

SEED COAT AND FRUIT SURFACE MICROMORPHOLOGY OF SOME *CYNOGLOSSUM* L. (BORAGINACEAE) SPECIES

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Abstract

Fruits and seeds of *Cynoglossum creticum* Miller, *C. officinale* L., *C. montanum* L. and *C. glochidiatum* Wallich distributed in the Middle and East Black Sea Region in Turkey were studied by scanning electron microscopy. Some differences were found in seed coats and fruit surfaces. SEM observations of fruit surface were focused on surface ornamentation and glochids. Two types (tuberculate and granulate) and two subtypes (granulate - punctuate and granulate - tuberculate) were observed among the species. Reticulate type of seed coat and detailed subtypes of reticulate types were determined on the basis of ornamentation of the seed coats.

Introduction

The genus *Cynoglossum* L. is the member of the family Boraginaceae. *Cynoglossum* is represented by 8 species in Turkey (Riedl 1978, Sutory 2005). The majority of Turkish species belong to subgen. *Cynoglossum*. In recent years, various studies have been carried out on *Cynoglossum*. Most of them are focused in seed ecology, seed germination and chemical structure (Fisher *et al.* 1989, Stabell *et al.* 1998). Akçin and Bilgener (2000) have studied chemotaxonomy of these species. However, there is still some problems in the systematics of this genus. According to the Riedl (1978), most of the Turkish representatives are poorly defined and it needs some additional characters for certain identification.

Barthlott and Ehler (1977) reported that the epidermal features are variable for Angiosperm taxa and can be used to evaluate possible relationships. The microstructural properties of the seed and fruit surface can be useful for delimiting taxa at various levels (Karcz *et al.* 2005). The morphology of fruits are used in the taxonomy of *Cynoglossum*. They have major taxonomic importance in this genus (Riedl 1978). But there have not been studies on micromorphological properties of fruit or seed of *Cynoglossum* species. The aims of our study are to show the different patterns in microstructure of seed coat and fruit surface of *Cynoglossum* species in Turkey.

Materials and Methods

The plants were collected from different localities of north Anatolia between 2001 and 2003. Four species collected from four locations are *C. creticum* Miller from A6 Ordu: Gölköy, 650 m, Akçin 15; *C. montanum* L. from A5 Amasya: Borabay Lake, 450 m, Akçin 34; *C. officinale* L. from A6 Ordu : Güzelyurt, 100 m, Akçin 36; *C. glochidiatum* Wallich from A8 Rize : kizdere 500 m, Akçin 45. These were identified by using Flora of Turkey and the East Aegean Islands (Riedl 1978). Fruit and seed characters (shape, size, colour and surface) were examined (Table 1). For scanning electron microscopy, dried fruits and seeds were mounted on stubs using double-sided adhesive tape. Samples were coated with 12.5 - 15 nm of gold. Coated materials were examined and photographed with JMS-6400 Scanning Electron Microscope. Observations were made on the surface patterns of fruit and seed as in Stearn (1973) and Barthlott (1981).

Results and Discussion

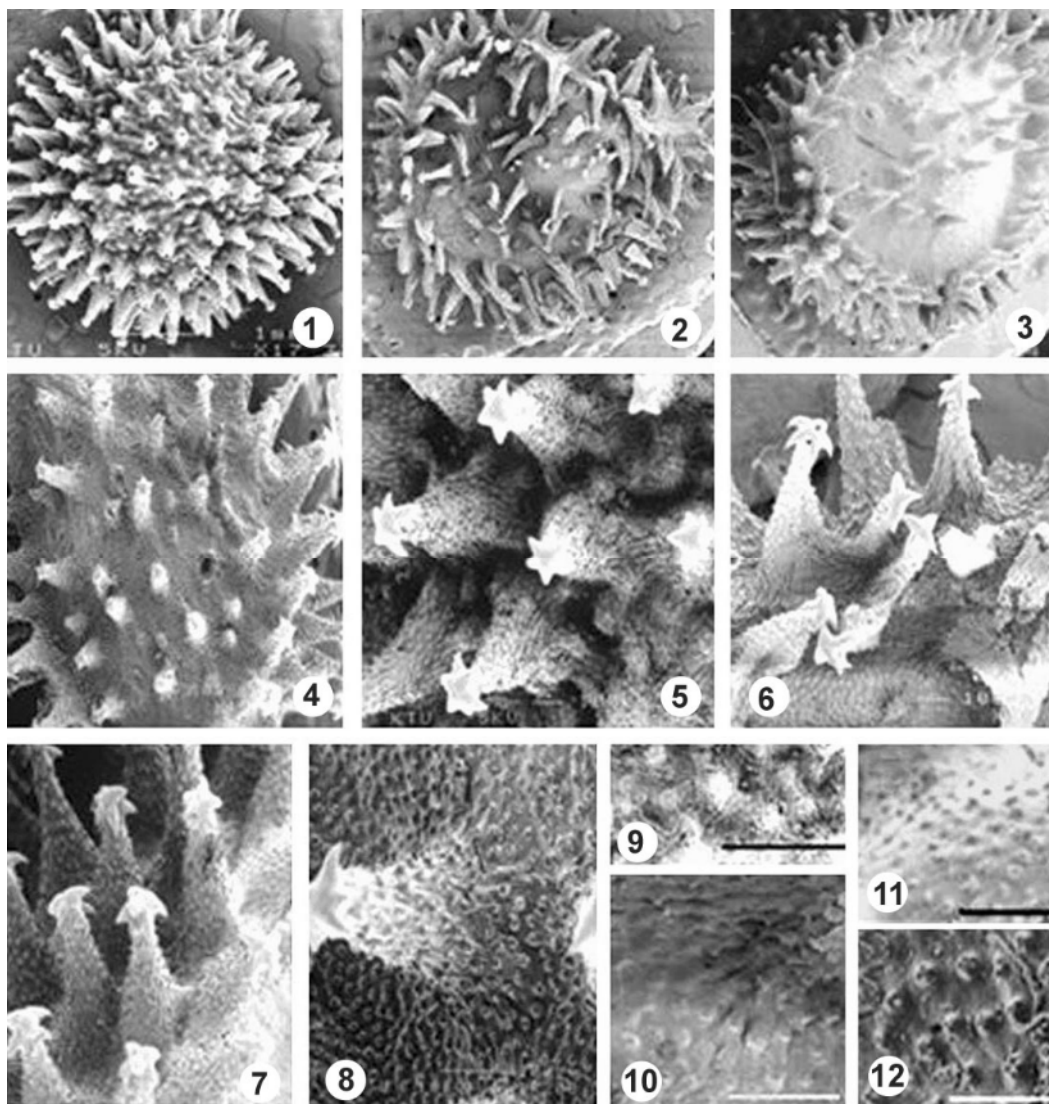
Fruit characters: The fruit surface characters of four *Cynoglossum* species are described in more detail in Table 1. SEM observations of fruit surface were focused on surface ornamentation and glochids. Fruit type of *Cynoglossum* species is nutlet. The fruit surface type of *C. creticum* is tuberculate. There are big tubercles on fruit surface and densely and evenly glochids between big tubercles on dorsal surface (Figs. 1, 5 and 9). In *C. montanum*, surface type is granulate - tuberculate. Glochids and with or without small tubercles are seen on the dorsal surface. Lateral and ventral surface more densely glochidiate than dorsal surface (Figs. 2, 6 and 10). *C. officinale* has granulate - punctate surface type. Ventral and lateral surfaces of *C. officinale* nutlet have densely glochidiate but dorsal surface has uncommon glochidiate (Figs. 3, 7 and 11) There are sparsely glochids on dorsal surface and frequent glochids on ventral and margin surfaces of *C. glochidiatum* (Figs. 4, 8 and 12). This species has granulate surface type.

Table 1. Characteristics of fruits and seeds.

Taxa	Characters			
	Shape	Colour	Size (mm)	Surface type
Fruit <i>C. creticum</i>	Ovoid, to depressed globose, immarginate	Light brown or brown	4 - 5 × 5 - 6	Tuberculate
<i>C. montanum</i>	mmarginate, dorsal surface convex	Light brown	3.5 - 4 × 4 - 5	Granulate - tuberculate
<i>C. officinale</i>	Depressed ovoid, prominently marginate	Light brown pale yellow	4 - 5 × 6 - 6.5	Granulate - punctate
<i>C. glochidiatum</i>	Ovoid, narrowly marginate	Brownish	2 - 2.5 × 3 - 3.5	Granulate
Seed <i>C. creticum</i>	Depressed ovoid	Brown or dark brown	4 - 4.5 × 4 - 4.5	Reticulate-foveolate
<i>C. montanum</i>	Depressed ovoid	Light brown	3 × 3.5 - 4	Reticulate - areolate
<i>C. officinale</i>	Broadly ovoid	Dark brown	4 × 4.5 - 5	Reticulate - ocellate
<i>C. glochidiatum</i>	Depressed ovoid	Brown	1.5 - 2 × 2.5 - 3	Reticulate - rugose

Seed characters: SEM observations of seed surface were studied on the structure and arrangement of epidermal cells (Table 2). The seed surface characters of four *Cynoglossum* species have some variations. *C. creticum* has reticulate - foveolate surface ornamentation. Irregular raised anticlinal walls and sometimes collapsed periclinal cell walls are seen on surface. Epidermal cells were more or less pitted (Fig. 13). In *C. montanum*, surface type is reticulate-areolate. This type has irregular polygonal cells (Fig. 14). Epidermal cells possessed sometimes distinctive pits. Reticulate - ocellate surface type was observed in *C. officinale*. This type is characterized by regular or irregular polygonal cells with blunt edges and thick cell walls. Anticlinal and periclinal walls were irregularly raised. Boundaries are higher than cells. Cells have rarely elevation (Fig. 15). *C. glochidiatum* has reticulate - rugose. This type has different shaped and stretch polygonal epidermal cells. Epidermal cells possessed thin cell walls and distinctive pits (Fig. 16).

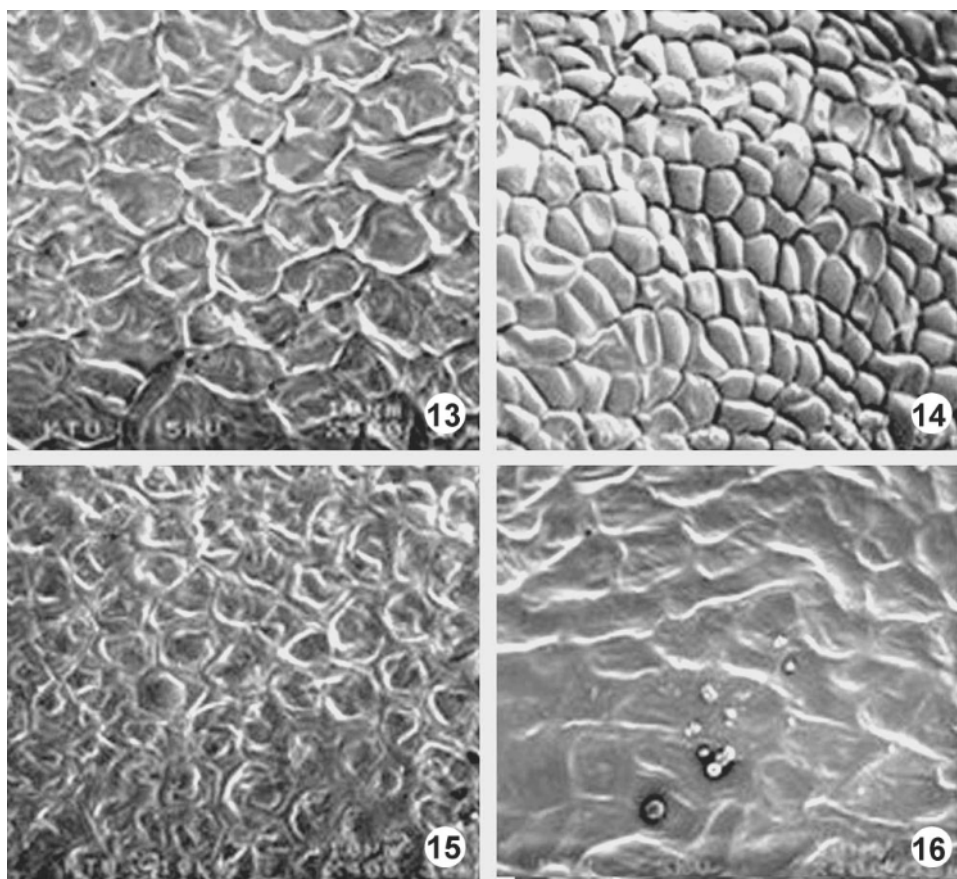
The micromorphological characters of the seed coat and fruit surface of four *Cynoglossum* species were examined by SEM. The majority of Turkish species belong to subgenus *Cynoglossum*. The fruits of Boraginaceae are characterized by one - seeded mericarpid (nutlets) with a sclerified exocarp protecting the seeds (Diane *et al.* 2002). It was seen that the fruit of *Cynoglossum* was nutlet by one-seeded.



Figs.1-12. Scanning electron micrographs of fruits, glochids and fruit surface of *Cynoglossum*. Figs. 1-4, fruit of *Cynoglossum* species. Figs. 5-8, glochids on the fruit. Figs. 9-12, fruit surface. 1, 5, 9, *C. creticum*; 2, 6, 10, *C. montanum*; 3, 7, 11, *C. officinale*; 4, 8, 12, *C. glochidiatum*. Bars: 1 mm (1, 2, 3), 100 μ m (4-8,10, 11), 50 μ m (9,12).

The seed and fruit morphology and micromorphology are distinctive features in taxa diagnosis (Lu and Chen 1991, Özcan 2002). The fruit and seed surface characters of four *Cynoglossum* species are described in more detail here. SEM observations of fruit surface were focused on surface ornamentation and glochids. Two types (tuberculate and granulate) and two subtypes (granulate - punctuate and granulate - tuberculate) were observed among the studied species. Glochids are important structures in *Cynoglossum* species. In the study, it was found that the glochids shows differences among species. Lateral and ventral surface more densely glochidiate than dorsal surface in *C. montanum*, *C. officinale* and *C. glochidiatum*. Densely and evenly glochids between big tubercles on dorsal surface were seen in *C. creticum*.

It appears that surface features of seed coats are little affected by the environmental conditions and seed coat characters always reflect genetic-phylogenetic differences in the plants concerned (Barthlott 1984, Özcan 2002). The seed surface characters of four *Cynoglossum* species showed some variations. The reticulate type was determined as a main type according to the ornamentation of the seed coat. The foveolate subtype in *C. creticum*, areolate subtype in *C. montanum*, ocellate subtype in *C. officinale* and rugose subtype in *C. glochidiatum* were observed in this study.



Figs. 13-16. Scanning electron micrographs of *Cynoglossum* seeds. Figs. 13, *C. creticum*. Figs 14, *C. montanum*. Figs 15, *C. officinale*. Figs 16, *C. glochidiatum*. Bars:10 μ m (13-16).

According to the Riedl (1978), most of the Turkish *Cynoglossum* species are poorly defined and it needs some additional characters for certain identifications. The present study revealed considerable diversity in seed coat and fruit surface micromorphology. Moreover fruit surface and seed coat morphologies are considered useful characters for species level identification of *Cynoglossum*.

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