Seed Morphology of Some *Barbarea* (Brassicaceae) Taxa

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Research Article

ABSTRACT

The seed macro- and micromorphologies of four taxa (*Barbarea auriculata* Hausskn. ex Bornm. var. auriculata, *Barbarea trichopoda* Hausskn. ex Bornm., *Barbarea vulgaris* subsp. *vulgaris* belonging to *Barbarea* R. Br. were investigated with scanning electron microscopy (SEM). Significance of seed features as taxonomic characters including seed color, shape, winged, measures, seed coat pattern were determined. Two coat patterns were observed; irregularly-reticulate and tuberculate-reticulate, and three shapes were distinguished: broadly oblong, oblong and broadly elliptic. The results showed that the morphological characteristics of seed could be contribute as criteria to distinguish taxa. This is the first SEM study about seed surface of any *Barbarea* taxa.

Keywords

Brassicaceae, Classification, Micromorphology, Taxonomy

ÖZET

*Barbarea* cinsine ait olan dört taksonun (*Barbarea auriculata* var. auriculata, *Barbarea trichopoda*, *Barbarea vulgaris* ve *Barbarea vulgaris* subsp. *vulgaris*) tohum morfolojileri, taramalı elektron mikroskobu ile incelendi. Bunların taksonomik karakter olarak önemi belirlendi. Makro- ve mikromorfolojik karakter olarak tohum rengi, şekli, ölçüleri ve yüzey modeli incelendi. Düzensiz retikulat ve tüberkülü retikulat olarak iki tohum yüzeyi modelli ve geniş oblong, oblong ve geniş eliptik olarak üç tohum şekli tespit edildi. Sonuçlar *Barbarea* cinsinde tohumların morfolojik karakterlerinin taksonların ayrırmada katkısı sağlayabileceğini göstermiştir.

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Brassicaceae, Mikromorfoloji, Sınıflandırma, Taksonomi

INTRODUCTION

Brassicaceae is one of the largest family in the Angiospermae, and is easily distinguished by its flower and fruit characteristics. Brassicaceae comprises cosmopolitan plants that are mainly distributed in temperate zones and the Mediterranean region; this family of plants is represented by 338 genera and 3,709 species (Warwick et al., 2006). *Barbarea* R.Br. species are distributed in the warm regions of Eurasia, Australia, and North America; in some South American countries; and in the eastern parts of Africa. This genus is represented by 29 species throughout the world and 13 species and 18 taxa distributed in Turkey (Bağcı, 2012).

The morphological characters Brassicaceae, especially those of the fruits, seeds, and cotyledons, are used in the tribal separation within the family (Bentham and Hooker, 1862). The morphology of the seed coat patterns are considered as stable characteristic and minimally affected by external environmental conditions (Heywood, 1971; Cole and Behnke, 1975; Barthlott, 1981; Barthlott, 1984).

In this study, the seed macro- and micromorphologies of four taxa: *Barbarea auriculata* Hausskn. ex Bornm. var. *auriculata*, *Barbarea trichopoda* Hausskn. ex Bornm., *Barbarea vulgaris* (Mill.) Asch., and *Barbarea vulgaris* R.Br. subsp. *vulgaris* were investigated with scanning electron microscopy (SEM). Seed surfaces, color, and size are valuable characteristics for distinguishing taxa belonging to genera such as *Allyssum* L., *Alyssoides* Tourn. ex Adans., *Berteroa* DC., *Clypeola* L., *Fibigia* Medik., *Lobularia* Desv., *Ptilotrichium* C.A.Mey., *Arabis* L., *Cardamine* L., *Cardaminopsis* Hayek, *Nasturtium* Mill., *Rorippa* Scop., *Boleum* Desv., *Brassica* L., *Cakile* Mill., *Calepina* Adans., *Conringia* Heist. ex Fabr., *Diplotaxis*
DC., *Eruca* Mill., *Erucaaria* Gaertn., *Erucastrum* C.Presl, *Moricandia* DC., *Raphanus* L., *Sinapis* L., *Succowia* Medik., *Armoracia* G.Gaertn., B.Mey. & Scherb., *Draba* L., *Hesperis* L. and *Lepidium* L. (Vaughan and Whitehouse, 1971; Barthlott, 1981; Koul et al., 2000; Karaismaılıoğlu, 2019). The main objective of this study is to examine and describe the seed coat of some taxa of *Barbarea* growing in Turkey by using scanning electron microscope and to be reference in future research about rest of the *Barbarea* species or related genera.

MATERIAL and METHODS

The study material comprised samples of ripe seeds from four taxa belonging to *Barbarea* collected from natural habitats in Turkey between 2015 and 2017.

Table 1. Localities of the studied *Barbarea* taxa

| Taxa (Taksyon)                  | Locality (Lokalite) |
|---------------------------------|---------------------|
| *B. auriculata* var. *auriculata* | B7 Erzincan: Kemaliye, Ergü village, riverside, 1600 m, 08.07.2017, E. Şirin 676 & M. Şirin (KNYA) |
| *B. trichopoda*                 | A4 Bolu: Gerede, Aktaş forest, *P. nigra* opens, 1200 m, 22.05.2015, E. Şirin 555 & M. Şirin (KNYA) |
| *B. verna*                      | C4 İçel: Mut, Tekirini nearby, steppe, 1450 m, E. Şirin 538 & M. Şirin (KNYA) |
| *B. vulgaris* subsp. *vulgaris*  | C4 Konya: Hadim, Çalca spot, stony places, 1650 m, E. Şirin 566 & M. Şirin (KNYA) |

RESULTS and DISCUSSION

The micrographs from the seeds of the four taxa studied are shown in Fig. 1 and the macro- and micromorphological properties of the seeds are provided in Table 2.

*Barbarea auriculata* var. *auriculata*: Seed dark brown to black, broadly oblong, unwinged, glabrous, 1.41–1.52 x 1.01–1.12 mm and the seed coat pattern is irregularly reticulate (Table 2, Figure 1).

*Barbarea trichopoda*: Seed dark brown to black, oblong, unwinged, glabrous, 1.62–2.01 x 0.91–1.13 mm and the seed coat pattern is irregularly reticulate (Table 2, Figure 1).

*Barbarea verna*: Seed dark brown to black, broadly elliptic, unwinged, glabrous, 1.22–1.41 x 0.62–1.02 mm and the seed coat pattern is tuberculate reticulate (Table 2, Figure 1).

*Barbarea vulgaris* subsp. *vulgaris*: Seed dark brown to black, broadly oblong, unwinged, glabrous, 1.32–1.52 x 0.91–1.03 mm and the seed coat pattern is irregularly reticulate (Table 2, Figure 1).

SEM studies showed that seed, fruit, and leaf surface model characteristics are useful for describing different families and genera (Kumar et al., 2012; Shavvon et al., 2012; Akçin et al., 2013). In general, oblong seeds were observed in the taxa used in our study. Similarly, Gabr (2018) have reported oblong seeds for *Raphanus sativus* L., *Cakile arabica* Velen., and *Sisymbrium irio* L., none of which are related to *Barbarea*. Vaughan et al. (1971) have reported the seed shapes to be orbicular to oval for *B. verna* and *B. vulgaris*; however, according to Stearn (1992), it is more appropriate to describe the shape of *B. verna* seeds as broadly elliptical and the shape of

Table 2. Macro- and micromorphological features of studied *Barbarea* taxa

| Taxa (Taksyon) | Colour (Renak) | Shape (Şekil) | Length (mm) (Uzunluk) | Width (mm) (Genişlik) | Coat Pattern (Yüzey Modeli) |
|----------------|---------------|--------------|-----------------------|-----------------------|-----------------------------|
| *B. auriculata* var. *auriculata* | Dark brown to black | Broadly oblong | 1.41–1.52 | 1.01–1.12 | Irregularly reticulate |
| *B. trichopoda* | Dark brown to black | Oblong | 1.62–2.01 | 0.91–1.13 | Irregularly reticulate |
| *B. verna* | Dark brown to black | Broadly elliptic | 1.22–1.41 | 0.62–1.02 | Tuberculate reticulate |
| *B. vulgaris* | Dark brown to black | Broadly oblong | 1.32–1.52 | 0.91–1.03 | Irregularly reticulate |

The samples were stored at Konya Selçuk University Faculty of Science Herbarium (KNYA). The locations and collector registration numbers of the taxa studied are provided in Table 1; the seed micromorphology characteristics are provided in Table 2. Twenty seeds from each taxon were examined in our study. Samples examined in our analyses using scanning electron microscopy (SEM) were first passed through a series of 70, 80, 96, and 100% alcohol for 20 min each. The surfaces were then observed and photographed with the scanning electron microscope at 30x, 1000x, and 2000x magnification in high vacuum mode. The seed micromorphology terminology used was according to Stearn (1992), Koul et al. (2000), and Zeng et al. (2004).
B. vulgaris seeds as broadly oblong. This characteristic cannot be considered distinctive because the seeds of all studied taxa were wingless. Some other species within the same family that have a wingless seed structure are Nasturtium officinale R.Br., Rorippa islandica (Oeder) Borbás, Brassica napus L., and Iberis linifolia L. (Vaughan et al., 1971).

Barbarea trichopoda has relatively larger seeds, while B. verna has relatively smaller seeds than those of other Barbarea species. Vaughan et al. (1971) have reported that the seed coat pattern of B. verna and B. vulgaris is reticulate; however, other researchers have reported that the seed coat pattern of B. verna is tuberculate reticulate because of the tubercles and reticulated structure on the seed surface and have reported a seed coat pattern in B. vulgaris as irregularly reticulate because of the irregularly reticulated structure on the seed surface.

Color characteristics cannot be considered distinctive because the color of the seeds from all taxa studied ranged from dark brown to black. Bona (2013) has observed a similar seed color in Lepidium species that are not related to those of Barbarea. The seed surface of all studied taxa was glabrous. Similarly, Ghaempanah et al. (2013) have reported a glabrous structure in Erysimum L. species that are not related to those of Barbarea.

The studied characteristics were not distinctive for Barbarea in genus level but the shape and size of the seeds and that seed coat patterns can be used as distinctive characteristics among the studied taxa. In future seed morphology studies about the rest of the Barbarea species will contribute to the interpretation of relationships of the taxa.

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Statement of Conflict of Interest
Authors have declared no conflict of interest.

Author’s Contributions
The contribution of the authors is equal.

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