Spartocarpus* *Spartocarpus*, *Cephalospartum*, *Acanthospartum* and *Fasselospartum* sections (Gibbs, 1966).

Among these, *Genista* subgenus *Genista* includes *G. tinctoria* L., *G. vuralii* A. Duran & H. Dural, *G. januensis* Viv. subsp. *januensis*, *G. januensis* subsp. *lydia* (Boiss.) Kit Tan & Zielinski, *G. sandrasica* Hartvig & Strid, *G. libanotica* and *G. burdurensis* from sect. *Genista* and *G. albida* and *G. involucrata* from sect. *Spartioides* in Turkey (Gibbs, 1970; Davis et al., 1988; Duran and Dural, 2003; Zielinski, et al., 2004; Özen, et al., 2013). *Genista* subgenus *Spartocarpus* Spach is centred in the Balkan Peninsula and the eastern Mediterranean, but has a secondary centre in the Balearic Islands, Sardinia, Sicily, North Africa, and southern Spain (Pardo et al., 2004). It is represented by *G. sessilifolia* and *G. aucheri* from sect. *Spartocarpus* and *G. acanthoclada* subsp. *acanthoclada* and *G. acanthoclada* subsp. *echinus* from sect. *Acanthospartum* in Turkey (Vierhapper, 1919; Gibbs, 1970). *Genista* subgenus *Phyllobotrys*

* Corresponding author / Haberleşmeden sorumlu yazar: Tel.: +902223350580; Fax.: +902223350750; E-mail: aykaya@anadolu.edu.tr

is mainly centred in west of Iberian Peninsula, but with some species, it reaches to North and central Europe. *G. anatolica* and *G. carinalis* included in sect. *Voglera* belonging to subgenus *Phyllobotrys* grow in Turkey (Gibbs, 1970).

In spite of the present infrageneric classification, the molecular data do not support division of these subgenera into taxonomical units at the sectional level except for the monophyletic sections *Genista* and *Spartocarpus* (Pardo et al., 2004). In addition, it is controversial that which sections some species belonging to. For example, there is some doubt about the taxonomic position of Turkish endemic *G. burdurensis* at sectional classification (Gibbs, 1970).

Scanning electron microscopy has uncovered relatively few characters, but has enabled the rapid, recordable and comparative study of a great many micromorphological features, so that these have become realistic and practicable as standard taxonomic characters. Seed surface is among the subject to have particularly benefited so far (Stace, 1989). The aim of this study is to determine the taxonomic value of the seed macro and micromorphology in the present sectional and interspecific classification of the genus in Turkey.

2. Materials and methods

The plants with mature seeds were collected from various districts of Turkey in 2006-2008. The specimens were kept in Necmettin Erbakan Üniversitesi Ahmet Keleşoğlu Fakültesi Herbarium. The collection data for the examined specimens are given in Table 1. Seeds were first observed with a stereomicroscope to ensure that they were of normal size and maturity. For seed length and width, 40 samples belonging to same or different individuals of each taxon were taken and measured using a stereomicroscope. The scores were analyzed using a homogeneous subsets analysis of means by the Tukey test using the SPSS 10.0 software package. Mature seeds were also mounted directly on aluminum stubs and coated with gold, after which they were observed and photographed with a LEO 440 scanning electron microscope at Erciyes University's Technology Research and Development Centre. The terms used for describing the seed surface patterns have been adopted according to the works of Stearn (1992) and Punt *et al.* (1994).

Table 1. Studied materials of *Genista* taxa in Turkey

Section	Taxa	Locality	Collection data
<i>Genista</i>	<i>G. tinctoria</i>	B7 Erzincan: Refahiye-İliç yolu 7. km, step, 1740 m.	M. Dinç 2844 & A.Duran
<i>Genista</i>	<i>G. januensis</i> subsp. <i>januensis</i>	C2 Muğla: Köyceğiz, Sandras Dağı, Ağla yukarısı, Aşit çevresi, karaçam ormanı, serpantin arazi, 1700 m.	A. Duran 7312 & M. Dinç
<i>Genista</i>	<i>G. januensis</i> subsp. <i>lydia</i>	B1 Balıkesir: Edremit, Kaz Dağı, orman açıklığı, 550 m.	M. Dinç 2660 & B. Doğan
<i>Genista</i>	<i>G. burdurensis</i>	C2 Burdur: Tefenni-Yeşilova karayolu, Karamanlı Barajı civarı, Karamanlı çıkışı, baraj çevresi, meşe açıklığı, 1200 m.	A. Duran 7336 & M. Dinç
<i>Spartioides</i>	<i>G. albida</i>	B6 Sivas: Akdağmadeni-Yıldızlı arası 25. km, meşe açıklığı, 1275 m.	M. Dinç 2808 & A.Duran
<i>Voglera</i>	<i>G. carinalis</i>	B1 Balıkesir: Gölcük mevkii, karaçam ve <i>Quercus</i> açıklığı, 400 m.	A.Duran 7302 & M. Dinç
<i>Voglera</i>	<i>G. anatolica</i>	C6 Osmaniye: Amanos dağları, Mitisin yaylası, karaçam açıklıkları, 1300 m.	M. Dinç 2801
<i>Asterospartum</i>	<i>G. sessilifolia</i>	B5 Aksaray: Kireçlik Tepe, step, 1000 m.	M. Dinç 2983
<i>Acanthospartum</i>	<i>G. acanthoclada</i> subsp. <i>acanthoclada</i>	B1 İzmir: Aydın yolu, Pınarbaşı kavşağını 5 km geçince, yol kenarı, 150 m.	M. Dinç 2661 & B. Doğan
<i>Acanthospartum</i>	<i>G. acanthoclada</i> subsp. <i>echinus</i>	C2 Muğla: Eski Kale yolu, makilik, 900 m.	A.Duran 7309 & M. Dinç

3. Results

The observations on the seed morphologies of the studied taxa are as follows;

G. tinctoria: The seeds are oblong-ovate to rhombic with mostly conspicuous corners, 2.00-2.80 (2.33±0.20) mm long, 1.70-2.50 (2.01±0.19) mm wide; the testa is greenish-brown to brown; the surface is undulated ridged with cerebral ornamentation (Table 2, Figure 1 a, b).

G. januensis subsp. *januensis*: The seeds are oblong-ovate to rhombic with mostly conspicuous corners, 2.40-3.20 (2.76±0.19) mm long, 2.00-2.70 (2.33±0.18) mm wide; the testa is greenish-brown to brown; the surface is straight to undulated ridged with cerebral ornamentation (Table 2, Figure 1 c, d).

G. januensis subsp. *lydia*: The seeds are oblong-ovate to rhombic with mostly conspicuous corners, 2.30-3.40 (2.73±0.27) mm long, 2.20-2.50 (2.37±0.11) mm wide; the testa is greenish-brown to brown; the surface ornamentation is microreticulate with deep, conspicuous and rugulate ridges (Table 2, Figure 1 e, f).

G. burdurensis: The seeds are oblong-ovate to rhombic with mostly conspicuous corners, 2.50-3.50 (2.87±0.25) mm long, 1.90-2.50 (2.17±0.17) mm wide; the testa is greenish-brown to brown; the surface ornamentation is irregular with undulated ridges (Table 2, Figure 1 g, h).

G. albida: The seeds are oblong-ovate to rhombic with mostly conspicuous corners, 2.20-3.10 (2.72±0.26) mm long, 2.00-2.60 (2.28±0.17) mm wide; the testa is black; the surface ornamentation is irregular with conspicuous rugulate ridges (Table 2, Figure 1 i, j).

G. carinalis: The seeds are oblong to oblong-ovate with mostly inconspicuous corners, 2.00-2.70 (2.42±0.19) mm long, 1.40-2.10 (1.79±0.18) mm wide; the testa is black; the surface ornamentation is shallow reticulate-foveate (Table 2, Figure 1 k, l).

G. anatolica: The seeds are oblong to oblong-ovate with mostly inconspicuous corners, 2.90-3.50 (3.27±0.14) mm long, 2.00-2.60 (2.31±0.15) mm wide; the testa is black; the surface ornamentation is irregular microreticulate with conspicuous and undulated ridges (Table 2, Figure 1 m, n).

G. sessilifolia: The seeds are oblong to oblong-ovate with mostly inconspicuous corners, 4.00-5.00 (4.46±0.30) mm long, 2.70-3.40 (3.03±0.18) mm wide; the testa is black; the surface ornamentation has high and conspicuous ridges with irregular and deep canals (Table 2, Figure 1 o, ö).

G. acanthoclada subsp. *acanthoclada*: The seeds are oblong to oblong-ovate with mostly inconspicuous corners, 2.50-2.90 (2.68±0.12) mm long, 1.50-2.00 (1.72±0.15) mm wide; the testa is black; the surface ornamentation has deep furrows with regular, high and conspicuous ridges (Table 2, Figure 1 p, r).

G. acanthoclada subsp. *echinus*: The seeds are oblong to oblong-ovate with mostly inconspicuous corners, 2.50-2.90 (2.73±0.11) mm long, 1.50-1.95 (1.73±0.14) mm wide; the testa is black; the surface is irregular granulate ornamentation (Table 2, Figure 1 s, t).

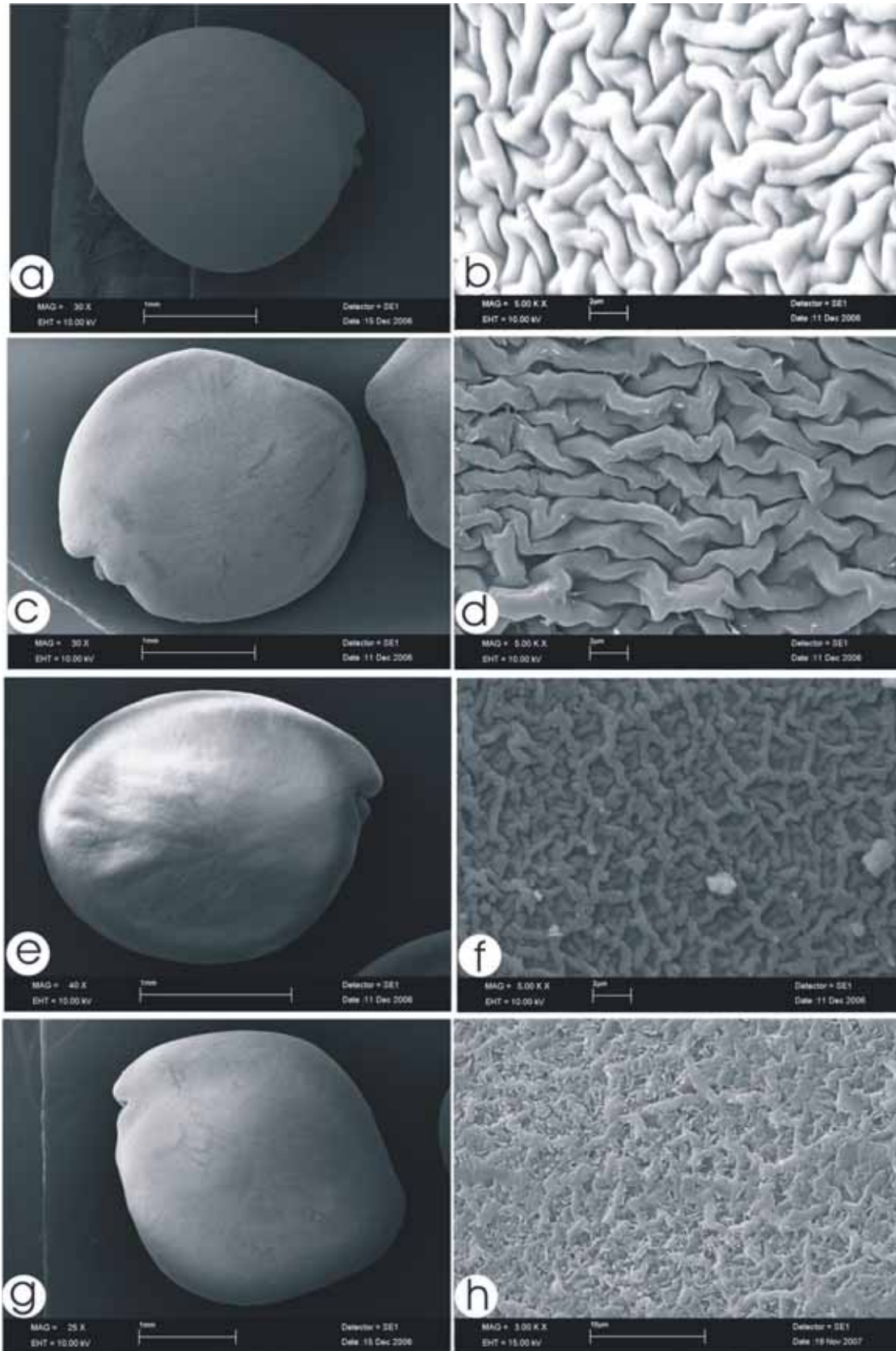
Statistical description of seed length and width of the studied *Genista* taxa are given in Table 2. The subsets consisted by the means for the taxa are given in Table 3. When the subsets related with the seed length is examined, only the subset including *Genista anatolica* and the other one including *G. sessilifolia* are statistically distinguished from the subsets consisted by the other studied taxa. Besides, *G. tinctoria* and *G. carinalis* are included in one subset, and *G. acanthoclada* subsp. *acanthoclada*, *G. albida*, *G. acanthoclada* subsp. *echinus*, *G. januensis* subsp. *lydia*, *G. januensis* subsp. *januensis* and *G. burdurensis* are in the other one. For the seed width, the subset containing *G. acanthoclada* subsp. *acanthoclada*, *G. acanthoclada* subsp. *echinus* and *G. carinalis* and the other one containing *G. sessilifolia* are separated from the other taxa. There are no meaningful difference among the remaining taxa statistically.

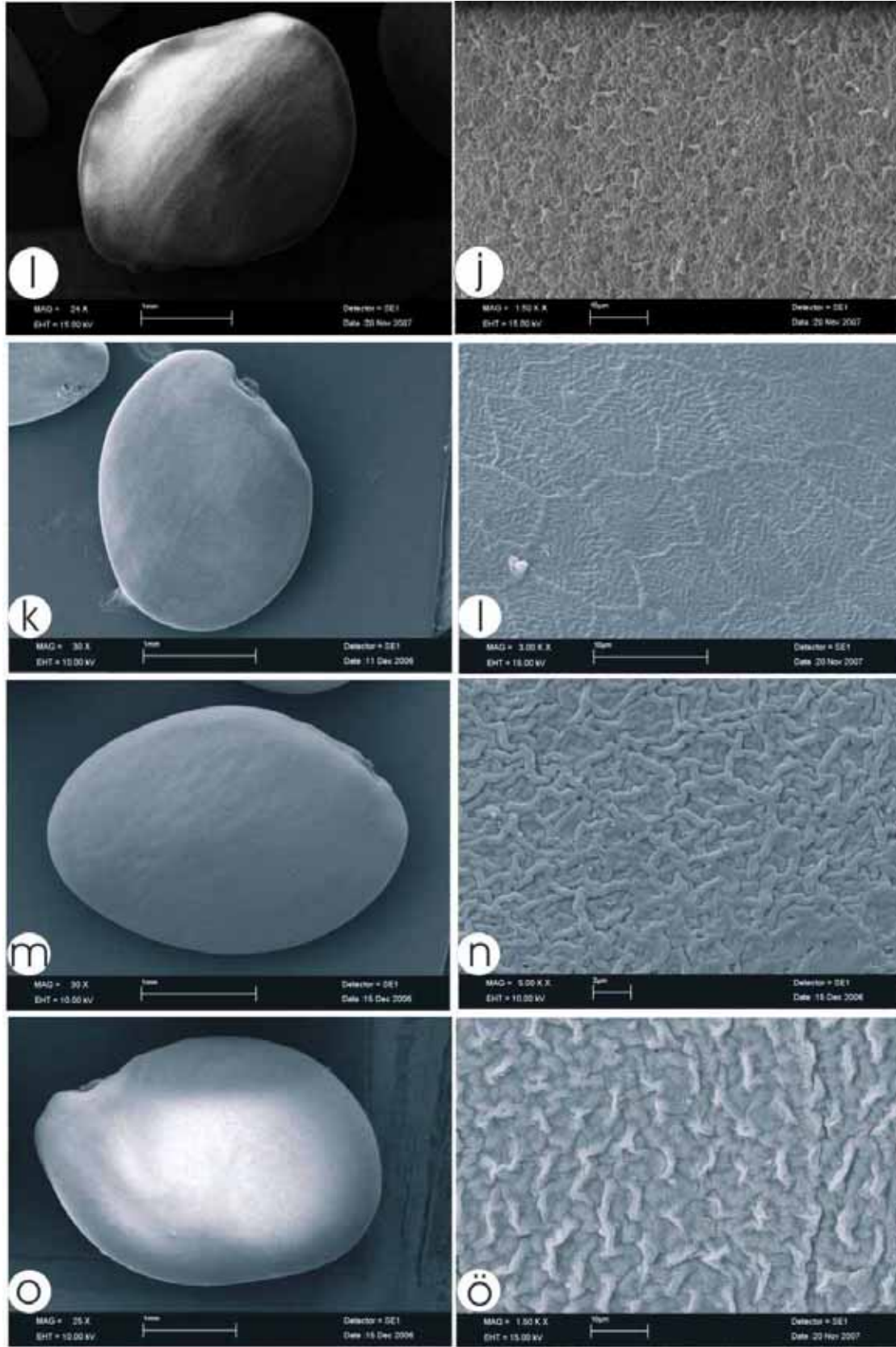
Table 2. Statistical description of seed sizes of the studied *Genista* taxa

Taxa	N	Seed length		Seed width	
		Min.-Max.	Mean±Std.	Min.-Max.	Mean±Std.
<i>G. tinctoria</i>	40	2.00-2.80	2.33±0.20	1.70-2.50	2.01±0.19
<i>G. januensis</i> subsp. <i>januensis</i>	40	2.40-3.20	2.76±0.19	2.00-2.70	2.33±0.18
<i>G. januensis</i> subsp. <i>lydia</i>	40	2.30-3.40	2.73±0.27	2.20-2.50	2.37±0.11
<i>G. burdurensis</i>	40	2.50-3.50	2.87±0.25	1.90-2.50	2.17±0.17
<i>G. albida</i>	40	2.20-3.10	2.72±0.26	2.00-2.60	2.28±0.17
<i>G. carinalis</i>	40	2.00-2.70	2.42±0.19	1.40-2.10	1.79±0.18
<i>G. anatolica</i>	40	2.90-3.50	3.27±0.14	2.00-2.60	2.31±0.15
<i>G. sessilifolia</i>	40	4.00-5.00	4.46±0.30	2.70-3.40	3.03±0.18
<i>G. acanthoclada</i> subsp. <i>acanthoclada</i>	40	2.50-2.90	2.68±0.12	1.50-2.00	1.72±0.15
<i>G. acanthoclada</i> subsp. <i>echinus</i>	40	2.50-2.90	2.73±0.11	1.50-1.95	1.73±0.14

Table 3. Means in homogeneous subsets for seed sizes of the studied *Genista* taxa. Subset refers to the designation of homogeneous groups by the Tukey test between means (subset for alpha = 0.05)

Seed length	Subsets				Seed width	Subsets				
	1	2	3	4		1	2	3	4	5
<i>G. tinctoria</i>	2.33				<i>G. acanthoclada</i> ssp. <i>acanthoclada</i>	1.72				
<i>G. carinalis</i>	2.42				<i>G. acanthoclada</i> ssp. <i>echinus</i>	1.73				
<i>G. acanthoclada</i> ssp.	2.68				<i>G. carinalis</i>	1.79				
<i>G. albida</i>	2.72				<i>G. tinctoria</i>	2.01				
<i>G. acanthoclada</i> ssp. <i>echinus</i>	2.73				<i>G. burdurensis</i>	2.17 2.17				
<i>G. januensis</i> ssp. <i>lydia</i>	2.73				<i>G. albida</i>	2.28 2.28				
<i>G. januensis</i> ssp. <i>januensis</i>	2.76				<i>G. anatolica</i>	2.31 2.31				
<i>G. burdurensis</i>	2.87				<i>G. januensis</i> ssp. <i>januensis</i>	2.33 2.33				
<i>G. anatolica</i>	3.27				<i>G. januensis</i> ssp. <i>lydia</i>	2.37				
<i>G. sessilifolia</i>	4.46				<i>G. sessilifolia</i>	3.03				
Sig.	0.95	0.17	1.00	1.00	Sig.	0.98	0.09	0.09	0.78	1.00





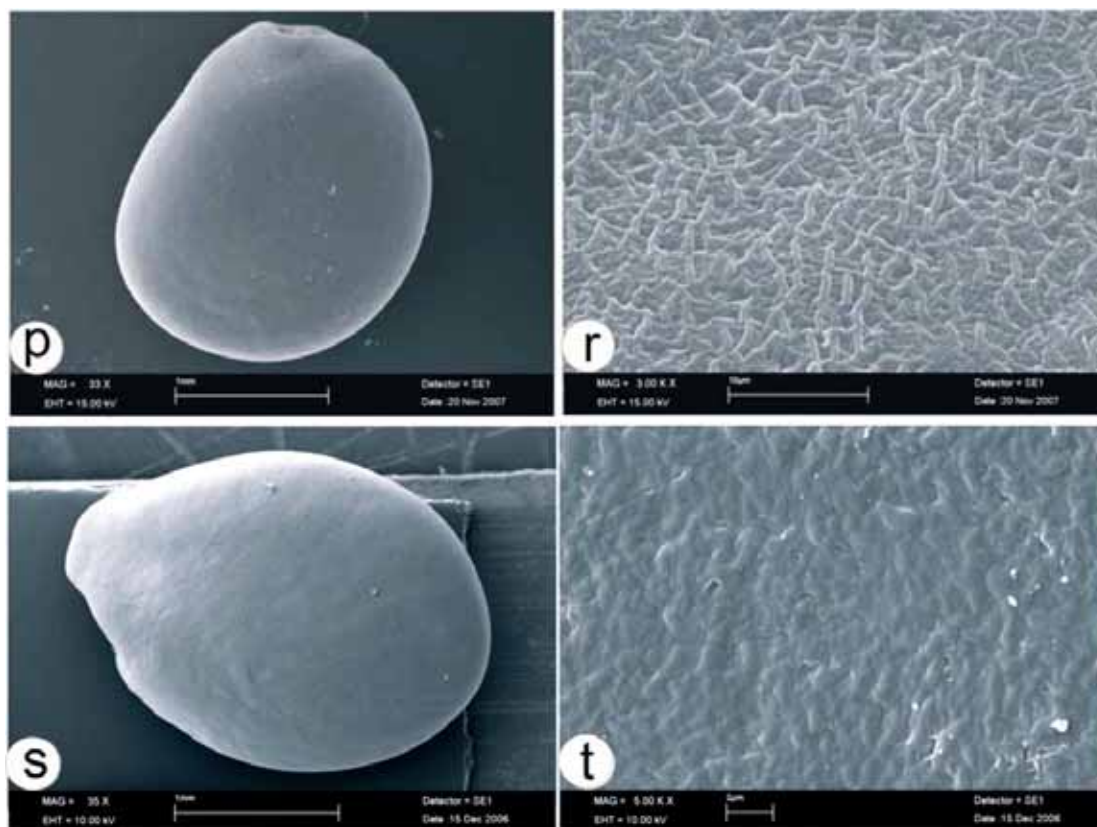


Figure 1. SEM of the studied *Genista* taxa. General views (at lefts), views in detail (at rights). a, b: *G. tinctoria*; c, d: *G. januensis* subsp. *januensis*; e, f: *G. januensis* subsp. *lydia*; g, h: *G. burdurensis*; i, j: *G. albida*; k, l: *G. carinalis*; m, n: *G. anatolica*; o, ð: *G. sessilifolia*; p, r: *G. acanthoclada* subsp. *acanthoclada*; s, t: *G. acanthoclada* subsp. *echinus*.

4. Conclusions

In the Fabaceae family seed surface ornamentation resembles within the closely related genera. The taxa belonging to the genus *Astragalus* L. have reticulate, rugulate reticulate, multi-reticulate, and foveolate and multifoveolate seed surface ornamentation (Engel, 1990; Vural et al., 2008; Bayrakdar et al., 2010). The studied *Genista* taxa have irregular or regular with cerebral, microreticulate, rugulate, reticulate-foveate or granulate seed surface ornamentation. The seed surface micromorphology show more or less differences among the studied taxa. However, it is not meaningful for the sectional classification of the genus in Turkey. These findings have been found in accordance to those by Villa (1989), Azzoui and Es-Sgaouri (1999), and Estrelles et al. (2006).

Investigation of seed morphology of the genus *Ebenus* showed that seed shapes and ornamentations were not adequate for interspecific separation (Bayrakdar et al., 2010). The results of the present study are agreed with this opinion in terms of seed surface ornamentation. According to the data obtained from the study, the surface ornamentations are not only adequate for interspecific separation, but also sectional classification of the genus in Turkey. But, seed shape support the sectional classification comparatively. It is ovate-rhombic and mostly tending with conspicuous corners in *G. tinctoria*, *G. januensis* subsp. *januensis*, *G. januensis* subsp. *lydia* and *G. burdurensis*, but oblong to oblong-rhombic and mostly with inconspicuous corners in *G. albida*, *G. carinalis*, *G. anatolica*, *G. sessilifolia*, *G. acanthoclada* subsp. *acanthoclada* and *G. acanthoclada* subsp. *echinus*. The seed morphology in *Genista* sect. *Genista* is generally different from that in the other sections of *Genista* in Turkey, but the difference is not persistence.

The testa colour is greenish brown to brown in the taxa *G. tinctoria*, *G. januensis* subsp. *januensis*, *G. januensis* subsp. *lydia* ve *G. burdurensis*, but it is black in the taxa *G. albida*, *G. carinalis*, *G. anatolica*, *G. sessilifolia*, *G. acanthoclada* subsp. *acanthoclada* and *G. acanthoclada* subsp. *echinus*. Namely, the testa colour exhibits distinctness between the taxa from *Genista* sect. *Genista* and the taxa from the other sections of the genus *Genista*. The most remarkable result from the statistical analysis of the quantitative characters is that the sect. *Asterospartum*, with large seeds, is clearly different from the other sections. The seed size appear to has diagnostic value in delimitation of sect. *Asterospartum*.

G. burdurensis exhibit a superficial similarity to *G. albida*, which is included in sect. *Spartioides*, but differs from it by the different habit and glabrous corolla. With these characters, it is referable to sect. *Genista*. But there is no

obvious affinities with any of the species in this section (Gibbs, 1970). The results obtained from the present study show that *G. burdurensis* is closer to sect. *Genista* in terms of the seed shape, size and colour..

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