Medicinal and Aromatic Plant Science and Biotechnology ©2011 Global Science Books

Hypericum Species in the Flora of Turkey

Umit Bingol[1] • Belgin Cosge[2] • Bilal Gurbuz[3*]

[1] Ankara University, Faculty of Applied Science, Biology Department, Ankara, Turkey
[2] Abant Izzet Baysal University, Mudurnu S.A. Vocational School of Higher Education, Mudurnu, Bolu, Turkey
[3] Ankara University, Faculty of Agriculture, Field Crops Department, 06110 Diskapi Ankara, Turkey

Corresponding author: * **gurbuz@agri.ankara.edu.tr**

ABSTRACT

Plants of the genus *Hypericum* (Hypericaceae), comprising over 400 species, have been used for a long time as traditional medicinal plants in various parts of the world. This genus is represented in the Flora of Turkey by 82 species or 98 taxa of which 45 taxa are endemic; the endemism ratio is 45.92%. In Turkey, *H. perforatum* and *H. scabrum* are the most domestically traded and exported species.

Keywords: endemism ratio, floristic characters, *Hypericum* spp., threat category

CONTENTS

INTRODUCTION

The genus *Hypericum* (Hypericaceae), comprising over 400 species, is found mainly in temperate regions all over the world where they have traditionally been used as medicinal plants (Yazaki and Okada 1994). They are used as sedatives, antiseptics and antispasmodics in Turkish folk medicine under several names (kantaron, kılıçotu, kanotu, yaraotu, kuzukıran, koyunkıran and binbirdelik out) (Baytop 1994). There is a growing interest in constituents of this genus because many species have been shown to possess various biological activities. They are a source of naphthodianthrones, flavonoides, xanthenes, tannins and essential oils (Pavlovic *et al.* 2006). Among this genus, *H. perforatum* L. is one of the best known and most frequently used herbs in recent years. The main components of essential oil of *H. perforatum* are 2-methyl octane (45%) and α-pinene (5-67%) (Radusiene *et al.* 2005). It is a potent anti-viral and has the potential for treating human immune deficiency virus (HIV), viral hepatitis, and chronic fatigue syndrome (Bown 2002). The aim of this study was to evaluate *Hypericum* species in the Flora of Turkey and their economical importance.

THE FLORISTIC CHARACTERS OF *HYPERICUM L.*

The floristic characters of *Hypericum* genus from The Flora of Turkey (Vol 2) are "shrubs or herbs are usually with translucent glands containing essential oils and sometimes red or black glands containing hypericin. Leaves simple, opposite or rarely whorled. Flowers bisexual. Sepals 5. Petals 5, usually yellow, often tinged red or with red veins, rarely with nectary appendages. Stamens in 5 fascicles, antipetalous, free or 4 of them united in pairs to form 2 antisepalous compound fascicles, with 3-c. 125 stamens in each, rarely alternating with sterile fascicles ('fasciclodes'). Ovary superior with axile or parietal placentation, 3-5-locular or partly or completely 1-locular with 2-many ovules on each placenta. Styles 3-5, free, slender. Fruit capsular, dehiscing septicidally, usually with resin-containing vittae or vesicles in the wall, or rarely fleshy and indehiscent. The distribution and configuration of glands is important in classification. In the following account, glands are described as *marginal* where they interrupt the contour of the organ, *intramarginal* where they occur near the margin without interrupting the contour and *superficial* where they occur away from the margin. Narrow glands in the ovary and capsule walls are termed *vittae*, and short swollen glands are described as *vesicles*" (Davis 1967).

HYPERICUM SPECIES IN THE FLORA OF TURKEY

Hypericum species grow naturally in Turkey between 750 and 3200 masl (Cakir *et al.* 1997). The genus *Hypericum* is represented in the Flora of Turkey by 82 species or 98 taxa of which 45 taxa are endemic; the endemism ratio is 45.92% (**Table 1**). In Turkey, all species and subspecies growing naturally are perennial (Davis *et al*. 1988; Güner *et al*. 2000).

According to IUCN threat categories, in Turkey two species are in CR (critically endangered) category (*H. fissurale* Woron and *H. malatyanum* Peşmen), 10 species are in the EN (endangered) category (*H. huber-morathii* Robson, *H. imbricatum* Poulter, *H. kazdagensis* Gemici & Leblebici, *H. marginatum* Woron, *H. minutum* Davis & Poulter, *H. monadenum* Robson *apud* Poulter, *H. peshmenii* Yıldırımlı, *H. pumilio* Bornm., *H. rupestre* Jaub. & Spach, and *H. sorgerae* Robson) and 16 species are in the VU (vulnerable) category (*H. avicularifolium* Jaub. & Spach subsp. *avicularifolium* var. *albiflorum* Hub.-Mor., *H. capitatum* Choisy

Received: 12 September, 2009. Accepted: 21 April, 2010.

Invited Mini-Review

Table 1 List of *Hypercium* species distribution of Turkish flora.

***Hypericum* species**	**Plant form**	**Phytogeographical region**	**Endemic**	**Rare**	**IUCN category**
H. adenotrichum Spach	H		+		
H. amblysepalum Hochst.	H				
H. androsaemum L. (**Fig. 1A**)	Sh	ES			
H. apricum Kar. & Kir.	H	IT			
H. armenum Jaub. & Spach	H	IT			
H. atomarium Boiss.	H	EM			
H. aucheri Jaub. & Spach	H				
H. aviculariifolium Jaub. & Spach subsp. *avicullariifolium* var. *albiflorum* Hub.-Mor.	H	EM	+		VU
H. avicullariifolium Jaub. & Spach subsp. *avicullariifolium* var. *avicullariifolium*	H	EM	+		LR (lc)
H. avicullariifolium Jaub. & Spach subsp. *byzantinum* (Azn.) Robson	H		+		LR (cd)
H. avicullariifolium Jaub. & Spach subsp. *depilatum* (Freyn & Bornm.) Robson var. *bourgaei* (Boiss.) Robson	H		+		LR (lc)
H. avicullariifolium Jaub. & Spach subsp. *depilatum* (Freyn & Bornm.) Robson var. *depilatum*	H	IT	+		LR (lc)
H. avicullariifolium Jaub. & Spach subsp. *depilatum* (Freyn & Bornm.) Robson var. *leprosum* (Boiss.) Robson	H	EM	+		LR (lc)
H. avicullariifolium Jaub. & Spach subsp. *uniflorum* (Boiss. & Heldr.) Robson	H		+		LR (cd)
H. bithynicum Boiss.	H	EUX			
H. bupleuroides Gris.	H	EUX			
H. calycinum L. (**Fig. 1B**)	Sh	EUX			
H. capitatum Choisy var. *capitatum*	H	IT	+		VU
H. capitatum Choisy var. *luteum* Robson	H	IT			VU
H. cardiophyllum Boiss.	Sh			+	VU
H. cerastoides (Spach) Robson	H				
H. confertum Choisy subsp. *confertum*	H		+		LR (lc)
H. confertum Choisy subsp. *stenobotrys* (Boiss.) Holmboe	H				
H. crenulatum Boiss.	H		+		LR (cd)
H. cuisinii Barbey	H	EM			
H. davisii Robson	H	IT			
H. elegans Steph. ex Willd.	H	ES			
H. elongatum Ledeb. subsp. *apiculatum* Robson	H	IT			
H. elongatum Ledeb. subsp. *elongatum*	H	IT			
H. elongatum Ledeb. subsp. *microcalycinum* (Boiss. & Heldr.) Robson	H	IT			
H. empetrifolium Willd.	Sh	EM			
H. fissurale Woron	H		+		CR
H. formosissimum Takht.	H	IT		+	VU
H. havvae Guner	H	EM	+		
H. helianthemoides (Spach) Boiss.	H	IT			
H. heterophyllum Vent.	Sh	A	+		LR (lc)
H. hircinum L. subsp. *albimontanum* (Greuter) Robson	Sh	EM			
H. hircinum L. subsp. *majus* (Aiton) Robson	Sh	M			
H. hirsutum L.	H	ES			
H. huber-morathii Robson	H	EM	+		EN
H. imbricatum Poulter	H		+		EN
H. kazdagensis Gemici & Leblebici	H	EM-MT	+		EN
H. kotschyanum Boiss.	H		+		LR (nt)
H. lanuginosum Lam. var. *lanuginosum*	H	EM			
H. lanuginosum Lam. var. *pestalozzae* (Boiss.) Robson	H	EM	+		VU
H. lanuginosum Lam. var. *scabrellum* (Boiss.) Robson	H	EM	+		LR (lc)
H. linarioides Bosse (**Fig. 1C**)	H				
H. lydium Boiss.	H	IT			
H. lysimachioides Boiss. & Noë var. *lysimachioides*	H	IT			
H. lysimachioides Boiss. & Noë var. *spathulatum* Robson	H	IT			
H. malatyanum Peşmen	H	IT	+		CR
H. marginatum Woron	H		+		EN
H. minutum Davis & Poulter	H	EM	+		EN
H. monadenum Robson apud Poulter	H	EM	+		EN
H. montanum L.	H	ES			
H. montbretii Spach	H				
H. neurocalycinum Boiss. & Heldr.	H	IT	+		VU
H. nummularioides Trautv.	H	EUX-MT		+	VU
H. olivieri (Spach) Boiss.	H	IT			
H. olympicum L. subsp. *olympicum*	H	EM			
H. olympicum L. subsp. *macrocalyx* (Freyn) Robson	H	EM-MT	+		
H. orientale L.	H				
H. origanifolium Willd.	H				
H. pallens Banks & Sol	Sh	EM			
H. pamphylicum Robson & Davis	Sh	EM	+		VU
H. perfoliatum L.	H	M			
H. perforatum L.	H				
H. peshmenii Yıldırımlı	H	IT	+		EN

Table 1 (Cont.)

***Hypericum* species**	**Plant form**	**Phytogeographical region**	**Endemic**	**Rare**	**IUCN category**
H. polyphyllum Boiss. & Bal. subsp. *lycium* Robson & Hub.-Mor.	H	EM	+		LR (cd)
H. polyphyllum Boiss. & Bal. subsp. *polyphyllum*	H	EM	+		LR (nt)
H. polyphyllum Boiss. & Bal. subsp. *subcordatum* Robson & Hub.-Mor.	H	EM	+		VU
H. pruinatum Boiss. & Bal.	H	EUX-MT			
H. pseudolaeve Robson	H	IT	+		LR (lc)
H. pumilio Bornm.	H	IT	+		EN
H. retusum Aucher	H	IT			
H. rumeliacum Boiss. subsp. *rumeliacum*	H	EM		+	VU
H. rupestre Jaub. & Spach	Sh	EM	+		EN
H. russeggeri (Fenzl) R. Keller	Sh	EM		+	DD
H. salsolifolium Hand.-Mazz	H	IT	+		DD
H. salsugineum Robson & Hub.-Mor.	H		+		VU
H. saxifragum Robson & Hub.-Mor.	H	EM-MT	+		LR (cd)
*H. saxifragum R*obson & Hub.-Mor. subsp. *eglandulosum* Parolly & Eren	H				
H. scabroides Robson & Poulter	H	IT	+		VU
H. scabrum L.	H	IT			
H. sorgerae Robson	H	IT	+		EN
H. spectabile Jaub. & Spach	H	IT	+		LR (nt)
H. ternatum Poulter	Sh	EM	+		VU
H. tetrapterum Fries	H				
H. thasium Griseb.	H			+	DD
H. thymbrifolium Boiss. & Noë	H	IT	+		LR (cd)
H. thymifolium Banks & Sol.	H	EM			
H. thymopsis Boiss.	H	IT	+		LR (nt)
H. triquetrifolium Turra	H				
H. uniglandulosum Hausskn. ex Bornm	H	IT	+		LR (nt)
H. vacciniifolium Hayek & Siehe	Sh	EM	+		VU
H. venustum Fenzl	H				
H. vesiculosum Griseb	H	EM		+	VU
H. xylosteifolium (Spach) Robson	Sh	EUX			

A: Anatolian Element, **CR**: critically endangered, **DD**: data deficient, **EM**: East Mediterranean Element, **EM-MT**: East Mediterranean-Mountainous Element, **EN**: endangered, **ES**: Euro-Siberian Element, **EUX**: Euxine Element, **EUX-MT**: Euxine-Mountainous Element, **EW**: extinct in the wild, **EX**: extinct, **IT**: Irano-Turanian Element, **IUCN**: The International Union for Conservation of Nature, **LR (cd)**: conservation dependent, **LR (lc)**: least concern, **LR (nt)**: near threatened, **LR**, lower risk, **M**: Mediterranean Element, **NE**: not evaluated, **VU**: vulnerable
Sources: Davis *et al*. 1967, 1988; Ekim *et al*. 2000; Güner *et al*. 2000

var. *capitatum*, *H. capitatum* Choisy var. *luteum* Robson, *H. cardiophyllum* Boiss., *H. lanuginosum* Lam. var. *pestalozzae* (Boiss.) Robson *H. formosissimum* Takht., *H. lanuginosum* Lam. var. *pestalozzae* (Boiss.) Robson, *H. neurocalycinum* Boiss. & Heldr., *H. nummularioides* Trautv., *H. pamphylicum* Robson & Davis, *H. polyphyllum* Boiss. & Bal. subsp. *subcordatum* Robson & Hub.-Mor., *H. rumeliacum* Boiss. subsp. *rumeliacum*, *H. salsugineum* Robson & Hub.-Mor., *H. scabroides* Robson & Poulter, *H. ternatum* Poulter, *H. vacciniifolium* Hayek & Siehe, and *H. vesiculosum* Griseb) (Ekim *et al*. 2000; Anonymous 2001).

THE ECONOMIC IMPORTANCE OF *HYPERICUM* SPECIES

The essential oils obtained from *Hypericum* species grown in different regions of the world have been studied by many researchers. Many factors such as genotype, the stage of plant development, the time of picking, differences in climatic and ecological conditions where the plants are grown, etc. influence both the ratio and composition of the essential oils from *Hypericum* species.

The essential oils (EOs) of *H. perforatum*, *H. scabrum* and *H. hyssopifolium* were rich in monoterpene hydrocarbons and α-pinene was the main component in the EOs of these species (Cakir *et al*. 1997, 2004). However, α-pinene and monoterpene hydrocarbons were not detected in the EO of *H. linarioides* (Cakir *et al*. 2005). Some *Hypericum* spp. are rich in sesquiterpene hydrocarbons (Demirci and Baser 2006; Toker *et al*. 2006; Ozkan *et al*. 2009).

The aerial parts of *Hypericum hyssopifolium* subsp. *elongatum* var. *elongatum* var. *elongatum* and *Hypericum heterophyllum* Vent. were collected in Erzurum and Gaziantep regions of Turkey by Cakir *et al*. (2004). Hydrodistillation of the dried aerial parts of *H. hyssopifolium* and *H. heterophyllum* yielded 0.1 and 0.09% of EO, respectively. In their study, the EOs showed remarkable differences in chemical composition. The major compound in the EO of *H. hyssopifolium* was α-pinene (57.3%), and this EO was rich in monoterpenes. However, 72.9% of the total EO obtained from *H. heterophyllum* consisted of sesquiterpenes (Cakir *et al*. 2004).

Demirci and Baser (2006) collected *Hypericum bupleurodies* Griseb. from the north eastern region of Turkey, and they characterized 30 components representing 92% of the total EO in the aerial parts. Also, sesquiterpenes such as β-sesquiphellandrene (33.2%) and β-caryophyllene (20.2%), were found as the main components.

Toker *et al*. (2006) collected *H. hyssopifolium* Chaix var. *microcalycinum* Boiss et Heldr and *H.lysimachioides* Boiss var. *lysimachioides* from Southeastern Anatolia, and recorded 0.08% EO in aerial parts of both species. In addition, caryophyllene oxide (20.4 and 30.8%, respectively) was found to be the major component in the EOs of both *Hypericum* species.

Ozkan *et al*. (2009) identified 72 compounds representing 82.4% of total EO obtained from the aerial parts of *Hypericum thymopsis* Boiss., and reported that the EO of *H. thymopsis* was rich in sesquiterpene hydrocarbons. The major constituents were spathulenol (10.8%), δ-cadinene (7.1%), germacrene D (6.1%), γ-muurolene (5.9%), 2,3,6-trimethylbenzaldehyde (5%) and γ-cadinene (4.4%).

Some *Hypericum* species are used in folk medicine for several purposes around the world. The most popular species in this genus is *Hypericum perforatum* L.

In recent years, interest in this plant increased because of its antidepressant effect. *Hypericum* species contain a broad range of structurally diverse natural compounds such as hyperforin, hypericin, hyyperoside, rutin, quarcetin, etc. (Patocka 2003). Hypericin and hyperforin have been re-

Fig. 1 (**A**) Fruits and leaves of *Hypericum androsaemum*, taken in July at 1060 m. (**B**) Flowering stage of *Hypericum calycinum*, taken in June at 384 m. (**C**) Flowering stage of *Hypericum linarioides*, taken in July at 1781 m.

ported to mainly contribute to the pharmacological effects of *Hypericum* extracts. The naphthodianthrones, mainly hypericin and pseudohypericin, are considered as marker compounds to identify *Hypericum* species. Hypericin content in the extracts used to make *Hypericum* by products has been utilized for standardization purposes in the pharmaceutical industry (Nahrstedt and Butterweck 1997). Commercial extracts from *H. perforatum* are standardized to contain 0.3% hypericin. In addition, flavonoids have made an important contribution to the antidepressant activity (Butterweck *et al*. 2000; Noldner and Schotz 2002; Cirak *et al*. 2007).

In Germany and the United States, preparations from this plant are sold. The market share of these drugs are about 570 million US$ in the world (Kacar and Azkan 2005). In Turkey, some *Hypericum* species especially *H. perforatum* and *H. scabrum* are used in folk medicine. These two species traded in the domestic market; in addition, they have been exported from Turkey. However there are no official records regarding their trade.

CONCLUSIONS

Turkey is an important gene center for *Hypericum* species. These plants have been used for a long time for the treatment of external wounds. Recently, there has been increasing interest in the genus *Hypericum*, because it is a source of variety of compounds with different biological activities. Many species of the genus may find importance and new applications in several medicinal fields in the future.

REFERENCES

Anonymous (2001) IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK

Baytop T (1994) *Türkçe Bitki Adları Sözlüğü*, Türk Dil Kurumu Yayınları, No. 578, 152 pp

Bown D (2002) *The Royal Horticultural Society'S Encyclopedia of Herbs and their Uses*, Dorling Kindersley Ltd., United Kingdom, 240 pp

Butterweck V, Jurgenliemk G, Nahrstedt A, Winterhoff H (2000) Flavonoids from *Hypericum perforatum* show antidepressant activity in the forced swimming test. *Planta Medica* **66**, 3-6

Cakir A, Duru ME, Harmandar M, Ciriminna R, Passannanti S, Piozzi F (1997) Comparison of the volatile oils of *Hypericum scabrum* L. and *Hypericum perforatum* L. from Turkey. *Flavour and Fragrance Journal* **12**, 285-287

Cakir A, Kordali S, Zengın H, Izumi S, Hirata T (2004) Composition and antifungal activity of essential oils isolated from *Hypericum hyssopifolium* and *Hypericum heterophyllum*. *Flavour and Fragrance Journal* **19**, 62-68

Cakir A, Kordali S, Kilic H, Kaya E (2005) Antifungal properties of essential oil and crude extracts of *Hypericum linarioides* Bosse. *Biochemical Systematics and Ecology* **33**, 245-256

Cirak C, Radušiene J, Ivanauskas L, Janulis V (2007) Variation of bioactive secondary metabolites in *Hypericum origanifolium* during its phenological cycle. *Acta Physiologiae Plantarum* **29**, 197-203

Davis PH, Cullen J, Coode MJE (1967) *Flora of Turkey and the East Aegean Islands*, (Vol 2), Edinburgh University Press, Edinburgh, 581 pp

Davis PH, Mill RR, Tan K (1988) *Flora of Turkey and the East Aegean Islands (Supplement)* (Vol 10), Edinburgh University Press, Edinburgh, 590 pp

Demirci F, Baser KHC (2006) Volatiles of *Hypericum bupleuroides* Griseb. *Journal of Essential Oil Research* **18**, 650-651

Ekim T, Koyuncu M, Vural M, Duman H, Aytaç Z, Adıgüzel N (2000) Red Data Book of Turkish Plants (Pteridophyta and Spermatophyta), Türkiye Tabiatını Koruma Derneği & Van 100. Yıl Üniversitesi, Barışcan Ofset, Ankara, 246 pp

Güner A, Özhatay N, Ekim T, Başer KHC (2000) *Flora of Turkey and The East Aegean Islands (Supplement)* (Vol 11), Edinburgh University Press, Edinburgh, 656 pp

Kacar O, Azkan N (2005) Different climate factors, ontogenetic and diurnal variability on the hypericin content of *Hypericum perforatum* L. *Ege University, Agricultural Faculty Journal* **42**, 23-34

Nahrstedt A, Butterweck V (1997) Biologically active and other chemical constituents of the herb *Hypericum perforatum* L. *Pharmacopsychiatry* **30**, 129-134

Noldner M, Schotz K (2002) Rutin is essential for the antidepressant activity of *Hypericum perforatum* extracts in the forced swimming test. *Planta Medica* **68**, 577-580

Ozkan AMG, Demirci B, Baser KHC (2009) Essential oil composition of

Hypericum thymopsis Boiss. *Journal of Essential Oil Research* **21**, 149-153

Patocka J (2003) The chemistry, pharmacology, and toxicology of the biologically active constituents of the herb *Hypericum perforatum* L. *Journal of Biomedical Materials Research Part B – Applied Biomaterials* **1**, 61-73

PavlovićM, Tzakou O, Petrakis PV, Couladis M (2006) The essential oil of *Hypericum perforatum* L., *Hypericum tetrapterum* Fries and *Hypericum olympicum* L. growing in Greece. *Flavour and Fragrance Journal* **21**, 84-87

Radusiene J, Judzentiene A, Bernotiene G (2005) Essential oil composition and variability of *Hypericum perforatum* L. growing in Lithuania. *Biochemical Systematics and Ecology* **33**, 113-124

Toker Z, Goksel K, Ozen H C, Kızıl M, Ertekin S (2006) Compositions and antimicrobial activities of the essential oils of two *Hypericum* species from Turkey. *Fitoterapia* **77**, 57-60

Yazaki K, Okada T (1994) Medicinal and Aromatic Plants VI. In: Bajaj YPS (Ed) *Biotechnology in Agriculture and Forestry* (Vol 26), Springer-Verlag, Berlin, pp 167-178