AN ANATOMICAL AND ETHNOBOTANICAL STUDY ON
RUTA SPECIES IN TURKEY

E. AKALIN¹, F. ERTUĞ²

SUMMARY

Three species of rue (Ruta) are growing in Turkey: R. montana (L.) L., R. chalepensis L. and R. graveolens L.. While the first two grow naturally and widespread, R. graveolens is cultivated in gardens. All three species are generally called “Sedefotu” in Turkish. The aim of this study is making more correct and easy identifications of these three species of Ruta, by studying their anatomical details, in addition to their well-known morphological characteristics. Anatomical differences, especially leaf differences were carefully studied. The results of our investigation have revealed that in addition to leaves, sections of petioles have distinct characteristics to enable differentiation of these three species. Ethnobotanical literature is also checked for highlighting their different uses in the folk medicine of Turkey, and new uses are added for Ruta chalepensis from an ethnobotanical study in Bodrum.

ÖZET

Türkiye’de üç Ruta türü yetiştirilmektedir; R. montana (L.) L., R. chalepensis L. ve R. graveolens L. Bunlardan R. graveolens bahçe çöllerinde yetiştirilmektedir. Her üç tür de Türkiye’de Sedefotu adıyla tanınmaktadır. Bu çalışmadan Ruta türlerinin ayrımlarda bilinen morfolojik özellikleri yanında farklı anatomik özellikleri de kullanılabileceği düşünülen anatomi yapıları karşılaştırmalı olarak çalışılmıştır. Daha ayrıntılı olarak:

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INTRODUCTION

Many plants can be identified adequately when all organs, such as flowers, fruits, and leaves are present. However most of the drugs used for medicinal purposes are sold in herbalists as dry leaves, barks, roots or rhizomes. To identify these samples through morphological data is very difficult. In this case anatomical data can be used more efficiently for identifications. The aim of this study is making more correct and easy identifications of the three species of Ruta which grow in Turkey: R. chalapensis, R. montana and R.graveolens, by providing their anatomical details, and also highlighting their different uses in folk medicine of Turkey. Quite a number of studies has been made on the phytochemistry and main constituents of Turkish Ruta species. While two Ruta species, R. chalapensis and R. montana grow naturally in Turkey (see Map), more references are available in the ethnomedical literature, related to cultivated R. graveolens. To our opinion this contradiction may originate from false identifications. When the samples are bought from herbalists, they might be incorrectly identified as R. graveolens. Anatomical investigation will be helpful for identifying Ruta species when morphological characteristics are not sufficient.

All three species are generally called “Sedefotu” in Turkey, meaning herb of psoriasis. Turkish Ruta species are not only examined for their morphological and anatomical characteristics, but their ethnomedical uses in the past and in present days are also investigated. New uses of Ruta chalapensis are recorded during an ethnomedical study in Bodrum, and these new uses are compared with uses in the literature.

Rutaceae is a large family comprising about 150 genera and 900 species. They are widely distributed throughout the tropical and temperate regions of the world. The genus of Ruta consists of 60 species, which grows in temperate regions, such as the Mediterranean (1). Ruta species are evergreen, shrubby plants, and easily distinguished with their distinct and powerful odour. Five Ruta species grow in Europe (2), and three in Turkey, and only one of them, R. graveolens is cultivated in gardens (3). All three species contain essential oils (monoterpen, sesquiterpen), alkaloids (quinolin group), coumarins (furanocoumarin, hydroxycoumarin), flavonoids (flavon,flavanol), organic acids, and tannin (Table 1).
Table 1: Components of *Ruta* species

<table>
<thead>
<tr>
<th></th>
<th><em>R. montana</em> (L.) L.</th>
<th><em>R. chalepensis</em> L.</th>
<th><em>R. graveolens</em> L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essential oils</td>
<td>2-undecanone</td>
<td>2-undecanone, 2-nonanone, 2-nonyl acetate</td>
<td>geijere, pregeijere, essential oil %0.1</td>
</tr>
<tr>
<td></td>
<td>essential oil %2.4</td>
<td>essential oil %7</td>
<td></td>
</tr>
<tr>
<td>Alkaloids</td>
<td>arborinine, kokusagin, marmesin, montanin, skimmianine</td>
<td>arborinine, chaloridone, γ-fagarine, graveoline, kokusagin, skimmianine, dictamin, γ-fagarine, kokusagin, ptelein, skimmianine and isogravacidonchlorine (furanocridon alkaloid)</td>
<td></td>
</tr>
<tr>
<td>Coumarins</td>
<td>bergapten, chalepensin, daphnoretin methyl ether, xanthotoxin, psoralene, rutamarin, umbelliferone</td>
<td>bergapten, chalepensin, chalepin, heliethin, isopimpinellin, xanthotoxin, marmesin, psoralen, rutamarin, rutalpinin, bergapten, chalepensin, chalepin, imperatorin, xanthotoxin, psoralen, rutamarin, rutaretin</td>
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</table>

*Table based on the following literature: 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17.

Generally, furoncoumarin type of compounds cause photo-dermatitis when rubbed on the skin, they react to sunlight by producing erythema, hyperpigmentation and blistering. Furoncoumarins reduce photomutagenic properties and bergapten is the most potent furcocoumarin. Psoralens have photoactivity. But it is not clear that the chemicals exactly have phototoxic, photomutagenic or photocarcinogenic effects. Chalepensin has antifertility activity (5, 17).

Map- Distribution of two natural *Ruta* species.
In the antique Herbals of the Mediterranean world, wild (*R. chalepensis* / Aleppo rue) as well as the cultivated rue (*R. graveolens*) was used as an antidote against snake bites and other poisons, and it was also given as an effective remedy by Dioscorides for respiratory complaints (18). Dioscorides also gave a specific warning about harvesting of rue, that it should be gathered about flowering time, and one should anoint oneself, because it causes swelling and redding of the skin (19). The followers of Hippocrates used rue for the control of hysteria, and according to Pliny, painters and sculptors mixed some rue with their food to keep their sight from deterioration (19). For many centuries, *Ruta* was a well-known antiseptic, and used as a preventive of contagion, and among its supposed virtues it was also effective against plague (20, 21). Rue was a common plant in folk genealogy, and thus became associated with the midwives, who were often discredited as witches (21). Even in modern Herbals, remedies such as compresses saturated with a strong decoction of the plant applied to the chest are suggested for chronic bronchitis, and fresh leaves of rue applied to the temples or a leaf or two being chewed are said to relieve headache (22).

**MATERIAL AND METHODS**

The samples of *Ruta chalepensis* are collected from Muğla-Bodrum-Ortakent, *R. montana* from İstanbul-Altinşehir, and *R. graveolens* from Tekirdağ-Malkara districts of Turkey. Leaves, petioles and pedicelles used in the anatomical studies were kept in 70% ethanol. Cross sections from preserved material obtained by hand were strained using sartur (lactic acid, sudan III, aniline, iodine, potassium iodide, alcohol, water) and chloral hydrate solutions. Drawings are compiled by using Wetzlar Microscope and Camera Lucida drawing tube. Photographs were taken by a photomicroscope (Olympus BH-2), and the map was composed by using the locality information of specimens from ANK, GAZI, ISTE, and ISTF Herbariums, as well as the data from the *Flora of Turkey and East Aegean Islands* (3). Ethnobotanical data are partly provided during an ethnobotanical study in Bodrum, and three informants provided information on *R. chalepensis*. For comparisons ethnobotanical literature are checked.

**RESULTS AND DISCUSSION**

**Medicinal Uses of Rue in Anatolia**

Various sources mention *Ruta graveolens*’s internal use (as tea, oil or tablet) as sudorific, appetizing, carminative, and for delayed menstruation; and externally as relaxant, to cure rheumatic pains and stomach aches (23, 24). In Malkara- Tekirdağ, garlic and black cumin seeds (*Nigella* sp.) are pounded, mixed with the fresh leaves of
R. graveolens, and roasted in olive oil. Some bee-wax is added and this ointment is applied to armpits and groins of babies for relaxing them. Leaves are pounded with Nigella seeds and nutmeg (Myristica fragrans Houtten) and some powdered sugar. This powder is externally applied against the heat rashes of babies. The same mixture is also given to babies in small quantities as carminative. Smashed rue leaves are eaten in small quantities to cure stomach ache (23). In Bergama, rue known as “kokarsedef”, smelly rue, or “çiftotu”, and its oil is externally used (leafy stems soaked in olive oil) to cure boils, flatulence of babies, and stomach ache. The leaves are used as infusion for stomach ache and severe pains, and their seeds are eaten against the palpitation of the hearth (25). Tabata et al. (26) reported that in Izmir and Manisa regions, Ruta leaves boiled in olive oil are exposed to sun for 2-3 day, and the oil is applied to the anus of the child as anthelmintic. Baytop added its use for aborting unwanted babies, and warned that its use can be mortal for women (24), however this use could not be found in any regional surveys in Turkey, and how it was used for abortion and whereabouts is not known. In many of these references it is not clear if the local people were using wild or cultivated rue, however, when we take into account the distribution, and availability of natural Ruta chalepensis (see Map), especially in western Anatolia, we have good reasons to re-evaluate these identifications.

In a survey, compiled in 1983-84, among the 96 herbalists in 40 provinces in Turkey, rue samples (identified as R. graveolens) were found in herb shops in the cities of Antalya, Aydın, Balıkesir, Bursa and Gaziantep (27). According to the information given by the herbalist in Gaziantep, rue is prescribed as a laxative: one glassful of an infusion, prepared of 5 g of rue flowers in one liter water sweetened with sugar, is taken after meals (27). Four other herbalists were told that rue is used for psoriasis (27), but no receipt was given. This information is probably false, due to that the name “sedef” meaning, both ‘mother and pearl’ and ‘psoriasis’ in Turkish. Başer also pointed out in his introduction that some of the herbalists lacked basic information on drugs (27). No other sources mentioned that rue is used for psoriasis. According to a decree issued by the Ministry of Health and Social Assistance in 1985, herbalists are prohibited from selling some poisonous drugs, and Ruta is in this list. Recently in a survey in the herbal shops in the Egyptian Bazaar (Mısır Çarşısı) in Istanbul, we could not find any herbalist who provided rue, or knew what it is good for.

No detailed record was found about how and where in Anatolia, R. chalepensis and R. montana are used. Baytop (24) mentions that these two are used in similar ways to R. graveolens. However, in an ethnobotanical study in the Bodrum peninsula, abundant distribution of R. chalepensis is observed and two different uses are recorded. In the case of severe coughs and in croup, the leaves of R. chalepensis roasted in olive oil, with some flour added are spread on a cloth while still warm and applied on the chest. Another application is preparing a mush with ‘tarhana’(a dried foodstuff made chiefly of curds and flour) for broken bones or injured muscles. For this mush dry or
fresh leaves (a few handful) are minced, mixed with a spoonful of tarhana, some vinegar and salt, and cooked. Then the mush is placed on the injured area while still warm. It was said that a local bone setter used this mush after she set the bones to stop pain. A bunch of leafy stems of rue was seen hanging in several houses, in the village of Gündoğan in Bodrum peninsula, for using when necessary. Several informants in Bodrum call this plant "Cennet Bekçisi", meaning the guard of heaven, and believe that "rue must be a fundamental component for many medicines".

**Morphological Characteristics of Turkish *Ruta* Species**

*Ruta* species are perennial herbs or suffrutescent plants with erect branched stems, which are often woody at the base, furnished with dark punctuate glands. Leaves are alternate, smooth, and grayish-green. Glad-dotted leaves are two or three times pinnately divided with spathulate or oblong segments. The yellowish green glandular flowers are arranged in terminal cymes. Sepals and petals are four or five, usually in the central flowers. Petals are yellow, cucullated and have dentate or ciliate, rarely entire or undulated margins. Stamens are twice as many as the petals, and the filaments are glabrous, narrow, as well as attenuate. The fruit is a capsule with four- or five-lobed, dehiscent, multiovulate loculi. Seeds are black and crescent-shaped (2, 3). Differences among the three species are summarized in Table 2.

**Table 2:** Morphological differences of Turkish *Ruta* species

<table>
<thead>
<tr>
<th></th>
<th><em>R. montana</em> (L.) L.</th>
<th><em>R. chalepensis</em> L.</th>
<th><em>R. graveolens</em> L.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leaves</strong></td>
<td>Bipinnatisect or tripinnatisect</td>
<td>Bipinnatisect or nearly</td>
<td>Bipinnatisect or nearly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tripinnatisect</td>
<td></td>
</tr>
<tr>
<td><strong>Lobes of leaf</strong></td>
<td>Linear, 1 mm or less</td>
<td>narrow oblong,</td>
<td>narrow oblong,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lanceolate or obovate</td>
<td>lanceolate or obovate</td>
</tr>
<tr>
<td><strong>Inflorescent</strong></td>
<td>Densely, Upper branched</td>
<td>narrow oblong,</td>
<td>narrow oblong,</td>
</tr>
<tr>
<td></td>
<td>subracemose have minutely and densely</td>
<td>lanceolate or obovate</td>
<td>lanceolate or obovate</td>
</tr>
<tr>
<td></td>
<td>glandular stipitate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bracts</strong></td>
<td>Narrow lanceolate</td>
<td>ovate-cordate</td>
<td>Lanceolate</td>
</tr>
<tr>
<td><strong>Sepals</strong></td>
<td>Lanceolate, acuminate,</td>
<td>Deltoid-ovate,</td>
<td>Lanceolate, acute,</td>
</tr>
<tr>
<td></td>
<td>entire margins</td>
<td>subacutie, entire</td>
<td>denticulate margins</td>
</tr>
<tr>
<td></td>
<td></td>
<td>margins</td>
<td></td>
</tr>
<tr>
<td><strong>Petals</strong></td>
<td>entire, undulate</td>
<td>Long ciliate</td>
<td>Long ciliate</td>
</tr>
<tr>
<td><strong>Pedicles</strong></td>
<td>Shorter than capsule</td>
<td>Equaling or exceeding the</td>
<td>Equaling or exceeding the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>capsule</td>
<td>capsule</td>
</tr>
<tr>
<td><strong>Capsules</strong></td>
<td>Glands acuminate pointed</td>
<td>Glands acuminate pointed</td>
<td>Glands bluntly pointed</td>
</tr>
</tbody>
</table>
Anatomy of *Ruta* Species

While studying anatomy of *Ruta* species, the lamina of leaves, petioles and pedicels are compared by their cross-sections (27).

**Leaves**

Leaves are bifacial or inconspicuous monofacial (Fig. 1- A) and amphistomatic but confined to lower side in most species. Stomata is provided with 4-6 epidermal cells and is anomocytic type (Fig. 1- B, C)

In the cross section of the midrib are seen flat on the upper side and slightly convex on the lower side.

**The epidermis:** The epidermis is composed regular size cells on the upper and the lower surface.

**The mesophyll:** The palisade paranchymatous cells are observed two layer in the upper side. The vascular bundle is collateral type. There are sclerenchyma on the upper and lower parts of the bundle. one or two layer angular collenchyma are found on the lower parts of bundle.

**Hairs:** No hair is observed.

**Secretory cavities:** They have 3-4 lysigenous secretory cavities on the paranchyma which appear to the naked eye as transparent dots.

**Crystal:** Druses are found in all tissue.

Although stomata numbers are difference on the upper surface in *R. chalepensis*, investigated tree species anatomical characters are similar.

The numbers of stomata in the three species:

**R. montana:** upper surface, 90 mm$^2$– lower surface, 110 mm$^2$

Stomata are dense on both surfaces.

**R. chalepensis:** upper surface, 10 mm$^2$– lower surface, 100 mm$^2$

Stomata are sparse on upper surface and dense on bottom surface.

**R. graveolens:** upper surface, 10 mm$^2$– lower surface, 190 mm$^2$

Stomata are sparse on upper surface and very dense on bottom surface.
Fig. 1: *Ruta graveolens* leaf; A- Cross sections of the midrib (x 45), B- surface view of the upper epidermis (x 450), C- surface view of the lower epidermis (x 450), col: collenchyma, d: druse, e: epidermis, lsc: lysigenous secretory cavities, ph: phloem, pp: palisade parenchyma, sc: sclerenchyma, sp: spongy parenchyma, st: stomata, x: xylem.

**Petioles**

In transverse sections, all species have the following tissues, working from outside inwards; the *epidermis*, the *hypodermis* (collenchymatous cells), the *cortex* (parenchymatous cells with angular collenchyma around lysigenous secretory cavities, in this tissue, starch are found in *R. montana* and *R. chalepensis*) (Fig.2-A, B), the *vascular tissue* and the *pith*. Vascular tissue is seperated nearly a closed such an
cylinder of phloem and xylem at the distal end expect *R. graveolens* with an arc of separate bundles (Fig.2- D).

**Hairs:** No hair is observed.

**Secretory cavities:** They have 2-4 lysigenous secretory cavities under the epidermis.

**Crystal:** Druses in parenchymatous tissue.

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**Fig. 2:** The cross sections of petioles (x 112.5); A- *R. montana*, B- *R. chalepensis*, C- *R. graveolens*. D- The cross sections of pedicel of *R. montana*. c: cortex, cu: cuticle, d: druse, e: epidermis, gh: glandular hairs, h: hypodermis, lsc: lysigenous secretory cavities, ph: phloem, pa: parenchyma, sc: sclerenchyma, st: starch layer, x: xylem.
Pedicels

Pedicel anatomy are shown stem anatomic characteristics too. In all species are similar expect hairs in R. montana.

The epidermis (thickness in both sides), the hypodermis (one layer) and the cortex (3-4 layers, irregular parenchymatous cells, 7-8 layers, irregular, angular collenchyma and in young pedicels an starch sheaths are observed). The Vascular tissue lack, such a cylinder with the phloem external to the xylem and have a 5-6 layer sclerenchyma. The pith is composed, of loose, isodiametric cells with big hollows.

Hairs: Simple glandular hairs are observed only in R. montana, they are densely present (Fig.2-D).

Secretary cavities: They have 2-4 lysigenous secretory cavities under the epidermis.

Crystal: Druses in parenchymatous tissue.

Morphologically;

R. montana differs from R. chalepensis and R. graveolens having narrower leaf lobes, densely glandular hairs in inflorescens and entire petal margin.

R. chalepensis differs from R. montana and R. graveolens, having wider bracts and sepal.

R. graveolens distinguishes from R. montana and R. chalepensis, having bluntly pointed glands on the capsules.

Although investigated three species by anatomical features that are closely related, they are assigned by these characteristics;

R. montana differs from the others by having glandular hairs in pedicels and nearly equal stomata numbers in both surface of leaves. Vascular tissue is an arc shape in R. graveolens in petiol and stomata are denser than the other two species in lower surface of leaves.

During this study it became obvious that the lack of ethnobotanical information related to Ruta chalepensis and R. montana in Anatolia, is probably associated with misidentification of many samples as being R. graveolens. The records of the common medicinal uses of R. chalepensis in Bodrum area, indicate that such uses might be available in other areas, where these species are abundant in nature.

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REFERENCES


