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COMPARATIVE ANATOMICAL STUDY OF *Viscum album* subsp. *album* L. AND *Viscum album* subsp. *austriacum* (Wiesb.) Vollman

Omer ELKIRAN

Sinop University, Vocational School of Health Services, Environmental Health Programme,
Sinop, Turkey

ORCID: 0000-0003-1933-4003

ABSTRACT

In this study, *Viscum album* subsp. *album* L. and *Viscum album* subsp. *austriacum* (Wiesb.) Vollman (Santalaceae) demonstrated in the genus *Viscum* were investigated for anatomical purposes. The samples were collected from the north of Turkey and it has been compared between the two taxa in terms of anatomical features. The stem and leaf anatomy were examined by light microscopy and illustrated. The vascular bundles, thickened cuticle, anomocytic stomata, glandular hairs, and existence the crystals of calcium oxalate, starch grains of the main microscopic characters of taxa. The findings obtained from the study were discussed with each other and the genus patterns.

Keywords: Santalaceae, *Viscum*, Anatomy, Turkey.

1. INTRODUCTION

The Genus *Viscum* comprises semi-parasitic plants which grow on various host trees and shrubs (Miller, 1982). The genus is represented by only one species (*Viscum album*) and three subspecies belonging to this species in Turkey. These subspecies are *Viscum album* L. ssp. *album*, ssp. *abietis* (Wiesb.) Abromeit and ssp. *austriacum* (Wiesb.) Vollmann and the genus is known with a common name as 'Ökse Otu' and 'The European white-berry mistletoe' in Turkey and in Europe (Amer, 2012; Miller, 1982; Deliorman et al., 2000; Baytop, 1984).

The *Viscum* species use water and water-soluble substances from the xylem, which is one of the transmission bundles of the host, causing the host to weaken and eventually the complete death of the plant (Üstüner et al., 2015; Calder and Bernhardt, 1983; Hawksworth and Wiens, 1996).

Viscum album is the most well-known species and can be found on apples, poplars and willows. The species has linear lanceolate leaves and whitish, translucent fruits (Amer et al., 2012).

In the literature, although several biological activities, morphological studies of this plant have been reported, there is a limited edition study examined its comparative anatomical studies. The aim of the present study at determines anatomical characters of subsp. *album* and subsp. *austriacum* and to compare the species anatomically.

2. MATERIAL AND METHODS

The subsp. *album* (on *Pyrus* sp.) and subsp. *austriacum* (on *Pinus* sp.) were collected from different host species during spring from natural populations in 2020 from the Sinop in Turkey (Table 1). The taxonomic description of the plant was made according to Davis (1982). Anatomical studies were carried out on aerial parts (stem and leaf) of taxa kept in 70% ethanol. The sections were studied and photographed from the preparations were taken with a LEICA (DFC 450C & DM 2500) microscope.

Taxa	Collection areas and collector's number
<i>Viscum album subsp. album L.</i>	Turkey, A4, Sinop: Lala village, 70m, 10.12.2019, ÖE-1145.
<i>Viscum album subsp. austriacum</i>	Turkey, A4, Sinop: Sazlı village, 1050m, 12.12.2019, ÖE-1155.

Table 1. Taxa used for anatomical studies and localities of specimen collection

3. RESULTS AND DISCUSSION

3.1. Stem Anatomy

The open collateral vascular bundles were seen in the stem cross-section of subsp. *album* and subsp. *austriacum*. Vascular bundles and cambium are evident in both types. In both taxa examined, the epidermis consisted of a single row of cells. There is a thick cuticle layer on the epidermis. Among the subsp. *austriacum* epidermis cells, stomata and oxalate crystals were more intense than subsp. *album*. Just below the epidermis are the cells that make up the hypodermis layer. The cells in the parenchyma of the cortex under the hypodermis are tightly lined and there is no space. Cambium is prominent between phloem and xylem. Sclerenchyma scabbard is seen upper and lower the vascular bundles. The row and number of cells in xylem is higher than in phloem. Phloem is composed of 3-7 layers of cells. Xylem is composed of 8-11 layers of cells. subsp. *album* was found to have higher cell counts for phloem and xylem. Cambium is distinguishable and 3-6 layered. There are pith regions between the vascular bundles and these are prominent. In the center of the stem, there is a pith region consisting of parenchymal cells.

There are no significant differences were found in the stem anatomy of the two taxa. Anatomy research on *Viscum* species is limited in the literature (Luther and Becker, 1987; Pharmacopoeia, 1983; Garnier, 1961; Metcalfe and Chalk, 1965; Ergun and Deliorman, 1997). Ergun and Deliorman reported that, found sclereids in the stem between the vascular bundles (Ergun and Deliorman, 1997). But it was not seen in our study.

Figure 1. The cross-sections of stems of subsp. *album*; e:Epidermis, cu: Cuticula, co: Cortex, sc: Sclerenchyma, ph: Phloem, ca: Cambium, xy: Xylem, pr: Pith regions, pi:Pith

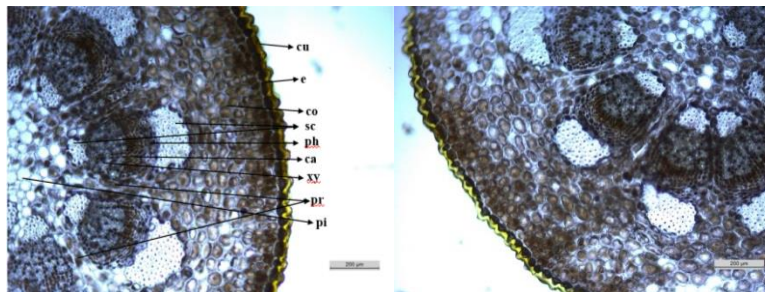
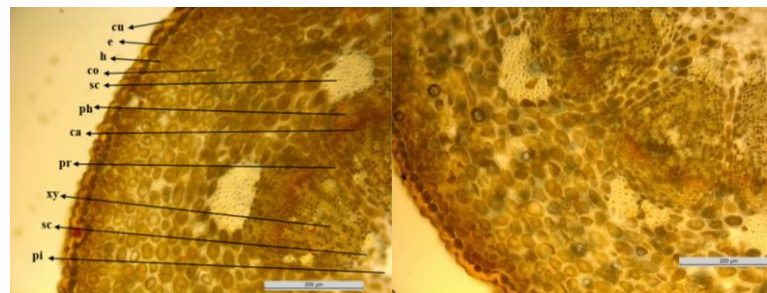


Figure 2. The cross-sections of stems of subsp. *austriacum*; cu: Cuticula, e: Epidermis, co: Cortex, sc: Sclerenchyma, ph: Phloem, ca: Cambium, xy: Xylem, pr: Pith regions, pi:Pith



3.2. Leaf Anatomy

The epidermis is single-layered, with elliptical and rectangular shaped cells in cross section. There is a thick cuticle for both upper and lower epidermis in the cross-sections of leaf in subsp. *album* and subsp. *austriacum*. There are glandular hairs on the upper surface only in subsp. *austriacum*. The glandular hairs are good taxonomic characters that can be exploited to distinguish these two subspecies from the other ones. The stomata are observed in the lower part of the leaf which type of mesomorph type stomata in both types. Palisade parenchyma is composed of 1-2 layers of cells. Spongy parenchyma consisted of 3-4 layers with rare intercellular spaces. There is palisade parenchyma on both the upper and lower surfaces of the leaf, so the leaf type is iso lateral (equifacial). There is a big vascular bundle in cross-section of leaf and it is in the middle. The vascular bundles are surrounded by a parenchyma cells.

In upper and lower surface section in both species, stoma types were found as amaryllis type with anomocytic type stomata. It was observed that the stomata were at the same level as the epidermis cells in the leaf. The calcium oxalate crystals and starch grains were identified in upper and lower surface section of examined plants. They were bigger than epidermis cells. The crystals were identified in leaf anatomy of *Viscum* sp. in literature, like our study (Mbagwu et al., 2009; Ergun and Deliorman, 1997). Subsp. *album* starch grains are denser and more prominent than subsp. *austriacum* starch grains. Although starch grains are not exactly a distinctive character in taxonomy, they can be used as a distinctive character in anatomical studies.

Figure 3. The cross-sections of leaf of subsp. *album*; cu: Cuticula, le: Lower epidermis, sp: Spongy parenchyma, xy: Xylem, ph: Phloem, sc: Sclerenchyma, t: Trichome, c: Crystals, st: Stoma



Figure 4. The upper surface section of the leaf of subsp. *album*; c: Crystals, st: Stoma, e: Epidermal cell, s: Starch grains

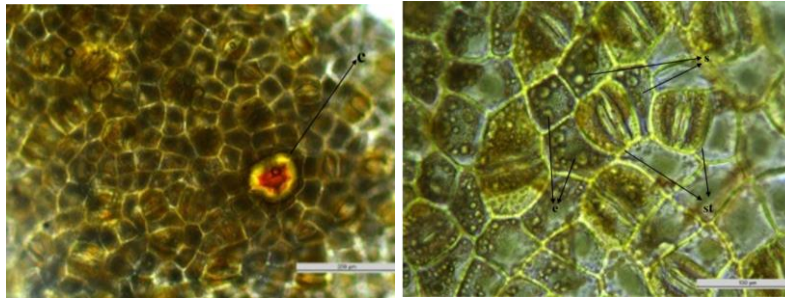


Figure 5. The lower surface section of the leaf of subsp. *album*; c: Crystals, st: Stoma, e: Epidermal cell, s: Starch grains

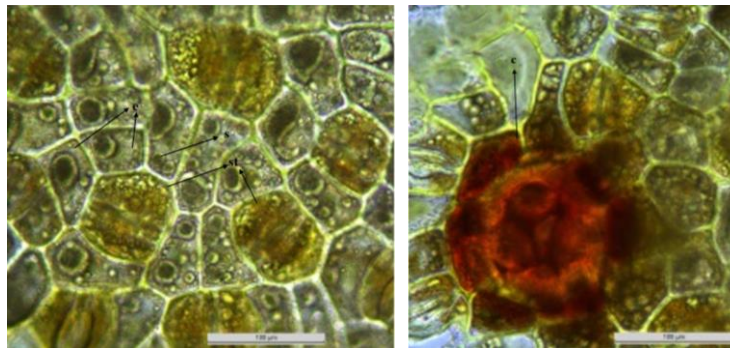


Figure 6. The cross-sections of leaf of subsp. *austriacum*; cu: Cuticula, ue: Upper epidermis, pp: palisade parenchyma, c: Crystals, ph: Phloem, xy: Xylem, le: Lower epidermis, sp: Spongy parenchyma

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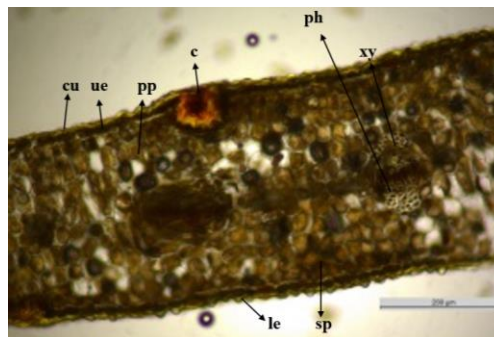


Figure 7. The upper surface section of the leaf of subsp. *austriacum*; c: Crystals, st: Stoma, e: Epidermal cell

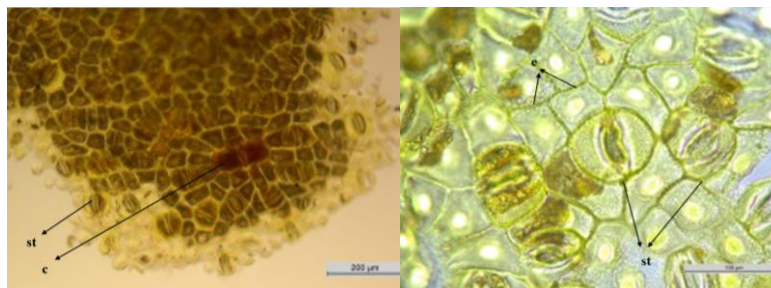
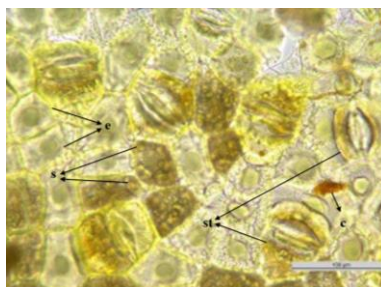


Figure 8. The lower surface section of the leaf of subsp. *austriacum*; c: Crystals, st: Stoma, e: Epidermal cell, s: Starch grains



4. CONCLUSIONS AND RECOMMENDATIONS

In this study, comparative anatomical were investigated taxa of *Viscum* of *album* and *austriacum*. The stem and leaf structure are similar in all examined taxa in terms of epidermis cells, thick cuticle, stoma types, starch grains and oxalate crystals. But, the absence of sclereids differs from other studies. However, the crystals were observed in leaves as in other studies (Pharmacopoeia, 1983; Garnier, 1961; Karsten, et al., 1962; Ergun and Deliorman, 1997). Subsp. *album* starch grains are denser and more prominent than subsp. *austriacum* starch grains. It is thought that the study will be helpful in the taxonomic identification of the *Viscum* genus.

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