

AN ANATOMICAL AND ETHNOBOTANICAL STUDY ON *RUTA* SPECIES IN TURKEY

E. AKALIN¹, F. ERTUĞ²

S U M M A R Y

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.

Ö Z E T

Türkiye'de üç *Ruta* türü yetişmektedir; *R. montana* (L.) L., *R. chalepensis* L. ve *R. graveolens* L. Bunlardan *R. graveolens* bahçelerde yetiştirilmektedir. Her üç tür de Türkiye'de Sedefotu adıyla tanınmaktadır. Bu çalışmada *Ruta* türlerinin ayırımında bilinen morfolojik özellikleri yanında farklı anatomik özelliklerinin de kullanılabilceği düşünülerek anatomik yapıları karşılaştırılmalı olarak çalışılmıştır. Daha ayrıntılı olarak

¹ University of Istanbul, Faculty of Pharmacy, Department of Pharmaceutical Botany, 34452, Beyazit, Istanbul- Turkey adaemine@hotmail.com

² Rıdvan Paşa Sokak, Refik Bey Apt. 13/14, 81080, Göztepe, İstanbul- Turkey fertug@attglobal.net

yaprak anatomik özellikleri incelenmiştir. Yaprak sapının anatomik özelliklerinin de türlerin ayırt edilmesinde önemli karakterler taşıdığı gözlenmiştir. Antik kaynaklarda ve günümüzde Türkiye'deki tıbbi kullanımına ilişkin literatür de taranarak bu üç türün kullanımında farklılık bulunup bulunmadığı araştırılmış ve *R. chalepensis*'in Bodrum yöresinde yapılan etnobotanik araştırmada saptanan ve yayınlarda yer almayan iki yeni kullanımı verilmiştir.

Key words: *Ruta chalepensis*, *R. montana*, *R. graveolens*, anatomy, ethnobotany, Turkey

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 ethnobotanical 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 ethnobotanical uses in the past and in present days are also investigated. New uses of *Ruta chalepensis* are recorded during an ethnobotanical study in Bodrum, and these new uses are compared with uses in the literature.

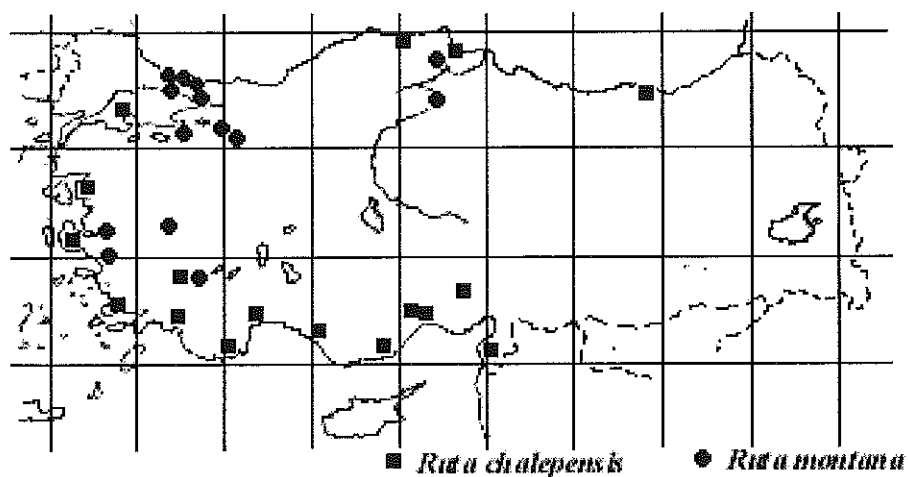
Rutaceae is a large family comprising about 150 genera and 900 species. They are widely distributed throughout the tropical and temperate regions of the world. The genus of *Ruta* consists of 60 species, which grows in temperate regions, such as the Mediterranean (1). *Ruta* species are evergreen, shrubby 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, flavonol), organic acids, and tannin (Table 1).

Table 1: Components of *Ruta* species

	<i>R. montana</i> (L.)L.	<i>R. chalepensis</i> L.	<i>R. graveolens</i> L.
Essential oils	2-undecanone essential oil %2.4	2-undecanone, 2-nonanone, 2-nonyl acetate essential oil %7	geijerene, pregeijerene essential oil %0.1
Alkaloids	arborinine, kokusaginin, marmesin, montanin, skimmianine	arborinine, chalaridone, γ - fagarine, graveoline, kokusaginine, skimmianine,	dictamnine, γ -fagarine, kokusaginine, ptelein, skimmianine and isogravacridonchlorine (furanoacridon alkaloid)
Coumarins	bergapten, chalepin, daphnoretin methyl ether, xanthotoxin, psoralene, rutamarin, umbelliferone	bergapten, chalepensis, chalepin, heliethin, isopimpinellin, xanthatoxin, marmesin, psoralen, rutamarin, ritalpinin,	bergapten, chalepensis, chalepin, imperatorin, xanthotoxin, psoralen, rutamarin, rutaretin

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

Generally, furocoumarin type of compounds cause photo-dermatitis when rubbed on the skin, they react to sunlight by producing erythema, hyperpigmentation and blistering. Furocoumarins reduce photomutagenic properties and bergapten is the most potent furocoumarin. Psoralens have photoactivity. But it is not clear that the chemicals exactly have phototoxic, photomutagenic or photocarcinogenic effects. Chalepensis 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).

M A T E R I A L A N D M E T H O D S

The samples of *Ruta chalepensis* are collected from Muğla-Bodrum-Ortakent, *R. montana* from İstanbul-Altınşehir, and *R. graveolens* from Tekirdağ-Malkara districts of Turkey. Leaves, petioles and pedicels 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.

R E S U L T S A N D D I S C U S S I O N

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 "çifitotu", 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 spatulate 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

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

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 mm²– lower surface, 110 mm²

Stomata are dense on both surfaces.

***R. chalepensis*:** upper surface, 10 mm²– lower surface, 100 mm²

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

***R. graveolens*:** upper surface, 10 mm²– lower surface, 190 mm²

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

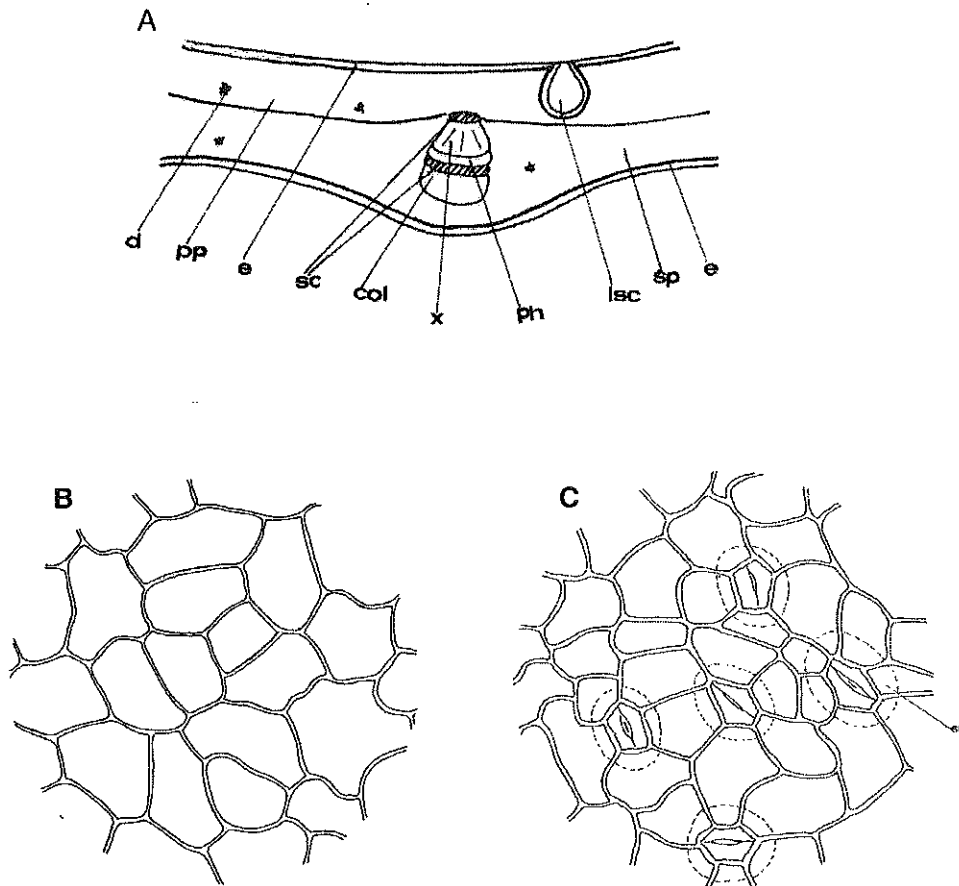


Fig. 1: *Ruta graveolens* leaf; A- Cross sections of the midrib (x 45), B- surface view of the upper epidermis (x 450), C- surface view of the lower epidermis (x 450), col: collenchyma, d: druse, e: epidermis, lsc: lysigenous secretory cavities, ph: phloem, pp: palisade parenchyma, sc: sclerenchyma, 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 separated nearly a closed such an

cylinder of phloem and xylem at the distal end except *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.

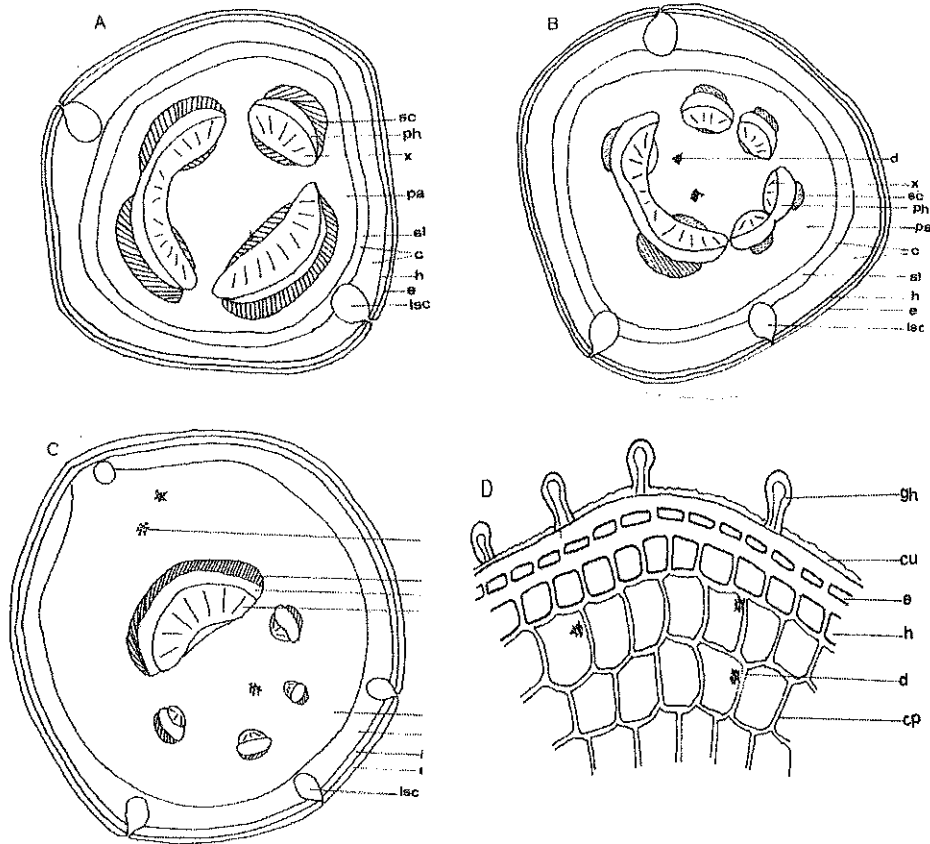


Fig. 2: The cross sections of petioles ($\times 112.5$); A- *R. montana*, B- *R. chalepensis*, C- *R. graveolens*, D- The cross sections of pedicel of *R. montana*. c: cortex, cu: cuticle, d: druse, e: epidermis, gh: glandular hairs, h: hypodermis, lsc: lysigenous secretory cavities, ph: phloem, pa: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

Secretory 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 sepals.

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.

Acknowledgement: we are grateful to Birgitte Jensen, Neriman Özhatay, Tuna Ekim for their comments and corrections on the manuscript.

R E F E R E N C E S

1. Willis, J.C., 1966 *A Dictionary of the Flowering Plants and Ferns*, Cambridge.
2. Townsend, C. C., 1968 *Ruta, Flora Europaea* (ed. T.G.Tutin), Vol. 2: 227 Cambridge.
3. Townsend, C. C., 1967 *Ruta, Flora of Turkey and The East Aegean Islands* (ed. P.H.Davis), Vol. 2: 495-496 Edinburg.
4. Bařer, K.H.C., Özek, T., and Beis, S.H., 1996 Constituents of the Essential Oil of *Ruta chalepensis* L. from Turkey, *J. Essent. Oil Res.*, 8: 413-414.
5. Büyükbingöl, E., Jabbar, A., Lewis, J.R., Noyanalpan, N., Şener, B., 1987 Phytochemistry of Turkish *Ruta* Species, *Ruta montana* and *Ruta chalepensis*, VI. *Bitkisel İlaç Hammaddeleri Toplantısı Bildiri Kitabı (16-19 Mayıs 1986, Ankara)* (ed. B.Şener), s. 221-225 Ankara.
6. Şener, B., Mutlugil, A., 1985 HPLC separation and structural elucation of furocoumarins from *Ruta* species, *J.Fac. Pharm. Gazi* 2: 109-114 .
7. Tanker, M., Baytop, T., 1967 *Ruta chalepensis* L. Türünde Bulunan Rutin Hakkında, *İstanbul Ecz. Fak. Mec.*, 3: 204-209.
8. Tanker, N., Şener, B., 1980 Türkiye *Ruta* Uçucu Yağlarının Metil-n-nonilketon Açısından Değerlendirilmesi, *Ankara Ecz. Fak. Mec.*, 10: 61-68.
9. Touati, D., Atta-ur-Rahman, Ulubelen, A., 2000 Alkaloids from *Ruta montana*, *Phytochemistry*, 53: 277-279.
10. Ulubelen, A., 1990 A new alkaloid, montanine, from *Ruta montana*, *Journal of Natural Products-Lloydia*, 53: 207-208.
11. Ulubelen, A., Doğanca, S., 1991 A new quinoline alkaloid from *Ruta montana*, *Fitoterapia*, 62: 279.
12. Ulubelen, A., Tan, N., 1990 A moskachan from the roots of *Ruta chalepensis*, *Phytochemistry*, 29: 3991.
13. Ulubelen, A., Terem, B., 1988 Alkaloids and coumarins from roots of *Ruta chalepensis*, *Phytochemistry*, 27(2):650-651.
14. Ulubelen, A. Terem, B., Tuzlacı, E., Cheng, K.F., Kong, Y.C., 1986 Alkaloids and coumarins from of *Ruta chalepensis*, *Phytochemistry*, 25: 2693-2695.
15. Ulubelen, A., Güner, H., Çetindağ, M., 1988 Alkaloids and coumarins from roots of *Ruta chalepensis* var. *latifolia*, *Planta Medica*, (6):551-552.
16. Ulubelen, A., Ertuğrul, L., Birman, H., Yiğit, R., Erseven, G., Olgaç, V., 1994 Antifertility effects of some coumarins isolated from *Ruta chalepensis* and *R.chalepensis* var. *latifolia* in rodents, *Phytotherapy Research*, 8: 233-236.

17. Wichtl, M., 1994 *Herbal Drugs and Phytopharmaceuticals* (ed. N. G. Bisset) Stuttgart.
18. Baumann, H., 1996 *Greek Wild Flowers and plant lore in ancient Greece*, Herbert Press, London.
19. Riddle, J.M. 1985 *Dioscorides on Pharmacy and Medicine*, University of Texas press, Austin.
20. Moldenke, H.N. ve A.L. Moldenke, 1986 *Plants of the Bible*, Dover Publications, New York.
21. Ratsch, C., 1992 *The Dictionary of Sacred and Magical Plants*, Unity Press, Dorset.
22. Grieve, M., 1996 *A Modern Herbal*, Barnes and Noble Books, Kent.
23. Akalın, E. 1993 Tekirdağ İlinde İlaç ve Gıda Olarak Kullanılan Yabani Bitkiler, İ.Ü. Farmasötik Botanik Bilim Dalı, Unpublished License thesis, İstanbul.
24. Baytop, T., 1999 *Türkiye'de Bitkiler ile Tedavi: Geçmişte ve Bugün*. Nobel Tıp Kitapevleri, İstanbul.
25. Bayatlı, O., 1968 *Bergama'da Şifalı Otlar*, Kültür Matbaası, İzmir.
26. Tabata, M., G. Honda ve E. Sezik 1988 *A Report on Traditional Medicine and Medicinal Plants*, Kyoto University, Kyoto.
27. Başer, K.H.C., G. Honda and W. Miki, 1986 *Herb Drugs and Herbalists in Turkey*, Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo.
28. Yentür, S., 1984 *Bitki Anatomisi*, İstanbul.