Australian Journal of Crop Science AJCS

AJCS 4(5):369-371 (2010) ISSN:1835-2707

Anatomical properties of *Colchicum kurdicum* (Bornm.) Stef. (Colchicaceae)

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Abstract

Colchicum kurdicum (Bornm.) Stef. (syn. *Merendera kurdica* Bornm.) (*Colchicaceae*), which grows in alpine steppe in the southern Turkey, Iran and Iraq, is a perennial acaulescent plant. This investigation presents anatomical features of *C. kurdicum* for the first time. Anatomical studies have been carried out on tranverse sections of roots, leaves and surface sections of the leaves of the species. The plant has the roots with 4 to 6-layered cortex, 4 sets of protoxylem arms and one large metaxylem, anomocytic stomata, amphistomatic and equifacial leaves, 2-layered (rarely 3) palisade parenchyma and 2 to 3-layered spongy parenchyma. The stomata are 30-37 µm long and 22-36 µm wide. Raphides (elongated needle-shaped crystals) were investigated in the roots of *C. kurdicum* and their distribution were determined.

Key words: *Colchicaceae*; *Colchicum kurdicum*; Anatomy; Turkey

Introduction

Colchicaceae, which is a family with a complicated distribution pattern, is made up of 19 genera distributed in Africa, Asia , Australia, Eurasia and North America (Vinnersten and Reeves, 2003). The pattern indicates an early Gondwanan distribution, however a previous investigation (Vinnersten and Bremer, 2001) revealed that the family is much younger. The taxonomic history of the family began in 1805 when de Candolle was the first to use the family name *Colchicaceae*. The taxonomic treatment of several genera within *Colchicaceae* is still ambiguous. For instance, *Colchicum* is often taken to include the genera *Bulbocodium* L. and *Merendera* Ramond, but some authors separate three genera based on style and tepal characters. Recently, Persson (2007) listed the subgeneric taxa of the genus *Colchicum* including a few genera such as *Bulbocodium*, *Fouha*, *Merendera*, *Monocaryum* and *Synsiphon*. In this study, *Merendera kurdica* Bornm. was treated as a synonym of *Colchicum kurdicum* (Bornm.) Stef. The genus *Colchicum* L. (*Colchicaceae*) in its most inclusive sense (including *Merendera* Ramond and *Bulbocodium* L.) includes nearly 100 species, which are very unevenly distributed (Dusen and Sumbul, 2007). Most species are confined to limited regions, but some of which are very rich in species. The high frequencies of species and of endemics in Turkey and the Balkans indicate that these regions are major centres of diversity and speciation. *Colchicum* is represented by 39 taxa, of which 18 are endemic in Turkey (Brickell, 1984; Persson, 2000, 2005, 2007; Akan and Satil 2005; Dusen and Sumbul, 2007). *Colchicum kurdicum* (Bornm.) Stef. (syn. *Merendera kurdica* Bornm.), an Irano-Turanian element, is a perennial stemless geophyte with three lanceolate leaves, mid-brown and membranous outher corm tunics, yellow anthers, and ellipsoid capsules. *C. kurdicum* grows in alpine steppe by melting snow ranging from 1800 to 3000 m in Hakkari, Şırnak and Van vicinities in the Southeast Anatolia. Moreover, the species is distributed in Iran and Iraq. It is not also related to any of the *Colchicum* species. Geophytes have an important commercial value especially in ornamental, food and medicinal industries (Celik et al., 2004). *C. kurdicum* may be used as an ornamental plant because of its beautiful purple flowers. It is known as "Karçiçeği" in Turkey. Colchicine is the main alkaloid of some genera of the family *Colchicaceae* such as *Colchicum, Merendera* and *Bulbocodium* (Mróz, 2008). Apart from antimitotic, anti-tumor, antiflammatory features, colchicine is well known for its cytotoxic effects and causes vomiting, diarrhea, and miscarriage in vertebrates (Paris and Moyse, 1967; Gómez et al., 2003). Sutlupinar (2002) studied the alkoloid content several organs of *C. kurdicum* (syn. *M. kurdica)* and determined colchicine and demecolcine in its corms and some homoaporphine such as baytopine, behuanine and kreysigine in its leaves and flowers. He studied its phenolics and identified benzoic and vanillic acids as aromatic acids.The genus *Colchicum* in Turkey has been subject to a number of morphological studies (Brickell, 1984; Kucuker, 1990; Persson, 2000, 2005, 2007; Akan and Eker, 2005). Anatomy of *Colchicum* and some genera in the Liliaceae was investigated by Vaikos et al. (1989), Akan and Satil (2005), Kaviani (2008) and Kahraman et al. (2010). However, the anatomical structures of roots and leaves of *Colchicum kurdicum* have not been studied previously. Thus, we aims to examine anatomical properties of *C. kurdicum* for the first time and to discuss our recent findings with previous studies.

Material and methods

The specimens were collected from Van (Van-Bahçesaray road, Yukarı Narlıca to Karlıgeçit, 2620 m, 38^{o} 08' 178'' N - 42^{0} 55' 903'' E, 02.06.2006, AG14220) and cultivated in Nezahat Gökyiğit Botanic Garden (NGBB) in İstanbul. The specimens for anatomical investigations were kept in 70% alcohol untill the sections were prepared. The paraffin wax method was used for the cross sections of roots and leaves. The samples were embedded in the paraffin wax, sectioned at

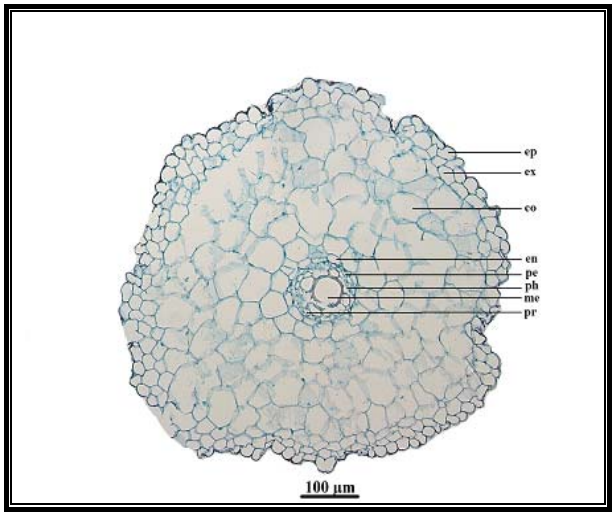

Fig 1. Cross-section of root of *Colchicum kurdicum*. **co** – cortex; **en** – endodermis; **ep** – epidermis; **ex** – exodermis; **me** – metaxylem; **pe** – pericycle; **ph** – phloem; **pr** – protoxylem.

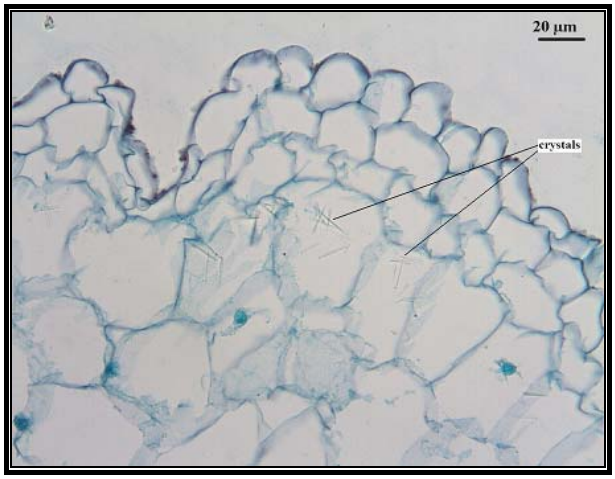

Fig 2. Raphide crystals in the first row of the root cortex of *Colchicum kurdicum*

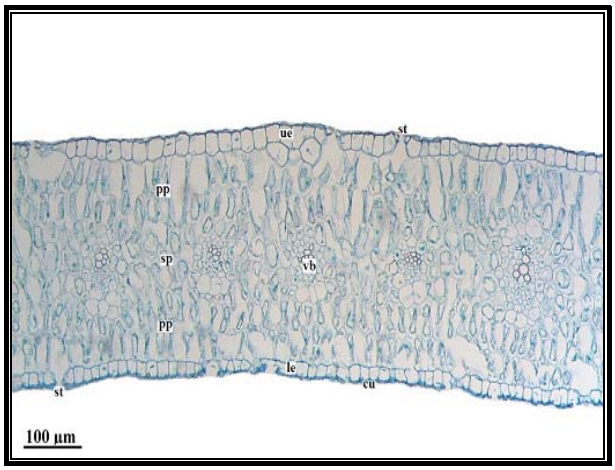

Fig 3. Cross-section of leaf of *Colchicum kurdicum*. **cu** – cuticle; **le** – lower epidermis; **pp** – palisade parenchyma; **sp** – spongy parenchyma; **st** – stoma; **ue** – upper epidermis; **vb** – vascular bundle

8-15 µm thickness with a Leica RM2125RT rotary microtome, stained with safranin-fast green solution and mounted using Canada Balsam. Surface sections of the leaves were also taken manually. The sections were examined and photographed using a Leica DM1000 binocular ligth microscope with a Leica DFC280 camera.

Results

Root anatomy

The epidermis is composed of a single layer of cells of various shapes at the surface and it is covered with a thin cuticle. 2-layered (rarely one-layered) exodermis is located underneath the epidermis. The cortex is covered with 4-6 layers of parenhymatous cells. These cells are filled with elongated needle-shaped crystals of calcium oxalate. Underneath the cortex, there is a single layered endodermis consisting of oval or rectangular cells. The pericycle has a single layer of parenchymatous cells that lies just inside the endodermis. The xylem consists of 4 sets of protoxylem, the narrow cells at the point of the arms, and one central and larger metaxylem. Phloem strands are located between protoxylem strands (Figs. 1-2).

Leaf anatomy

The upper epidermis is covered by a the thinner cuticle than the lower epidermis. Both epidermises are made up of uniseriate, isodiametric or rectangular cells. Cells of the upper epidermis is larger than those of the lower epidermis. Stomata are anomocytic. They are found more abundant on the lower surface. They are also located slighly higher from the epidermal cells. Stomata on the upper surface are 30-35 µm in length and 29-36 µm in width whereas stomata on the lower surface are 31-37 µm in length and 22-26 µm in width. The leaf is of the equifacial type. The mesophyll is composed of 2 layers (sometimes 3) of elongated rectangular palisade parenchymatous cells and 2 to 3 layers of irregular spongy parenchymatous cells. The vascular bundle is of the collateral type and of nealy equal sizes. The midrib do not constitute a projecting part (Figs. 3-5).

Discussion

In this study, root and leaf anatomy of *C. kurdicum* are reported for the first time. The cortex in the root is 4-6-layered parenchymatic cells. The first row of the cortex includes abundant raphides, elongated needle forms of calcium oxalate crystals. Akan and Satil (2005), who studied the anatomy of five species of *Colchicum*, determined raphides in only the *C. crocifolium* roots. They also recognized that protoxylem arms were triarch in *C. szovitsii* and *C. cilicicum*, tetrarch in *C. serpentinum* and *C. persicum*, and pentarch in *C. crocifolium*. Our present study showed that the protoxylem arms of *C. kurdicum* were found to be tetrarch. Thus, presence or absence of raphide chrystals in the root and number of the protoxylem arms can represent useful taxonomic characters. The leaf of *C. kurdicum* are equifacial and amphistomatic. Stomata are anomocytic and are located more abundant on the lower surface. Moreover, stomata on the lower epidermis are narrower. Our results reveal that in many respects the leaves of *C. kurdicum* is similar to those of the species previously investigated by Akan and Satil (2005). There are 2-layered (sometimes 3) palisade parenchyma and 2-3 layers of spongy parenchyma. In *C. kurdicum* the upper

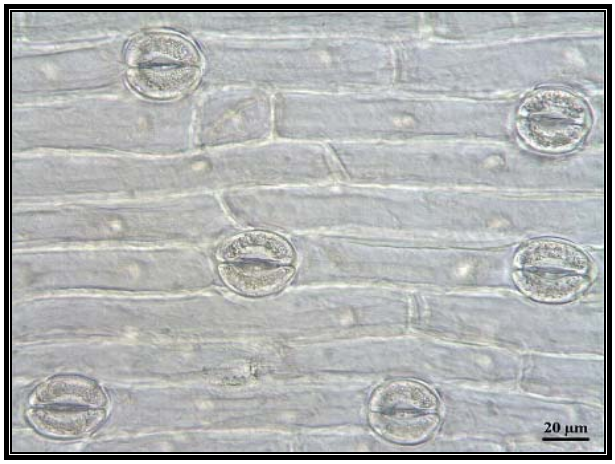

Fig 4. A view of of the stomata on the upper surface of *Colchicum kurdicum*

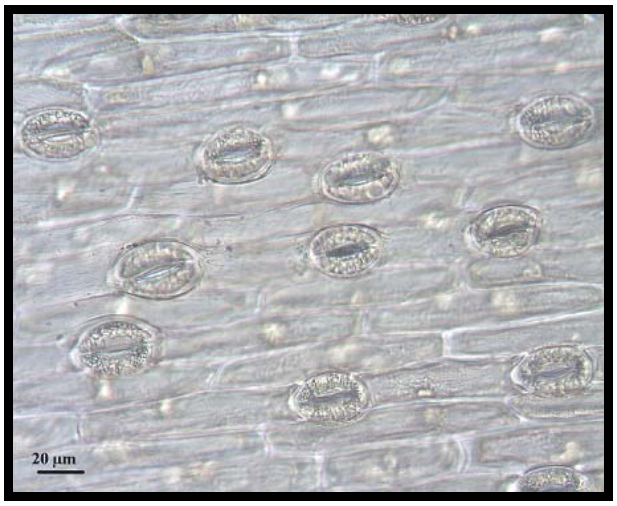

Fig 5. A view of of the stomata on the lower surface of *Colchicum kurdicum*

epidermal cells are larger than the lower epidermal ones. Akan and Satil (2005) reported that the palisade parenchyma was 2 or 3 in four species studied except *C. cilicicum* with the one-layered palisade and also in *C. serpentinum* and *C. crocifolium* the upper epidermal cells are larger than the lower epidermal cells. However, they documented that both epidermal cells were similar size in *C. szovitsii*, *C. cilicicum* and *C. persicum*. This present study shows that the root and leaf anatomical characteristics of *C. kurdicum* are different from those of the species previously examined. At the same time, the study may serve as a significant reference for future studies on *Colchicum*.

Acknowledgements

We sincerely thank Prof. Dr. Adil Güner and other staff at the Nezahat Gökyiğit Botanic Garden (NGBB) for fresh plant material.

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