



Seed mucilage components in 11 *Alyssum* taxa (Brassicaceae) from Turkey and their taxonomical and ecological significance

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Abstract

In this work, mucilage characterization and their taxonomical and ecological significance in the seeds of 11 *Alyssum* taxa (*A. dasycarpum* var. *dasycarpum*, *A. desertorum*, *A. filiforme*, *A. hirsutum* var. *hirsutum*, *A. linifolium* var. *linifolium*, *A. minutum*, *Alyssum murale* var. *murale*, *A. parviflorum*, *A. sibiricum*, *A. strictum* and *A. strigosum* subsp. *strigosum*) were investigated. The mucilage producing cells were seen on the seed surface of the all studied taxa when hydrated in water. The seed mucilage was comprised of cellulose or pectin in the all examined taxa. There were differences in columella lines such as flattened, prominent or reduced forms. Besides, soil adhesion capacities of the seeds of the examined taxa ranged from 29 mg to 106 mg. The mucilage production in examined taxa can provide advantages in seed dispersion and colonization.

Key words: *Alyssum*, colonization, morphology, pectin, mucilage

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Türkiye'den 11 *Alyssum* taksonundaki tohum musilaj bileşenleri ve onların taksonomik ve ekolojik önemi

Özet

Bu çalışmada, 11 *Alyssum* taksonunun (*A. dasycarpum* var. *dasycarpum*, *A. desertorum*, *A. filiforme*, *A. hirsutum* var. *hirsutum*, *A. linifolium* var. *linifolium*, *A. minutum*, *Alyssum murale* var. *murale*, *A. parviflorum*, *A. sibiricum*, *A. strictum* ve *A. strigosum* subsp. *strigosum*) tohumlarındaki musilaj karakterizasyonu ve onların taksonomik ve ekolojik önemi çalışılmıştır. Musilaj hücreleri su ile temas halinde çalışılan taksonların tohum yüzeylerinde görülmüştür. Tohum musilajı incelenilen tüm taksonlarda selüloz veya pektinden oluşmuştur. Kolumela şekillerinde düzlenmiş, belirginleşmiş veya indirgenmiş gibi farklılıklar vardı. Ayrıca, incelenilen taksonların tohumlarının toprak bağlama kapasiteleri 29 mg ile 106 mg arasında çeşitlilik gösterdi. İncelenen taksonlardaki musilaj üretimi tohum dağılımı ve kolonizasyonda avantajlar sağlayabilir.

Anahtar kelimeler: *Alyssum*, kolonizasyon, morfoloji, pektin, musilaj

1. Introduction

Brassicaceae family is spread worldwide, excluding Antarctica (Koch and Kiefer, 2006). It has approximately 321 genera, and 3660 species (Al-Shehbaz, 2012; Fidan et al., 2017). The *Alyssum* L. genus is spread mainly in Europe, Southwest Asia, and Northern Africa (Al-Shehbaz, 1987; Al-Shehbaz et al., 2006; Karabacak et al., 2016). Anatolia is one of the main diversity areas of genus. *Alyssum* has 113 taxa in the Flora of Turkey, 56 of which are endemic (Yilmaz, 2012).

Some genera in the Brassicaceae family has a common convergence for old characteristics utilized in taxonomy, particularly in fruit (Mummenhoff et al., 1997). This situation induces some difficulties in their classification now and again; thus, extra characters in diagnostic are required in the re-classification of such as *Alyssum*, *Aethionema* W.T. Aiton and *Thlaspi* L. genera within family.

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Mucilage is placed in distinguished epidermis cells. It provides adaptive advantages such as germination, dispersion, and adhesion to soil in terms of colonization (Ryding, 2001; Western, 2012). The mucilage layer has a key role in blocked of germination (Kreitschitz et al., 2009). Also, Seed mucilage can help seed development, with providing a humid location and preserving metabolic activity in the seed. In arid surroundings, mucilage can stop drying of the seeds or recruit DNA repair mechanisms. Mucilage decreases oxygen circulation to the seed and therefore has a key role in the regulation of the seed dormancy (Yang et al., 2012). Besides, mucilage layer offers the defensive against pathogenic incidences (Young and Martens, 1991; Huang and Gutterman, 1999; Western, 2012). It is seen in many angiosperm families such as Plantaginaceae, Asteraceae and Brassicaceae (Greubert, 1974; Ryding, 2001; Kreitschitz et al., 2007; Western, 2012). The former many works have reported presence of the mucilage cells of some taxa in Brassicaceae family (Harper and Benton, 1966; Gutterman and Shem-tov, 1997; Western et al., 2000; Lu et al., 2010; Karaismailoğlu, 2017).

The information about mucilage content of the seeds in the genus *Alyssum* is quite limited (Young and Evans, 1973; Baskin and Baskin, 1974; Koocheki et al., 2009; Sun et al., 2012). The purpose of this investigation has been to work the mucilage contents of the seeds and soil adhesion capacity, and taxonomical and ecological importance of the mucilage in the examined *Alyssum* seeds.

2. Materials and methods

Plants were collected from natural populations in Turkey. The vouchers and location data of the examined taxa were presented in Table 1. The specimens of the plants were stored in ISTF herbarium or M.C. KARAIŞMAİLOĞLU collection.

The changes on wetted seeds was detected, and assessments on the ability to hydrate were made. The wetted analysis with distilled water were done at room temperature for 10 minutes. Methylene blue and safranin dyes were used to define the mucilage type with 10 minutes dyeing (Kreitschitz et al., 2009).

Pure sea sand was used for determining the soil adhesion capacity of the seeds of the examined taxa. Firstly, the 20 seeds were placed on the wetted sea sand in a petri dishes, mucilage shaped later 10 min. Later, the petri dishes with the seeds and sand were transferred to 50°C for 24 h. Afterwards, seeds were sensibly detached from petri dishes and the weights (final weights) were calculated. The soil adhesion capacity of the mucilage layer was determined by comparison of the first and final weight of the seeds (Huang et al., 2000; Karaismailoğlu, 2017).

Mucilage characters were noticed by an Olympus CX21FS1 microscope and Kameram Imaging Software.

3. Results

The wetted seed analyses indicate that there are the mucilage cells on surface of the seeds, which are in cellulosic structure display a heterogenous form. The *Alyssum* seeds dyed with safranin and methylene blue have pectin matrix and cellulosic edge (Fig. 1). Methylene blue enclosed with blue, violet or violet-blue cover around seeds as orange was found with staining safranin (Fig. 1).

The volume of the shaped mucilage has offered differences in the examined *Alyssum* taxa (Table 2). Besides, there were differences in columellae figures in the studied *Alyssum* taxa, which are in prominent, reduced or flattened shapes. The soil adhesion capacities of the examined taxa ranged from 29 mg to 106 mg. Mucilage occurrence among the examined *Alyssum* taxa was the highest at *A. filiforme*. Also, it is the lowest at *A. linifolium* var. *linifolium* (Table 2). The differences in mucilage occurrence may arise from the habitat structures of the examined taxa. This situation has been reported in some families such as Lamiaceae, Asteraceae and Brassicaceae (Mosquero et al., 2004; Kreitschitz et al., 2009; Karaismailoğlu, 2017). The seeds of *A. filiforme* and *A. strigosum* subsp. *strigosum* scattering in mostly thirsty and stone regions propagate more mucilage than other studied taxa. They are hold to soil surface by virtue of the mucilage layer (Gutterman and Shem-Tov, 1997), and thus became colonized. This finding is suitable with the obtained information from this study, especially in invasive plant such as *A. murale* var. *murale*. Alike variation condition has been reported in *Matricaria chamomilla* (Inceer, 2011) and in some *Aubrieta* species (Karaismailoğlu, 2017).

The mucilage structure of the examined *Alyssum* taxa is cellulosic form, with cellulose and pectin. The cellulosic mucilage is a sample of colloiddally dispersal cellulose and typically derive from pectins, which are acidic polysaccharides with a special capacity for hydration (Grant et al., 1969; Fahn and Werker, 1972; Kreitschitz et al., 2007; Karaismailoğlu, 2017, Table 3). This work is the first on the mucilage structure of the genus *Alyssum*. The structure of cellulose threads is alike in examined taxa, which is consistent with their taxonomic closeness. This finding is compatible with earlier works (Gerlach, 1972; Braune et al., 1975; Western et al., 2000; Western, 2006; Kreitschitz et al., 2009; Inceer, 2011; Karaismailoğlu, 2017).

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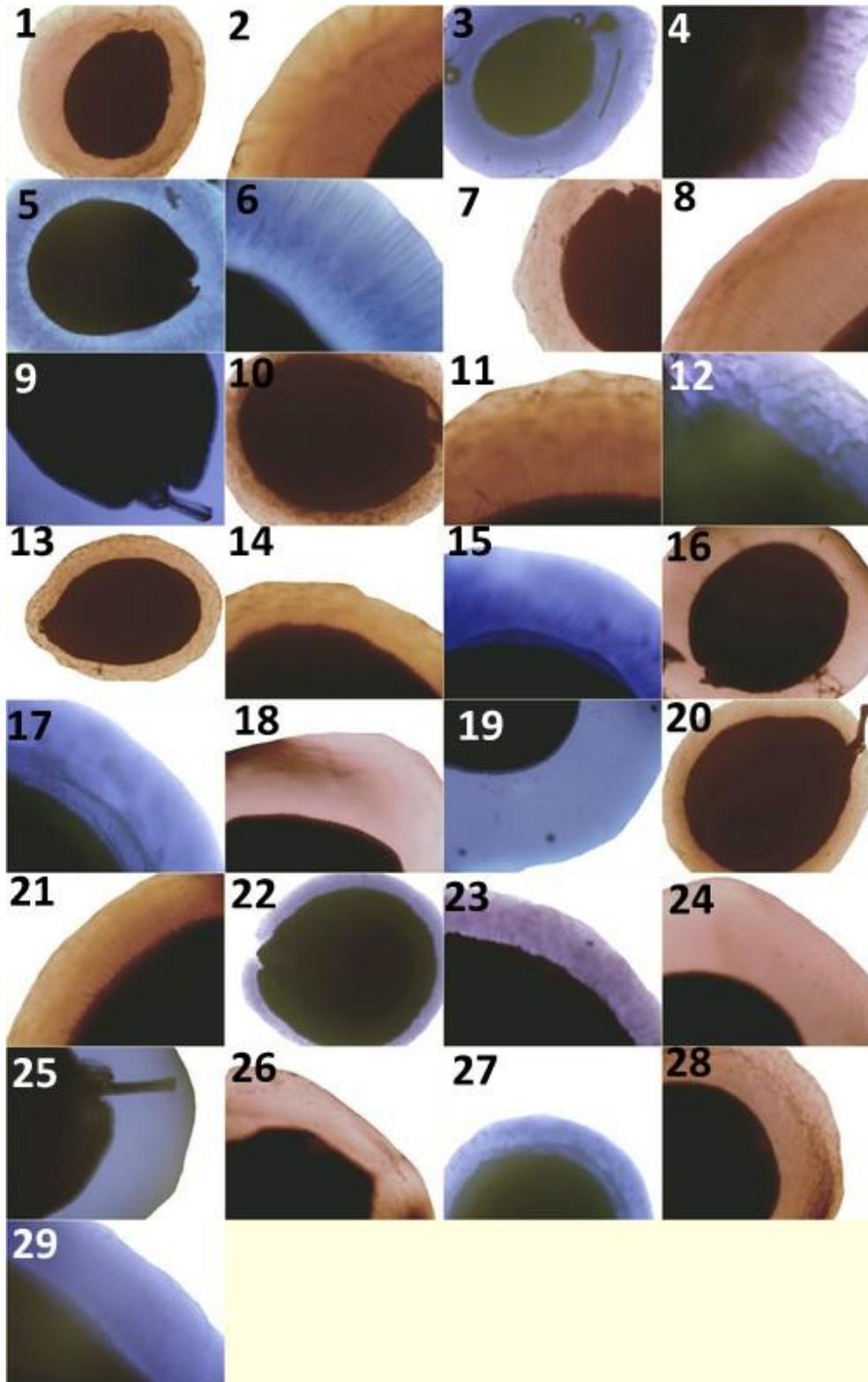


Figure 1. The mucilage structure in seeds of the examined taxa; *Alyssum dasycarpum* var. *dasycarpum*: 1-2 (Safranin), 3-4 (Methylene Blue), *A. desertorum*: 5-6 (Methylene Blue), 7 (Safranin), *A. filiforme*: 8 (Safranin), 9 (Methylene Blue), *A. hirsutum* var. *hirsutum*: 10-11 (Safranin), 12 (Methylene Blue), *A. linifolium* var. *linifolium*: 13-14 (Safranin), 15 (Methylene Blue), *A. minutum*: 16 (Safranin), 17 (Methylene Blue), *A. murale* var. *murale*: 18 (Safranin), 19 (Methylene Blue), *A. parviflorum*: 20-21 (Safranin), 22-23 (Methylene Blue), *A. sibiricum*: 24 (Safranin), 25 (Methylene Blue), *A. strictum*: 26 (Safranin), 27 (Methylene Blue), *A. strigosum* subsp. *strigosum*: 28 (Safranin), 29 (Methylene Blue).

Table 1. The examined taxa and their locations

Taxa	Location	Voucher
<i>Alyssum dasycarpum</i> STEPHEN EX WILLD. var. <i>dasycarpum</i>	Ankara, Haymana, open areas around Mogan lake, 980 m, 10.8.2016	Karaismailoğlu 330
<i>Alyssum desertorum</i> STAPP.	Ankara, Keçiören, roadside, open areas, 900 m, 17.08.2016	Karaismailoğlu 337
* <i>Alyssum filiforme</i> NYAR.	Gümüşhane, Kürtün, Karagöl, roadsides, inclined slopes, 1600 m, 13.7.2014	Karaismailoğlu 85b
<i>Alyssum hirsutum</i> BIEB. var. <i>hirsutum</i> VENT.	Mersin, Mut, Kucukeğre mountain, inclined stone slopes, 900 m, 27.7.2012	Karaismailoğlu 8
<i>Alyssum linifolium</i> STEPH. EX WILLD. var. <i>linifolium</i>	Konya, Cihanbeyli-Yavşan, salt lake edge, 960 m, 11.7.2016	Karaismailoğlu 316
<i>Alyssum minutum</i> SCHLECHT. EX DC.	Bursa, Uludağ, Yiğitalı, roadsides, inclined slopes, 1500 m, 1.7.2016	Karaismailoğlu 295
<i>Alyssum murale</i> WALDST. ET KIT. var. <i>murale</i> WALDST. ET KIT.	Gümüşhane, Kürtün, Karagöl mountain road, 675 m, 13.7.2014	Karaismailoğlu 74b
<i>Alyssum parviflorum</i> FISCH. ex M. BIEB.	İstanbul, Büyükçekmece-Çatalca, roadsides, 4 m, 8.7.2016	Karaismailoğlu 312
<i>Alyssum sibiricum</i> WILLD.	Kütahya, Gediz, Çukurören, 1350 m, 24.6.2016	Karaismailoğlu 290
<i>Alyssum strictum</i> WILLD.	Niğde, Çamardı, Yelatan village hills, 2083 m, 12.6.2016	Karaismailoğlu 271
<i>Alyssum strigosum</i> BANKS ET SOL. subsp. <i>strigosum</i>	Bursa, Uludağ, past the hotels, open inclined slopes, 1800 m, 1.7.2016	Karaismailoğlu 296

Table 2. Columellae structures and soil adhesion capacities of the mucilage cells in the examined *Alyssum* taxa

Taxa	Columellae structure	Soil adhesion capacity of seeds		
		First weight (mg)	Final weight (mg)	Net (Final-First w.) (mg)
<i>Alyssum dasycarpum</i> var. <i>dasycarpum</i>	flattened or prominent	18	58	40
<i>A. desertorum</i>	flattened or reduced	53	119	66
<i>A. filiforme</i>	flattened	99	205	106
<i>A. hirsutum</i> var. <i>hirsutum</i>	prominent	63	118	55
<i>A. linifolium</i> var. <i>linifolium</i>	flattened or reduced	10	39	29
<i>A. minutum</i>	prominent	43	115	68
<i>A. murale</i> var. <i>murale</i>	prominent	34	141	87
<i>A. parviflorum</i>	prominent	13	45	32
<i>A. sibiricum</i>	prominent	10	77	67
<i>A. strictum</i>	prominent or reduced	8	91	82
<i>A. strigosum</i> subsp. <i>strigosum</i>	flattened or reduced	52	151	99

Table 3. The staining of mucilage layer and literature data

Dyeing	Target	Obtained Color	Literature data	Prior works
Safranin	Pectin	Orange	Orange, Orange-Red	Gerlach 1972, Braune et al. 1975, Kreitschitz et al. 2009, Inceer 2011, Karaismailoğlu 2017
	Cellulose	Orange	Orange, Orange-Red, Red	
Methylene Blue	Pectin	Blue, Violet-Blue, Violet	Blue, Violet Blue	Broda 1971, Gerlach 1972, Kreitschitz and Valles 2007, Kreitschitz et al. 2009, Inceer 2011, Karaismailoğlu 2017
	Cellulose	Blue, Violet-blue	Violet-Blue, Blue	

(Received for publication 14 June 2017; The date of publication 15 August 2018)