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REVIEW ARTICLE

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General overview on the conservation of medicinal plants in Turkey

Türkiye'de tıbbi bitkilerin korunmasına genel bakış

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ABSTRACT

Medicinal plants are a special area that needs to be evaluated with different parameters than the general biodiversity threatening due to intense collection pressure.

In the study, Turkey's plant diversity, requirements and strategies for sustainable use of Turkish medicinal plants, criticizing and planning of data for the protection of medicinal plants have been evaluated using standards of the Guidelines on the Conservation of Medicinal Plants by WHO, IUCN, WWF and Traffic. In addition, the richness of traditional medicinal plant uses in Turkey, the concept, and usage potentials, administrative requirements for the protection, creation of the in situ and ex situ conservation areas and recommendations for the future have been presented.

ÖZ

Tıbbi bitkiler yoğun bir toplama baskısı nedeniyle genel biyoçeşitlilik üzerindeki baskıdan daha farklı parametrelerle değerlendirilmesi gereken bir alandır. Çalışmada, Türkiye'nin bitki zenginliği, tıbbi bitki olarak kullanılan bitkilerin sürdürülebilir kullanımı için gereksinimler ve stratejiler, verilerin ve tıbbi bitkilerin korunmasına yönelik planlamalar, WHO, IUCN, WWF ve Traffic tarafından hazırlanmış Tıbbi Bitkileri Koruma Kılavuzu'na göre değerlendirilmiştir. Ayrıca Türkiye'nin geleneksel tıbbi bitki kullanım zenginliği, tıbbi bitki kavramı ve kullanım potansiyeli, korumaya yönelik yönetsel gereksinimler, in situ ve ex situ koruma alanlarının oluşturulması ve geleceğe yönelik öneriler sunulmuştur.

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1. INTRODUCTION

Medicinal plants known and used since ancient times are still commonly used, and they have remarkable importance in national and international trade. According to the World Health Organization (1998) data, 80% of the population of developing countries is used mostly medicinal plants, for their primary health care needs on traditional medicines. Also, modern pharmacopoeias still contain at least 25% of drugs derived from plants and many others which are synthetic analogues built on prototype compounds isolated from plants (Kingston, 2011). Medicinal plants are used directly as therapeutic agents, but also as starting materials for the synthesis of drugs or as models for pharmacologically active compounds in this respect they have an important role

for pharmacological research and drug development (As shown in Table 1). Despite the use of herbal medicines over many centuries, only a relatively small number of plant species have been studied for possible drugs (WHO, 1998). The traditional uses of medicinal plants in the world are documented by ethnobotanical studies. Ethnobotanical/ ethnopharmacological studies are increasing the possibilities of identifying new molecules instead of random screening (Harvey, 1999; De Melo et al., 2011). Plants are threatened in many parts of the world. According to IUCN (2010) data 15,000 species of medicinal plants are globally threatened from, amongst others, loss of habitat, overexploitation, invasive species and pollution (IUCN, 2010; Chen et al. 2016). The United Nations Convention on Biological Diversity states that the conservation and sustainable use of biological diversity is

of critical importance for meeting the food, health and other needs of the growing world population (WHO, 1998; Heide, 1993). However, the majority of the material traded is still from wild-harvested sources and number of species cultivated are very few. According to the report of WHO, approximately the market (annual) for medicinal and aromatic plants are \$ 60 billion in 2000, \$ 93 billion in 2015, \$ 107 billion in 2017 in the world (Willis, 2017). Despite lacking detailed information, numerous medicinal plants encounter extinction or endangered. There is no serious conservation action plan for most medicinal plants which are endangered. For instance, there is very little material of them in gene banks. Much

importance has been put on the potential for discovering new drugs, less on different problems in use of traditional herbal medicines by indigenous people. There is still no complete inventory of medicinal plants for most countries. Most of the knowledge on their uses are held by traditional societies, whose existence is under threat now. Less data has been recorded by way of systematic approach. Besides the identification and selection of medicinal plants for use in health services, there is the potential that plants hold as an inexhaustible reservoir for the identification and isolation of useful chemical compounds for diseases such as cancer (Akerele et al., 1991; Kathe, 2006).

Table 1. Some examples of raw materials used as herbal medicine or medicine (Benzie & Wachtel-Galor, 2011).

Isolating pure active compounds for formulation into drugs	Isolating intermediates for the production of semi-synthetic drugs	Preparing standardized galenicals (extracts, tinctures, etc.)	Herbal teas
<i>Astragalus</i> species (Cycloartanes)	<i>Ruscus aculeatus</i> (Steroidal saponins)	<i>Glycyrrhiza glabra</i> (Root extract)	<i>Matricaria chamomilla</i>
<i>Liquidambar orientalis</i> (Cinnamic acid and derivatives)	<i>Pinus brutia</i> (Resin and essential oils)	<i>Vitex agnus-castus</i> (fruit extract)	<i>Salvia fruticosa</i>
<i>Leucojum</i> / <i>Galanthus</i> species (Galanthamine)	<i>Papaver somniferum</i> (Opioids)	<i>Colchicum</i> species (Seed extract)	<i>Origanum</i> species
<i>Gypsophila</i> species (Saponins)	<i>Colchicum</i> sp. (Colchicosides)	<i>Sambucus nigra</i> (Flower extract)	<i>Sideritis</i> species (<i>S. congesta</i> , <i>S. caesarea</i> , <i>S. stricta</i>)
<i>Mentha spicata</i> , <i>M. pulegium</i> (Menthol)		<i>Hypericum perforatum</i> (Herb extract)	<i>Melissa officinalis</i>
<i>Papaver somniferum</i> (Morphine, thebaine, codeine, papaverine etc.)		<i>Crataegus monogyna</i> (Leaf, flower, fruit extract)	<i>Tilia</i> sp.
<i>Artemisia absinthium</i> (Absinthe)		<i>Viscum album</i> (Leaf extract)	<i>Althaea officinalis</i>
		<i>Scolymus hispanicus</i> (Leaf and flower extract)	

1.1. Medicinal plants in Turkey

Turkey has a rich flora with approximately 12,000 taxa of vascular plants – one- third of them endemic to the country (Davis, 1965–1985; Davis et al., 1988; Güner et al., 2000; Özhatay et al., 2015, 2017). Traditional knowledge of medicinal plants is common and it is

transferred inter-generational. According to ethnobotanical studies 1546 species are recorded as medicinal plants in Turkey (Tuzlaci, 2016). In Turkey, the number of plants collected from nature which is subject to trade in the domestic market is about 350. Approximately 100 of these plants are exported. In Turkey, agriculture of 20 kinds of medicinal and aromatic

plants is done in 1.3 million acres although it has changed over the years. Black tea, red pepper, poppy, cumin, mint, oregano, rose oil and anise are placed near the top in terms of production amount. (TTOD, 2018) (As shown in Table 2). Legalizations in Turkey related to medicinal plants are given below. Medicinal plants have to be licensed if they are to be sold as a herbal medicinal product except for traditional uses. The critical part here is whether the indication is specified. Accordingly, two licenses are issued by authorities in Turkey. The products

licensed from the Ministry of Agriculture usually come out as nutritional supplements. Indication is not included: Ministry of Agriculture and Forestry authorization;

It contains indications: Ministry of Health authorization, Traditional Herbal Medicinal Products Directive, Ministry of Health authorization- October 6, 2010, Supplemental Imports of Food, Production, Processing and Marketing Regulations, Ministry of Food, Agriculture and Livestock authorization- May 2, 2013.

Table 2. Medicinal and aromatic plants cultivation area and production status over the years in Turkey (TUIK 2020).

No	Plant name	2006		2012		2015		Change %	
		Hectares	Tons	Hectares	Tons	Hectares	Tons	Hectares	Tons
1	Black tea	76.613	112.120	75.856	125.000	76.207	132.793	-0.1	7.5
2	Red pepper	6.696	4.586	11.268	16.553	11.289	20.413	3.9	85.7
3	Poppy	42.024	2.744	13.510	350	61.591	3.073	12.4	16.6
4	Cumin	21.154	1.199	22.629	1.390	27.024	1.690	10	14.5
5	Mint	989,4	959	1.047	1.260	1.058	1.494	5.2	19.9
6	Thyme	5.885,3	798	9.428	1.160	10.486	1.300	10	8.6
7	Rose (for oil)	1.700*	840*	3.083	1.022	2.824	948	6.3	4.4
8	Anise	12.654,2	8478	19.443	1.102	13.812	905	-6.2	-5.5
9	Dill Grass	260	245	326	290	478	449	17	16.4
10	Heather	-	-	-	-	1.503	208	-	-
11	Hops	267,7	138	344	175	350	187	1	15.3
12	Fennel	-	-	1.577	186	1.551	146	-0.2	136.1
13	Black cumin	-	-	230	16	468	42.5	10.4	32.5
14	White Lupin	601	48	468	42	374	41	-1.7	1.5
15	Lavender	-	-	51	12	329	40	53	22.5
16	Lemon balm	-	-	45	24	51	24	1.4	0.2
17	Sage	-	-	5.4	0.7	53.6	1.9	89.3	17.1
18	Coriander	-	-	1.1	0.1	15	1.1	126.4	100
19	Caper bush	-	-	-	-	1.5	-	-	-
20	Stinging nettle	-	-	0.3	0,042	0	0	-	-
21	Linen	144,8	8.4	18	1.3	0	0	-10	-10
22	Hemp	65		6.4		1	0.1	-10	-10
	Total	167.355		159.338		209.461		2.2	

1.2. Conservation strategies

Conservation is very important to benefit from the medicinal plants and also for sustainability. The aim of conservation is to support sustainable uses and protecting biological resources. Two methods for the conservation of plant genetic resources are valued, namely in situ and ex situ conservation. Some approaches for ex situ conservation include gene banks, seed storage, pollen storage, botanical gardens. (Kasagana & Karumuri, 2011). Turkey Seed Gene Bank in business under Biodiversity and Genetic Resources Department of Field Crops Central Research Institute was inaugurated in 2010. 122.000 materials are conserved in the Seed Gene Banks as of 2015. Ex situ conservation of some threatened species is conducted at the Nezahat Gökyiğit Botanic

Garden, Istanbul. Botanical gardens in Turkey are shown in Table 3. In situ conservation involves establishing protected areas and taking an approach that is habitat/ecosystem-oriented (Chen et al., 2016). Total 144 of sites are identified as an IPA (Important Plant Area) in Turkey (Özhatay et al., 2010; Özhatay, 2006). In addition to this, small protected areas and hot spots are identified in Turkey (Akalın et al., 2013; Kocyigit & Demirci, 2018). Species Action Plan Projects have been carried out by the Republic of Turkey Ministry of Agriculture and Forestry. Different strategies have been developed for plant conservation. The situation of medicinal plants in Turkey was evaluated using the standards of the Guidelines on the Conservation of Medicinal Plants published by WHO, IUCN, WWF and TRAFFIC (Akerele et al., 1991; Kathe, 2006).

Table 3. Botanical gardens in Turkey (Ekim, 2017).

Botanical Garden	Establish date	Herbarium specimens	Number of taxa	Medicinal plant department
Alfred Heilbronn Botanic Garden (İstanbul)	1935	50000 samples	6000	None
Atatürk Arboretum of İstanbul University (İstanbul)	1949	40000 samples	1650	None
Ege University Botanical Garden (İzmir)	1968	30000 samples	3000	None
Çukurova University Ali Nihat Gökyiğit Botanic Garden (Adana)	1999	250 samples	600	Yes 180 taxa
Karaca Arboretum (İstanbul)	1980	Non herbarium	Woody plants (c. 7000 taxa) and herbaceous perennials (c. 7000 taxa)	None
Nezahat Gökyiğit Botanic Garden (İstanbul)	2001	8500 samples	Woody plants (c. 800 taxa) and herbaceous perennials (c. 6000 taxa)	Medicinal and aromatic plants in the useful plants department 115 taxa
Zeytinburnu Medicinal Plants Garden (İstanbul)	2005	300 taxa, 100 seed	800	First medicinal plants garden

2. MATERIAL AND METHODS

The goal of the study defines the outlines of Turkey's threats and protection management on medicinal plants used as natural resources. For this purpose, the criteria of

The Guidelines on the Conservation of Medicinal Plants (Kathe, 2006) are followed for the evaluation of Turkish medicinal plants. The data were obtained as a result of the literature research and evaluated.

3. RESULTS AND DISCUSSIONS

The guideline states that due diligence must be made about medicinal plants, management's approach and solutions must be evaluated. In this study, this process will be followed. There are also suggestions in the last section. The attitude of the central government is the most important part of the protection of Medicinal Plants like all good management processes.

3.1. To study traditional knowledge on the use of plants in health care

Many academic or folkloric studies are carried out about the usage of plants mainly for medicinal purposes in Turkey. Studies on "Determination of Traditional Knowledge Based on Biological Diversity" started in 2017-2018 are carried out under the coordination of the Republic of Turkey Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks, Department of Biological Diversity. In these surveys, it is mainly aimed to investigate medicinal plants. Up to this day, inventory studies for 11 provinces in two parts have been planned and started, but some of them have not been yet concluded. These provinces are Ankara, Hatay, Erzurum, Afyon, Çorum, Aydın, Samsun in first part and Mersin, Bursa, Şanlıurfa, Gümüşhane in second part. The Project of Recording Traditional Information Based on Biodiversity is carried out by Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks. In the first group, the Project were ended in Aydın, Afyonkarahisar, Hatay, Ankara, Erzurum, Samsun and Çorum provinces in 2018. In the second group, field work in Bursa, Mersin, Kayseri, Gümüşhane and Şanlıurfa provinces was completed in 2019. Project studies are continuing in Kırklareli, Mardin, İzmir, Isparta, Aksaray, Sinop, Bartın, Trabzon and Van, which started in 2019. It is aimed to complete field work in all provinces by 2023 (UBSEP, 2013). Also, Ministry of Health issued a regulation in order to make an arrangement associated with traditional treatment methods (GETAT, 2014).

3.2. To identify the medicinal plants, outline their distributions and assess their abundance

Turkey that the plant diversity is the richest country is located in the temperate zone. 12000 vascular plant taxa grow naturally in Turkey. Approximately 35% of these plants are endemic. Each year, an average of 60 new species is added to the Flora of Turkey (Özhatay et al., 2017). Taxonomic and floristic studies have contributed

greatly in recent years. There is not a national herbarium in Turkey yet. However, especially in faculties of pharmacy herbaria are located and have rich collection of medicinal plants. For example, Istanbul University The Herbarium of the Faculty of Pharmacy (ISTE) with 130000 samples has nearly all species of important medicinal genera (*Papaver*, *Salvia*, *Allium*, *Rosa*, *Ferula* etc.) and all important medicinal species. In some herbaria, such as IZEF or ISTE, the databases for medicinal plants have been made for documentation. These databases will be a considerable important step in the systematical determination and protection of traditional medicinal plants. Currently, there are two special databases for the traditional use of plants:

Data Bank of Turkish Folk Remedies (TUHIB-Türk Halk İlaçları Bilgi Bankası); According to this database, the number of species used as folk remedy in Turkey have recently been figured around 1,500 (Yesilada, 2002). Turkish Ethnobotanical Data Bank (TEBVET Türk Ethnobotanik Veri Tabanı); It is reported that approximately 1,200 species used for medicinal purposes (Ospankulova, 2005). These data are cataloged and analyzed in some papers. But there is no regulation about making benefits to the communities providing the data from any commercial use of the information. The most vital point is to determine correctly named plant.

3.3. Wherever possible, to cultivate the medicinal plants as the source of supply

Only 130-140 species are cultivated in Europe. This number is being 20 species in India, 100-250 species in China (Canuto et al., 2012). The majority of medicinal and aromatic plants in Turkey (347 species) are collected from nature and directly consumed or sold in the domestic market. Some of them are *Glycyrrhiza glabra* (licorice), *Rosmarinus officinalis* (Rosemary), *Salvia* sp. (Sage types), *Sideritis* sp. (Ironwood worth), *Origanum* sp. (Marjoram), *Satureja* sp. (Savory), *Capparis* sp. (Kebere), *Gypsophilla* sp. (Soapwort) and some bulbous plants such as *Galanthus* sp. (Snowdrop) and *Orchis* sp. (Orchid) (Özhatay et al., 1997; Sandal & Söğüt, 2010). Some of the projects for cultivation of medicinal plants have been undertaken, but there is no permanent plan in Ministry of Agriculture and Forestry or Ministry of Health. Horticultural Research Institutes improve the agronomy of cultivated medicinal plants and bring into cultivation those species needed in medicine that have not been cultivated before and provide effective horticultural training and information. Such as Atatürk Horticultural

Central Research Institute, Ege Horticultural Central Research Institute, Zeytinburnu Medicinal Plant Botanic Gardens.

3.4. To ensure that any collecting from the wild is sustainable

There is no regulation on the collection of medicinal plants (except geophytes) from the wild or no control on trade in medicinal plants and their products. Solution suggestions in this area can be planned in two parts;

Primarily, organizing collections under control from nature, and training about sustainable collecting by official authorities and increased the awareness of local people who collect the medicinal plants.

The second and more sustainable way, instead of collecting from nature, these plants can be cultivated in accordance with ecological and social interests. From an ecological ethnobotanical point of view, an economic system should be created based on community interactions and human behavior- conservation, genetic preservation.

3.5. To improve techniques for harvesting, storage and production

Medicinal plants have special importance for Turkey. Cultivation, harvesting, production and trading of these plants should be organized by a single authority, although it is under the jurisdiction of different ministries such as agriculture, forestry or health. Ministry of Agriculture and Forestry improves the techniques for harvesting and storing medicinal plants and preparing products by Horticultural Research Institutes. Herbal monographs of important medicinal plants for Turkey are preparing to take part in the Turkish Pharmacopoeia by the Ministry of Health. For example: Silivri Municipality Agricultural Production and Research Center (TÜRAM) is founded in Silivri in 2009 and started the trial process in 2010 in cooperation with Namik Kemal University Faculty of Agriculture. Agricultural production and research centers, which will be established with such cooperation, will prevent the collection of plants used for medicinal purposes from nature and will prevent the damage to biological diversity.

3.6. To conserve populations of medicinal plant species in natural habitats

In Turkey, the most areas belong to a Protected Area System and are governed by national laws. The list of

protected areas is within the protected area system in Turkey (2013) (As shown in Table 4). However, these areas including medicinal plants are not considered when determining a protected area system.

Table 4. Summary of Protected Areas in Turkey (DKMP, 2018).

Protected Areas in Turkey		
National Park	National	44
Nature Conservation Areas	National	30
Nature Park	National	243
Natural Monument	National	112
Wildlife Protection Areas	National	81
Protective Forests	National	58
Natural Sites	National	1273
Special Protected Areas	Regional	16
Ramsar Sites	Global	14
Biosphere Reserve Areas	Global	1
World Heritage Areas	Global	11

3.7. To conserve populations of medicinal plant species ex situ

Valuable tools are both in situ and ex situ conservation for medicinal plant conservation. Related to these tools, inventorying and monitoring of medicinal plant species and their populations, medicinal-plant resource management and the role of gene banks and tissue cultures are important. Species Action Plan Projects were targeted for 100 endangered species (plants and animals) between 2013-2019 years. The action plan of 60 species had been completed in 2017. While there was a conservation action plan for many rare and threatened species, an action plan was made by the fight against invasive species, such as *Sicyos angulatus* (İtdolanbacı) in Giresun. At the end of 2019, 20 more action plans were planned (As shown in Table 5). There are particularly rare and endemic species in these plans, although they are not species that are collected for direct medical purposes, they are found in some species of medicinal genera with numerous species, such as *Astragalus*, *Ferula*, *Hypericum*, *Salvia* and *Verbascum*. There are no species collected from nature for commercial purposes.

Table 5. Some plant species that their protection action plans have been completed or ongoing (UBENİS, 2013).

<i>Aethionema karamanicum</i> Karaman Kayagülü
<i>Ajuga xylorrhiza</i> Kit Tan, Kabamayasıl
<i>Astragalus beypazaricus</i> Podlech & Aytaç, Beypazarı Geveni
<i>Bellevalia edirnenensis</i> Özhatay & B.Mathew, Edirne sümbülü
<i>Campanula damboldtiana</i> P.H.Davis & Sorger, Ayaş Çançiçeği
<i>Centaurea aksoyi</i> Hamzaoglu & Budak, Şahdügmesi, Yozgat Peygamber Çiçeği
<i>Centaurea mykalea</i> Hub.-Mor., Aydın Gaşağı (Tüllüşah)
<i>Centaurea tchihatcheffii</i> Peygamber Çiçeği
<i>Cephalaria tuteliana</i> S.Kuş & Göktürk, Sultan Pelemiri
<i>Erodium hendrikii</i> Alpınar, Gündük İğnelik
<i>Ferula mervynii</i> Sağiroğlu & H.Duman, Kerkür
<i>Fritillaria baskilensis</i> Behcet, Baskil Lalesi
<i>Galanthus trojanus</i> A.P.Davis & N.Özhatay, Truva Kardeleni
<i>Hyacinthus orientalis</i> L., Sümbül
<i>Hypericum malatyanum</i> Peşmen, Malatya Kantaronu
<i>Iris peshmeniana</i> Güner & T.Hall, Peşmen Navruzu
<i>Lilium candidum</i> L., Ak Zambak
<i>Ornithogalum malatyanum</i> Mutlu, Yar Sasalı
<i>Polygonum samsunicum</i> Yıld. & Leblebici, Samsun Madımağı
<i>Psephellus brevifimbriatus</i> (Hub.-Mor.) Wagenitz, Has Tülübaş
<i>Psephellus hadimensis</i> Wagenitz, Koyak Tülübaş
<i>Psephellus turcicus</i> A.Duran & Hamzaoglu, Yurt Tülübaş
<i>Salvia siirtica</i> Kahraman, Celep & Doğan, Siirt Adaçayı
<i>Scilla mesopotamica</i> Speta, Hoş Sümbül
<i>Sicyos angulatus</i> L., İt Dolanbacı, Hambostan
<i>Tchihatchewia isatidea</i> Boiss., Allıgelin
<i>Thermopsis turcica</i> Kit Tan & al., Eber Sarısı- Piyan
<i>Tulipa orphanidea</i> Boiss. ex Heldr., Manisa Lalesi
<i>Verbascum eskisehirensis</i> Karavel., Ocak & Ekici, Eski Sığır Kuyruğu

3.8. To build public support for the conservation of medicinal plants through communication and cooperation

Conservation of wild medicinal plants requires conservation of their habitats and thus success in conserving medicinal plants (driven by the motivational forces of health, income or culture) and it has the potential to benefit many other types of plants and animals too. Several types of conservation measures have been applied to medicinal plants, including protected

areas and other forms of legal control, cultivation (intended to reduce the collection pressure on wild medicinal plants) and ex situ conservation. Protected areas are useful for conserving medicinal plants – as important for biodiversity in general. Theoretically, well-designed networks of protected areas would be great value for conserving the genetic diversity of medicinal species, though in actuality it is doubtful whether the geography of medicinal plants has ever been a serious consideration in designing such networks. The

identification of IMPAs (Important Medicinal Plants Area) is based on four broad criteria (Akalin & Özhatay, 2014):

- Medicinal plants in the site: Ethnobotanical data or regional anthropological research.
- Threatened species in the medicinal plants: Endemic and rare plants, especially only grew up a certain habitat, slowly growing or extensive collecting (e.g. *Gentiana lutea*)
- Threatened habitats: The last 40 years, rare habitats are threatened in Turkey (mining, deforestation or reforestation, to achieve land, water policy, etc.)
- Rich genera or families where have important medicinal plants: such as *Papaver*, *Salvia* genera or Apocynaceae, Apiaceae or Labiatae families.

Nowadays, clearly visible and measurable threats on biodiversity, which are very important in terms of our future, have given a great impetus to the protection studies of these areas. Medicinal plants are also one of the most important subjects of such studies. It is possible that these plants may be more threatened than the others in Anatolia or the world. 144 Important Plant Areas (IPA) of Turkey are determined (Özhatay et al., 2010; Özhatay, 2006). The Republic of Turkey Ministry of Agriculture and Forestry start the projects of Recording Traditional Knowledge Based on Biodiversity in 2017. Several protected areas (National parks, biosphere reserve areas etc.) have been identified in Turkey. When utilized all of these, the criteria of important medicinal plant areas can be carried out in these areas (Akalin & Özhatay, 2014). Then focusing on ex situ/ in situ conservation or cultivation of endangered medicinal plants of Turkey is important for sustainability. In Turkey, 1500 different plants for different purposes have been used (Yesilada, 2002).

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