# Chapter 5
# Ethnobotanical Features of *Teucrium* Species


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**Abstract** Species of the *Teucrium* genus have been used in ethnopharmacology for centuries, helping to treat many pathophysiological conditions, such as diabetes, gastrointestinal disorders, rheumatism, inflammations, and tuberculosis. They can also be used as a diuretic, antipyretic, tonic, diaphoretic, analgesic and antihyperlipidemic. This study provides a comprehensive analysis of the traditional use of *Teucrium* species based on research conducted up to now in different parts of the world. With this aim, 72 ethnobotanical studies were analyzed and a total of 20 *Teucrium* species were identified for this analysis. Nineteen of these species are used in human ethnomedicine, 3 in veterinary ethnomedicine and 4 for other purposes. *Teucrium chamaedrys*, *T. polium* and *T. montanum* are mentioned in the largest number of studies and have the widest range of uses. The aerial parts of the plant are those that are most frequently used, with infusions (77.8%) and decoctions (48.6%) the most common methods of preparation. The use of *Teucrium* species for treating abdominal problems is mentioned in 56 of the studies and in 21 studies for treating disorders heart and blood vessels. Treating respiratory problems is referenced in 17 studies and problems in the functioning of the endocrine glands in 16 studies. The medicinal properties of *Teucrium* species can be ascribed to their chemical composition, specifically essential oils, phenolic acids, flavonoids, and other secondary metabolites. However, the long-term use of some of the preparations can have negative side effects, such as hepatotoxicity or gradual deterioration in neuromuscular coordination.

**Keywords** Ethnobotanical research · *Teucrium* species · *T. chamaedrys* · *T. polium* · *T. montanum*

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## 5.1 Introduction

Medicinal plants and products made from them have been used in ethnomedicine all across the world since time immemorial. Numerous plant species are central to beliefs, methods and institutions for diagnosing and treating diseases and preventing them. Hence, botanical folk knowledge plays a crucial role in the ethnomedicine of every civilisation (Nedelcheva and Draganov 2014). Indeed, the most useful starting point for developing new pharmaceuticals is provided by the array of botanical sources, particularly metabolites and their biological activities, in addition to the various practices developed by ethnic groups over the centuries in terms of the preparation and application of herbal remedies (Jarić et al. 2007). According to estimations provided by Uritu et al. (2018), up to 70,000 plant species are used for ethnomedicine worldwide, while according to data from the World Health Organization (WHO), approximately 80% of the world's population still relies mainly on plant-based drugs (Bahmani et al. 2014). The reasons for the wide use of medicinal plants in ethnomedicine across the world include their relative ease of availability and the fact that they are quite a cost effective alternative when it comes to daily health care and self-medication; in light of this, many people, particularly those in poorer rural areas or when economic crisis hits, depend on them as home remedies for health problems (Leonti 2011). Their therapeutic value is based primarily on the link between the chemical structure of the active substances they contain and their pharmacodynamic effects on the body (Rafieian-Kopaei 2012; Jarić et al. 2014, 2015a).

Medicinal and aromatic plants come from a whole variety of plant families that often have common active ingredients (due to their biosynthetic pathways being similar). One, highly significant example is the plant family Labiatae (Lamiaceae), which includes many species that contain essential oils (Máthé 2015; Jarić et al. 2015b) and, as such, have biological and medical applications. Their high concentrations of biologically active substances mean they contribute significantly to both traditional and modern medicine (phytotherapy). This family includes aromatic herbs such as thyme, mint, oregano, basil, sage, savory, rosemary, self-heal, hyssop, and lemon balm, while other species have more limited uses (Bekut et al. 2018).

This chapter provides a comprehensive analysis of the traditional uses of *Teucrium* species from the ethnobotanical and ethnomedicine points of view, based on ethnobotanical research undertaken in different parts of the world. With this aim, 72 ethnobotanical studies were analysed and 20 species of the *Teucrium* genus were identified for the purposes of this analysis.

## 5.2 Botanical Characterization and Distribution of *Teucrium* Species

*Teucrium* L. (germander) is a large, polymorphic, cosmopolitan genus, belonging to the family Lamiaceae, within the subfamily Ajugoideae. This family has a cosmopolitan distribution with about 236 genera and contains between 6900 (Heywood et al. 2007) and 7200 species (Harley et al. 2004), although the World Checklist lists 7534 (https://wcsp.science.kew.org/qsearch.do). The genus *Teucrium* comprises more than 300 species, which are widely found in Europe, North Africa, and temperate parts of Asia, but 96% are distributed in the Mediterranean region (Tutin et al. 1972; Meusel et al. 1978; Navarro and El Oualidi 2000). About 195 taxa are present at the level of species and subspecies, 83 of which are on the Pyrenean peninsula, 72 in the northwestern part of Northern Africa (Algeria and Morocco), 61 in Asia Minor, 41 on the Balkan Peninsula, and 23 on the Apennine Peninsula (Greuter et al. 1986). In terms of European flora, the genus *Teucrium* has been divided into seven sections with 49 species (Tutin et al. 1972), while a few are spread throughout South America, mountainous tropical Northeast and South Africa, and Australia (Wielgorskaya 1995).

Species of the genus *Teucrium* are mostly perennial herbs, shrubs or subshrubs, and more rarely, annual herbaceous plants (e.g. *T. botrys*) (Tutin et al. 1972). Research into micromorphological characteristics, especially trichomes and pollen, nutlet morphology and vegetative anatomy has shown that these have taxonomic value for sectional and interspecific classification in this genus (Oybak-Dönmez and Inceoğlu 1988; Navarro and El Oualidi 2000; Jurišić Grubešić et al. 2007; Dinç et al. 2008, 2009; Eshratifar et al. 2011; Lakušić and Lakušić 2014).

## 5.3 Ethnobotanical and Ethnomedicinal Research into *Teucrium* Species

### 5.3.1 *A Historical Review of the Use of* Teucrium *Species in Ethnomedicine*

For over two millennia, *Teucrium* species have been used as medicinal herbs, with many still used in folk medicine today (Milošević-Djordjević et al. 2013). Used to treat coughs and asthma since ancient Greek times (Menichini et al. 2009), there are many other records of their use in ethnomedicine. Pharmaceutical manuscripts from Persia, dating from the period between the ninth and eighteenth centuries AD, note the use of the aerial part of *T. montanum* as a decoction to treat headaches (Zarshenas et al. 2013). Moreover, in medieval written documents, i.e. in lists of *materia medica* used by the Jewish community of Medieval (eleventh to fourteenth centuries) Cairo, found at the Taylor–Schechter Genizah collection, Cambridge, the species

*Teucrium capitatum* L. is mentioned twice, with its leaves and stems used in the treatment of eye diseases, stomach ailments and colic (Lev 2007). Similarly, the botanical *materia medica* of the *Iatrosophikon* – A collection of prescriptions from a monastery in Cyprus, which dates back to the Ottoman period (1571–1878), includes *Teucrium micropodioides* Rouy as an exotic taxon originating from the New World, used to treat catarrh and the common cold (Lardos 2006). In their work on the use of medicinal herbs for the treatment of rheumatic disorders in the sixteenth and seventeenth centuries, Adams et al. (2009) stated that important European herbals (Fuchs 1543; Bock 1577; Matthiolus 1590; Tabernaemontanus 1687) mention the ethnomedicinal use of *Teucrium chamaedrys* L. Namely, its aerial parts were boiled in wine and this concoction was taken for 60 days, 3 h before meals on an empty stomach. Any patient seeking to use this as a remedy for gout of the feet or hip pains also had to avoid sour and salty foods.

### 5.3.2 *The Use of* Teucrium *Species in Human Ethnomedicine*

*Teucrium* species are generally aromatic, ornamental plants and also a valuable source of pollen, while many are used in folk medicine and pharmacy. Numerous phytochemical and pharmacological studies have confirmed their medicinal and biological properties, such as hypoglycemic (Gharaibeh et al. 1988; Baluchnejadmojarad et al. 2005), hypolipidemic (Rasekh et al. 2001), hepatoprotective (Shtukmaster et al. 2010), antipyretic (Autore et al. 1984), anti-inflammatory and antiulcerogenic (Sghaier et al. 2011a), anticarcinogenic (Sghaier et al. 2011b; Stanković et al. 2011a), and antimicrobial activities (Vuković et al. 2007). These species are very rich in phenolic compounds with very strong biological activity (Yin et al. 2009; Hasani-Ranjbar et al. 2010).

Knowledge on the use of *Teucrium* species, which are used by locals in various geographical regions, has been well documented in numerous ethnobotanical studies. In this chapter, 72 ethnobotanical studies from across the world were analysed and 20 species of the genus *Teucrium* were identified for their medicinal properties. Nineteen species are used in human ethnomedicine (Table 5.1) and 3 in veterinary ethnomedicine (Table 5.2), while 4 are also used for other purposes (Table 5.3). It should be noted that some of them have multiple uses, while *Teucrium scorodonia* is only used in veterinary medicine.

Our analysis of these studies revealed that the people of Turkey, Iran, Bosnia and Herzegovina, Italy, Pakistan, Serbia and Palestine know most about *Teucrium* species and use them most frequently (Fig. 5.1). It was also determined that the species *Teucrium chamaedrys* was the most frequently mentioned of all the species of the genus *Teucrium*. Details on its use were found in 34 (47.2%) ethnobotanical studies; 13 (18.15%) of these were conducted in different parts of Turkey, 5 (7%) in Italy and the same number in Bosnia and Herzegovina. The species *Teucrium polium* is used in 23 regions of the world (31.9%), but is most familiar to and most frequently used by the people of Iran (6 studies, 26.1%) and Turkey (5 studies, 21.8%).

**Table 5.1** The use of *Teucrium* species in traditional medicine

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. arduini* | Bosnia and Herzegovina | Aerial part | **I:** Infusion | Stomach diseases | Redžić (2007) |
| *T. arduini* | Bosnia and Herzegovina (Central, Southern and Western) | Aerial part | **I:** Infusion | Gastrointestinal ailments | Šarić-Kundalić et al. (2010a) |
| *T. arduini* | Bosnia and Herzegovina (Eastern, Northern and Northeastern) | Aerial part | **I:** Infusion | Diarrhoea | Šarić-Kundalić et al. (2011) |
| *T. capitatum* | Palestine (West Bank) | Leaf | **E:** Decoction (about 50 g leaves are boiled in 100 ml water and the affected area is bathed with this decoction once a day) | Psoriasis | Shawahna and Jaradat (2017) |
| *T. capitatum* subsp. *capitatum* | Lebanon (Mount Hermon) | Aerial part | **I:** Infusion | Diabetes, insomnia and neurological disorders, abdominal cramps | Baydoun et al. (2015) |
| *T. chamaedrys* | Turkey (Nigde, Aladaglar) | Aerial part | **I:** Infusion | Abdominal pain, haemorrhoids, diabetes, a painkiller, stomach pains | Özdemir and Alpınar (2015) |
| *T. chamaedrys* | Turkey (Afyonkarahisar, Inner-West Anatolia) | Leaf, flower | **I:** Infusion | A painkiller, stomach problems and haemorrhoids | Ari et al. (2015) |
| *T. chamaedrys* | Turkey (East Anatolia) | Herb/aerial part | **I:** Infusion, decoction | Toothache, kidney pains, a stomachic, indigestion, heart disease | Altundag and Ozturk (2011) |
| *T. chamaedrys* | Turkey (Edremit Gulf, Balıkesir Province) | Flowering branches | **I:** Infusion (drink one cupful twice a day for a week) | Abdominal pains, kidney stones | Polat and Satil (2012) |
| *T. chamaedrys* | Turkey (Bozyazı district of Mersin) | Aerial part | **I:** Decoction (gargle 1 glassful and spit, once a day for 3–5 days) | Mouth sores | Sargin (2015) |

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**Table 5.1** (continued)

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. chamaedrys* | Turkey (Hatay Province, Antakya) | Aerial part | **I:** Decoction | An antidiabetic | Güzel et al. (2015) |
| *T. chamaedrys* | Turkey (Central Anatolia) | Herb/aerial part | **I:** Infusion (as tea) | Stomachaches | Sezik et al. (2001) |
| *T. chamaedrys* | Italy (Rotonda, Pollino National Park) | Flowering tops | **I:** Decoction | A febrifuge | Di Sanzo et al. (2013) |
| *T. chamaedrys* | Italy (Mundimitar/ Montemitro) | Aerial part | **I:** Decoction | An antimalarial (in the past), hypertension | di Tizio et al. (2012) |
| *T. chamaedrys* | Italy (Dolomiti Lucane) | Aerial part | **I:** Decoction | An antimalarial | Pieroni et al. (2004) |
| *T. chamaedrys* | Italy (North-western Ligurian Alps) | Leaf | **I:** Decoction | A hypotensive, abdominal pain | Cornara et al. (2014) |
| *T. chamaedrys* | Italy (Lucania region) | Aerial part | – | An antimalarial | Pieroni and Quave (2005) |
| *T. chamaedrys* | Serbia (Kosovo, Albanian Alps) | Aerial part | **I:** Infusion | An antihaemorrhoidal | Mustafa et al. (2012) |
| | | Whole plant | | An antidiabetic | |
| *T. chamaedrys* | Serbia (Kopaonik) | Aerial part | **I:** Infusion (tea) | Gastrointestinal ailments | Jarić et al. (2007) |
| *T. chamaedrys* | Serbia (Suva planina) | Aerial part | **I:** Infusion (tea) | A digestive, stomach problems | Jarić et al. (2015a) |
| *T. chamaedrys* | Serbia (Zlatibor) | Leaf | **I:** Infusion | Digestive complaints, diarrhoea | Šavikin et al. (2013) |
| *T. chamaedrys* | Bosnia and Herzegovina (Central, Southern and Western) | Aerial part | **I:** Infusion (tea) | Spasms (a mixture of *Agrimonia* sp., *Frangula* sp., *Melissa* sp., *Mentha* sp., and *T. montanum*), diarrhoea (a mixture of *Agrimonia* sp., *Matricaria* sp., *Rosa* sp., and *Tilia* sp.) | Šarić-Kundalić et al. (2010a) |

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| *T. chamaedrys* | Bosnia and Herzegovina (Eastern, Northern and North-eastern) | Aerial part | **I:** Infusion (tea) | Anaemia, digestive ailments | Šarić-Kundalić et al. (2011) |
| *T. chamaedrys* | Bosnia and Herzegovina (Pristine Village of Prokoško Lake on Mt. Vranica) | Aerial part | **I:** Infusion (tea) | Spasms | Šarić-Kundalić et al. (2010b) |
| *T. chamaedrys* | Bosnia and Herzegovina (Mt. Javor) | Aerial part | **I:** Infusion | Digestive complaints, diarrhoea | Savić et al. (2019) |
| *T. chamaedrys* | Bosnia and Herzegovina | Aerial part | **I:** Fresh juice, infusion | Diarrhoea | Redžić (2007) |
| *T. chamaedrys* | Spain (Balearic Islands, Eastern Mallorca, Mediterranean Sea) | Flowering tops | **I:** Drops | Earache | Carrió and Vallès (2012) |
| *T. chamaedrys* | Macedonia (Southeastern) | Leaf | **E:** Compress from fresh leaves on the neck area | An aphrodisiac (anti-aphrodisiac), 'anti sex crusader' | Nedelcheva et al. (2017) |
| | | Aerial part | **I:** Infusion (tea) | Childlessness | |
| *T. chamaedrys* | Greece (Epirus, Zagori) | – | – | A haemostatic, haemorrhoids, a tonic and stimulant, rheumatism and arthritis | Vokou et al. (1993) |
| *T. chamaedrys* | Albania (Theth, a village in the Northern Albanian Alps) | Aerial part | **I:** Infusion *Aerial part dried and sold to the city markets.* | Stomachaches, fevers | Pieroni (2008) |
| *T. chamaedrys* | Israel (the Golan Heights and the West Bank region) | Leaf | **I:** Decoction (a standard decoction is prepared from 50 g leaves and stems and taken orally, 100 cc, three times a day) | Stomach and intestinal pain and inflammation, lack of appetite, jaundice | Said et al. (2002) |
| *T. chamaedrys* | Iran (North Khorasan Province) | Aerial part | – | An anti-inflammatory, an aperient, an astringent, a carminative, a diaphoretic, a digestive, a diuretic, a stimulant | Mashayekhan et al. (2015) |

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**Table 5.1** (continued)

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. chamaedrys* | Palestine (West Bank) | – | – | Digestive disorders | Ali-Shtayeh et al. (2000) |
| *T. chamaedrys* subsp. *chamaedrys* | Turkey (Honaz Mountain National Park, Middle Aegean Region of Turkey) | Aerial part | **I:** Decoction (use 2–3 cupfuls daily to relieve pain) | An analgesic | Kargıoğlu et al. (2010) |
| *T. chamaedrys* subsp. *chamaedrys* | Turkey (Ulukışla) | Aerial part | **E:** Decoction (bath; take a bath; take a sitz bath twice a day) | Haemorrhoids, itching | Paksoy et al. (2016) |
| *T. chamaedrys* subsp. *lydium* | Turkey (Bayramiç, Çanakkale) | Aerial part | **I:** Infusion | Eczema | Bulut and Tuzlacı (2015) |
| *T. chamaedrys* subsp. *sinuatum* | Turkey (Hakkari- Geçitli) | Aerial part | **I:** Decoction, infusion (drink one glassful of the tea from the plant twice a day) | Gastric pain, poisoning, rheumatism | Kaval et al. (2014) |
| *T. chamaedrys* subsp. *sinuatum* | Turkey (Bingöl, Solhan) | Aerial part | **I:** Infusion (drink one teacupful after meals) | Insomnia, colds and influenza, a sedative | Polat et al. (2013) |
| *T. chamaedrys* subsp. *sinuatum* | Turkey (Sivrice, Elazığ) | Aerial part | **E:** Infusion (compress) | An antispasmodic, haemorrhoids | Cakilcioglu and Turkoglu (2010) |
| *T. chardonianum* | Western Sahara (Moroccan occupied territories) | Flowering tops (dried and triturated) | **E:** Infusion | Mixed with water and applied to hair to perfume it and stimulate hair growth | Volpato et al. (2012) |
| *T. cubense* | Mexico (Nuevo León, Bustamante) | Whole plant | **I/E**: Infusion (as a tea to drink and for bathing) | Fevers | Estrada-Castillón et al. (2018) |
| | | Leaf | **I:** Infusion (as a tea to be drunk for several weeks) | Kidney disorders | |

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| *T. divaricatum* subsp. *canescens* | Cyprus | Aerial part (in flower) | **I/E:** Infusion (taken orally but also together with inhalation of the steam) | A stomachic, fevers and common colds | Arnold (1985) |
| | | | **E:** Infusion | Wound healing (cicatrisant) | |
| *T. divaricatum* subsp. *divaricatum* | Turkey (Mugla, Marmaris) | Aerial part | **I:** Infusion | Coughs, a tonic for the eyes, stomachaches, urinary diseases | Gürdal and Kültür (2013) |
| *T. fruticans* | Morocco (middle region of Oum *Rbai*) | Aerial part | **I:** Infusion | Influenza (in the treatment of respiratory diseases) | Fatiha et al. (2017) |
| *T. fruticans* | Spain | – | – | Cardiovascular problems, mental/nervous disorders | Gonzalez-Tejero et al. (2008) |
| *T. lusitanicum* | Spain (Granada province) | Aerial part | **I:** Decoction | Fevers | Benítez et al. (2010) |
| *T. micropodioides* | Cyprus (Paphos and Larnaca) | – | – | A digestive, mental/nervous disorders | Gonzalez-Tejero et al. (2008) |
| *T. montanum* | Bosnia and Herzegovina (Mt. Javor) | Aerial part | **I:** Infusion | Digestive complaints | Savić et al. (2019) |
| *T. montanum* | Bosnia and Herzegovina (Eastern, Northern and North-eastern) | Aerial part | **I:** – | Gastrointestinal ailments, digestive ailments, rheumatism, arthritis, hangovers, biliary tract purification, lung cancer | Šarić-Kundalić et al. (2011) |
| *T. montanum* | Bosnia and Herzegovina (Pristine Village of Prokoško Lake on Mt. Vranica) | Aerial part | **I:** Infusion/tea | Spasms, blood purification | Šarić-Kundalić et al. (2010b) |
| | | | **E:** Balm | Rheumatism | |
| *T. montanum* | Bosnia and Herzegovina (Lukomir) | – | **I:** – | Diabetes | Ferrier et al. (2014) |
| *T. montanum* | Bosnia and Herzegovina | Aerial part | **I:** Infusion | Liver and stomach diseases | Redžić (2007) |

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**Table 5.1** (continued)

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. montanum* | Serbia (Zlatibor) | Aerial part | **I:** Infusion | Digestive complaints | Šavikin et al. (2013) |
| *T. montanum* | Serbia (Mt. Suva planina) | Aerial part | **I:** Infusion | Disorders of the abdominal organs, 'male' headaches, a tonic (tea), improving appetite, an antipyretic ('bitter tea' – blend: mountain germander, wall germander, yarrow, sage, pennyroyal and oregano) | Jarić et al. (2015a) |
| | | | **E:** Infusion: 'bitter tea' | Tuberculosis – a bath soak: add yellow chamomile (*Anthemis tinctoria* L.) to the 'bitter tea' or set the plants mentioned above alight for the patient to inhale the 'smoke' **a combination of internal and external use is recommended* | |
| *T. montanum* | Serbia (Rtanj) | Aerial part | **I:** Infusion | Strengthening the immune system | Zlatković et al. (2014) |
| *T. montanum* | Croatia (Dubrovnik coast) | Leaf, flower | **I:** Infusion/tea, brandy | – | Dolina and Łuczaj (2014) |
| *T. montanum* | Montenegro (Mt. Prokletije) | Aerial part | **I:** Infusion/tea | Cirrhosis | Menković et al. (2011) |
| *T. montanum* | Iran = Persia (pharmaceutical manuscripts from ninth to eighteenth century AD) | Aerial part | **I:** Decoction | Headaches | Zarshenas et al. (2013) |
| *T. oliverianum* | Saudi Arabia (Al-Rass province) | Whole plant | – | Diabetes | El-Ghazali et al. (2010) |
| *T. orientale* | Iran (Hormozgan province) | Leaf, flower | **I:** Decoction | Hoarseness | Safa et al. (2013) |

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| *T. orientale* subsp. *orientale* | Lebanon (Mount Hermon) | Aerial part | **I:** Infusion | Fevers | Baydoun et al. (2015) |
| | | | **E:** Infusion | Wounds and skin injuries | |
| *T. parviflorum* | Turkey (East Anatolia) | Aerial part | **I:** Decoction | An antihemorrhoidal | Altundag and Ozturk (2011) |
| *T. polium* | Turkey (East Anatolia) | Aerial part | **I:** Fresh, decoction | Stomach problems, diarrhoea, an antihemorrhoidal, internal diseases, diabetes, an analgesic, an anti-inflammatory, an oedema, stomachaches, a digestive, an orexigenic, a carminative, tuberculosis, abdominal pain | Altundag and Ozturk (2011) |
| | | | **E:** Direct application | Sunstroke, a haemostatic | |
| *T. polium* | Turkey (Midyat) | Aerial part | **I:** Infusion, decoction | Stomachaches | Akgul et al. (2018) |
| *T. polium* | Turkey (Honaz Mountain National Park, Middle Aegean Region of Turkey) | Aerial part | **I:** Decoction (use 2–3 cupfuls daily to relieve abdominal pain) | Stomach diseases | Kargıoğlu et al. (2010) |
| | | | **I:** Decoction (use 2–3 cupfuls daily) | Rheumatic diseases, alleviating spasms and cramps | |
| *T. polium* | Turkey (Manisa, Turgutlu) | Aerial part | **I:** Infusion (one glassful of the infusion after meals) | Haemorrhoids | Bulut and Tuzlaci (2013) |
| | | | **I:** Crushed with honey (eaten before breakfast) | Haemorrhoids | |
| | | | **I:** Decoction | Diabetes | |
| *T. polium* | Turkey (Bayramiç, Çanakkale) | Aerial part | **I:** Infusion (before breakfast) | Haemorrhoids, eczema | Bulut and Tuzlacı (2015) |
| *T. polium* | Iran (Turkmen Sahra) | Aerial part | **I:** Decoction | Digestive problems, a stomachic, liver disorders | Ghorbani (2005) |
| *T. polium* | Iran (Mt. Hezar, Southeastern Iran) | Aerial part | **I:** Hydrodistillation | Stomachaches, a carminative | Rajaei and Mohamadi (2012) |

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**Table 5.1** (continued)

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. polium* | Iran (Arjan, Parishan protected area in Fars Province) | Leaf, flower | **I:** Infusion | Regulating blood lipids and sugars, diabetes, a scent | Dolatkhahi et al. (2014) |
| *T. polium* | Iran (Kohghiluyeh va Boyer Ahmad province) | Aerial part | **I:** Decoction, infusion, cooked aerial part | Menstruation disorders, toothache, body and joint pains, abortions, gynaecological infections, a carminative | Mosaddegh et al. (2012) |
| *T. polium* | Iran (Hormozgan province) | Flower, leaf, seed (fresh) | **I:** Decoction | Stomachaches, abdominal pain, flatulence, diarrhoea, regulating blood pressure, menstruation in women who have just given birth, measles, eye pain, headaches | Safa et al. (2013) |
| | | | **E:** Powder | Scorpion stings, snake bites, wound healing | |
| *T. polium* | Iran (Kurd tribe, Dehloran and Abdanan districts, Ilam province) | Leaf, flower | **I:** – | An antiseptic for gastric problems, a breath freshener | Ghasemi Pirbalouti et al. (2013) |
| *T. polium* | Albania (Albanians of Lepushe, Northern Albanian Alps) | Aerial part | **I:** Decoction | A digestive | Pieroni et al. (2005) |
| *T. polium* | Albania | – | **I:** – | A digestive | Gonzalez-Tejero et al. (2008) |
| *T. polium* | Jordan (the Ajloun Heights region) | Aerial part | **I:** Infusion | An antispasmodic, flatulence, an antidiabetic, kidney stones | Aburjai et al. (2007) |
| *T. polium* | Jordan (Al-Mafraq region) | Leaf | **I:** Fresh, soaked, cooled and taken orally whenever needed | An anti-inflammatory for the stomach and intestines | Al-Quran (2014) |
| *T. polium* | Morocco (Seksaoua Region) | Aerial part | **I:** Decoction | Abdominal pain | Sbai-Jouilil et al. (2017) |

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| *T. polium* | Israel (the Golan Heights and the West Bank region) | Leaf | **I:** Decoction (a standard decoction is prepared from 50 g plant material and taken orally, 100 cc, three times a day) | Kidney and liver diseases, diabetes, stomach and intestinal pain and inflammation | Said et al. (2002) |
| *T. polium* | Algeria | – | **I:** – | A digestive | Gonzalez-Tejero et al. (2008) |
| *T. polium* | Bosnia and Herzegovina | Aerial part | **I:** Infusion | Stomach diseases | Redžić (2007) |
| *T. polium* | Palestine | Leaf, aerial part | **I:** Decoction | Diabetes | Ali-Shtayeh et al. (2012) |
| *T. polium* | Palestine | Leaf | **I:** – | Local treatment of stomach and intestinal inflammation, an antispasmodic, an anthelmintic, smallpox | Jaradat (2005) |
| *T. polium* | Libya (Wadi Alkuf, Al-Jabal Al-Akhder) | – | – | Diabetes, gastritis, thyroiditis, anaemia, common colds, hypertension, kidney stones, arthritis, herpes, hair loss, rheumatism, scabies | El-Mokasabi (2014) |
| *T. pruinosum* | Lebanon (Mount Hermon) | Whole plant | **I:** Infusion | Gastrointestinal disorders | Baydoun et al. (2015) |
| | | | **E:** Infusion | Wounds, fevers | |
| | | | **I:** Steam | Colds | |
| *T. royleanum* | Pakistan (Dir Lower, Talash Valley) | Aerial part | **I:** Decoction | Fevers, an antiseptic and stimulant, a vermifuge (anthelmintic) | Khan et al. (2018a) |
| *T. scordium* | Bosnia and Herzegovina | Aerial part | **I:** Infusion | Diarrhoea | Redžić (2007) |
| *T. scordium* | Bosnia and Herzegovina (Central, Southern and Western) | Aerial part | **I:** Infusion | Gastrointestinal ailments | Šarić-Kundalić et al. (2010a) |
| *T. scordium* | Bosnia and Herzegovina (Eastern, Northern and Northeastern) | Aerial part | **I:** – | Diarrhoea | Šarić-Kundalić et al. (2011) |

(continued)

**Table 5.1** (continued)

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. stocksianum* | Pakistan (Kurram agency, lower Kurram) | Leaf, flower | **I:** Infusion | A blood purifier, an antipyretic, malaria, weight loss/obesity, an antidiabetic | Hussain et al. (2018) |
| *T. stocksianum* | Pakistan (Khyber Pakhtunkhwa, Lower Dir District, Tehsil Khall) | Leaf | **I:** Decoction | Diabetes | Irfan et al. (2018) |
| *T. stocksianum* | Pakistan (Bahadur Khel, Karak District, Khyber Pakhtunkhwa) | Seeds, leaf | **I/E:** Powder | Arthritis, coughs, a blood purifier, asthma, pneumonia, jaundice, diarrhoea | Khan et al. (2018b) |
| *T. stocksianum* | Pakistan (Madyan Valley in the Swat district) | Leaf | – | An expectorant | Ahmad et al. (2013) |
| *T. stocksianum* | Iran (Hormozgan province) | Leaf | **I:** Decoction, powder (when fresh) | Stomachaches, abdominal pain, flatulence, toxicity, emesis, stomach acidification, regulating blood pressure, lowering lipids, aiding the recovery of women who have recently given birth | Safa et al. (2013) |
| *T. trifidum* | South Africa (Southeastern Karoo) | Aerial part | **I:** Infusion | Colds, back pain, bladder problems in women, influenza | Van Wyk et al. (2008) |

**Table 5.2** The use of *Teucrium* species in veterinary medicine

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. chamaedrys* | Macedonia (Southeastern) | Aerial part | **E:** Compress with honey | For foot-and-mouth disease in cloven-hoofed animals | Nedelcheva et al. (2017) |
| *T. scorodonia* | Canada (British Columbia) | – | **I:** Tincture | Mastitis in cattle (cows)/Woodsage (*T. scorodonia*) tincture is infused into the udder | Lans et al. (2007) |
| *T. trifidum* | South Africa (Southeastern Karoo) | Aerial part | **I:** Infusion | Fever in sheep and cattle | Van Wyk et al. (2008) |

**Table 5.3** Uses of *Teucrium* species for other purposes

| *Teucrium* species | Locality | Part used | Forms of preparation and method of administration | Traditional uses | References |
|---|---|---|---|---|---|
| *T. chamaedrys* | Italy (Campania, National Park of Cilento and Vallo di Diano) | Aerial part | **I:** *T. chamaedrys* with the aerial part of *Urtica dioica* L., *Gallium verum* L. and *Veronica chamaedrys* L. is chopped and put in white vinegar. This mixture is used in the preparation of cheese. | For human nutrition | Di Novella et al. (2013) |
| *T. chamaedrys* | Italy (Rotonda, Pollino National Park) | Whole plant | **I:** Infusion | As an appetizer | Di Sanzo et al. (2013) |
| *T. polium* | Egypt | – | **I:** – | For human nutrition | Gonzalez-Tejero et al. (2008) |
| *T. cubense* | Mexico (Nuevo León, Bustamante) | Whole plant | **E:** Rub the whole body with the dry plant while praying | Fright | Estrada-Castillón et al. (2018) |
| | | | Ornamental | Planted in private gardens | |
| *T. chardonianum* | Western Sahara (Moroccan occupied territories) | Flowering tops (dried and triturated) | – (In its dry state) | Burnt inside a tent to perfume the air | Volpato et al. (2012) |

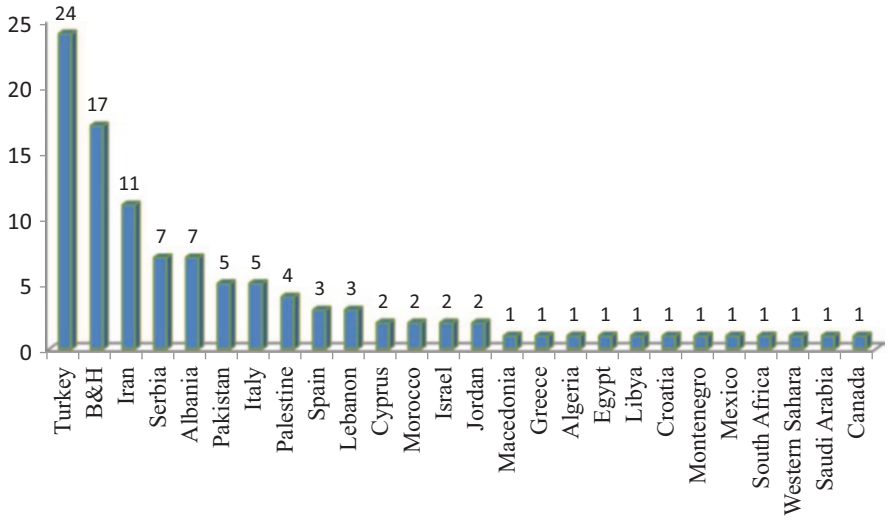


**Fig. 5.1** The number of analysed studies in the different countries where *Teucrium* species are used

Furthermore, the species *Teucrium montanum* also features significantly in ethnomedicine, as is confirmed by 11 (15.3%) ethnobotanical studies. It is used most in the mountain regions of Bosnia and Herzegovina (5 studies, 45.4%) and Serbia (4 studies, 27.3%). In addition, the use of *Teucrium stocksianum* was recorded in 5 (6.94%) ethnobotanical studies conducted in Pakistan and Iran (Fig. 5.2).

Research showed that infusions (77.8%) and decoctions (48.6%) were the dominant methods for preparing and using *Teucrium* species; however, these plants were also found to be used in the form of fresh juice, drops, brandy, tincture, balm or by applying the fresh aerial parts wrapped either whole or chopped and mixed with honey in a gauze (Table 5.1). According to the available data, their internal use was the dominant form (85%), while their use externally (for rheumatism, haemorrhoids, psoriasis, wound healing, and sunstroke, as an antidote to the snake bites and scorpion stings, and as a haemostatic) was significantly lower (12%). Combined internal/external use was mentioned in 3% of the studies analysed.

*Teucrium* species were used most often to treat various gastrointestinal disorders (56 of the analysed studies), followed by problems related to the functioning of the heart (e.g. hypertension) and blood vessels (e.g. haemorrhoids) (21 studies), and respiratory tract problems (colds, lung cancer, tuberculosis, asthma, pneumonia, influenza, etc., 17 studies). Their use in the treatment of problems related to endocrine function disorders (diabetes, thyroiditis) was mentioned in 16 ethnobotanical studies, while 14 studies noted their being used to treat problems connected to muscle and skeletal disorders and skin diseases (Fig. 5.3). In addition, *Teucrium* species were also used to treat problems concerning the excretory organs (7 studies), fevers (7 studies), as a stimulant and tonic (6 studies), to treat inflammations (5 studies), gynaecological ailments (4 studies), malaria (4 studies), mental disorders (3) and

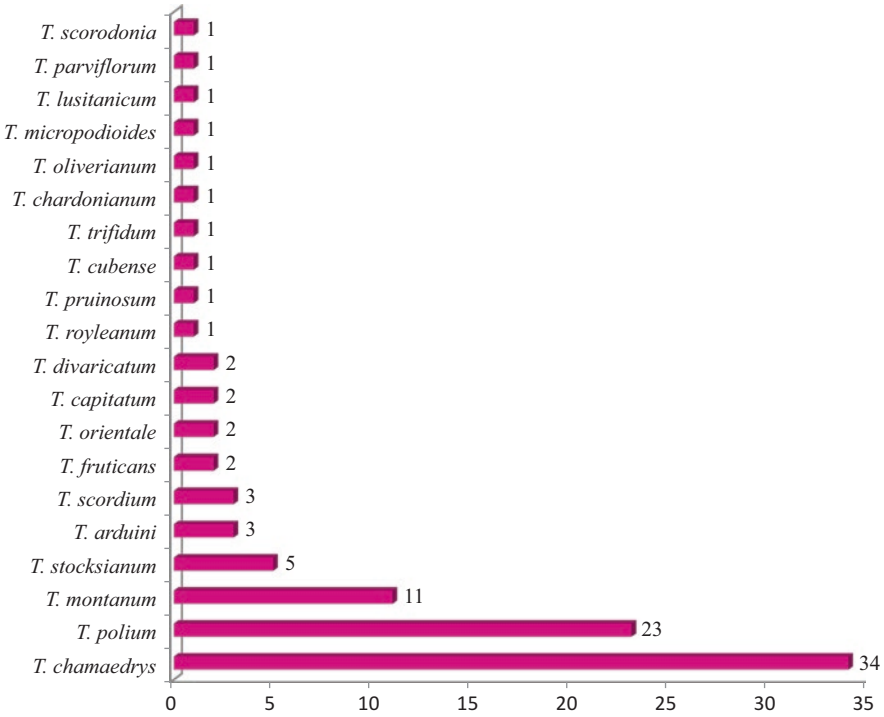


**Fig. 5.2** The total number of ethnobotanical studies in which *Teucrium* species are cited

headaches (3 studies). Twenty-four studies noted health problems and diseases that were only mentioned once or twice (Other, Fig. 5.3).

### 5.3.3 *The Use of* Teucrium *Species in Veterinary Ethnomedicine*

Our research established that three *Teucrium* species, mentioned in three ethnobotanical studies, are used in veterinary ethnomedicine (Table 5.2). Namely, in Southeastern Macedonia, Nedelcheva et al. (2017) recorded the use of *Teucrium chamaedrys* in the treatment of foot-and-mouth disease in cloven-hoofed animals. The South African endemic species *Teucrium trifidum* (Codd 1977) is used to treat fevers in sheep and cattle (Van Wyk et al. 2008). In the British Columbia region (Canada), tincture of *Teucrium scorodonia* is used to treat mastitis in cattle, particularly cows (Lans et al. 2007). In line with this, laboratory research by Djilas et al. (2006) found that ethyl acetate, chloroform and n-butanol extracts of *Teucrium montanum* exhibit a wide range of inhibitory activities against Gram (+) and Gram (−) bacteria, representing mid-level validity for mastitis.

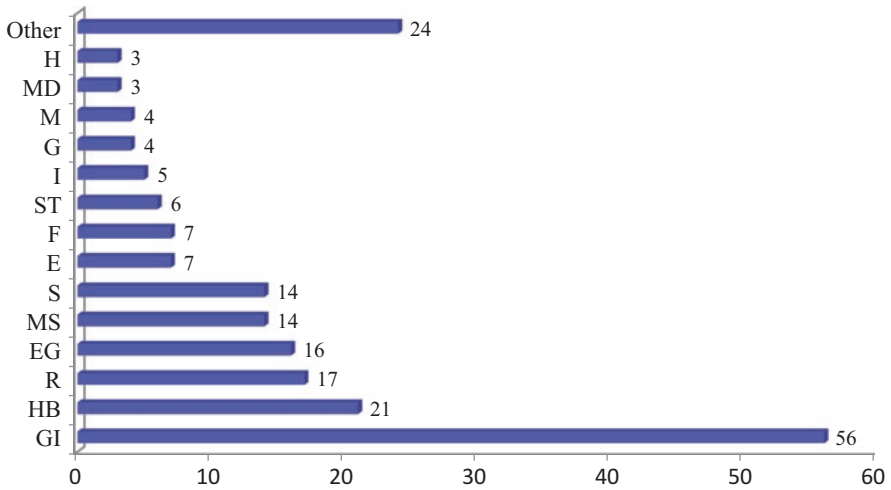


**Fig. 5.3** The frequency of the use of *Teucrium* species in human therapy based on the analysed studies: **GI** – gastrointestinal disorders; **HB** – heart and blood vessels; **R** – respiratory diseases; **EG** – diseases of the endocrine glands; **MS** – muscular and skeletal problems; **S** – skin diseases; **E** – excretory organ problems; **F** – fever; **ST** – stimulant and tonic; **I** – inflammation; **G** – gynaecological ailments; **M** – malaria; **MD** – mental disorders; **H** – headaches; **Other –** toothache, earache, poisoning, lack of appetite, an aphrodisiac, oedema, sunstroke, weight loss, an analgesic, etc

### *5.3.4 The Use of* Teucrium *Species for Other Purposes*

Besides the traditional uses for treating a variety of health problems and complaints in people and animals, *Teucrium* species are also used for other purposes. Namely, they are important alimentary plants with some used to prepare flavoured wines, herbal teas, bitters and liqueurs, while people use infusions of leaves and flowers to flavour beer in some regions (Maccioni et al. 2007). Furthermore, in studies by Saroglou et al. (2007), Ulubelen et al. (2000) and Özkan et al. (2007), this genus was found to be important in the food industry with many species serving as natural preservatives due to their antimicrobial, antioxidant and antifungal properties. Hence, in ethnobotanical research conducted in two national parks in Italy, *Teucrium chamaedrys* is mentioned as being used in cheese preparation (Di Novella et al. 2013) and as an appetizer (Di Sanzo et al. 2013) (Table 5.3). *Teucrium polium* is also used in Egypt in human nutrition (Gonzalez-Tejero et al. 2008). Estrada-Castillón et al. (2018) mentioned *Teucrium* cubense as an ornamental plant in Mexico and its use in rituals, while *Teucrium chardonianum* is used as an air freshener in the Western Sahara region (Volpato et al. 2012).

## 5.4 The Medicinal Properties of *Teucrium* Species

As with other Lamiaceae, the aerial organs of *Teucrium* species are covered by an indumentum of glandular and non-glandular trichomes in which essential oils are secreted. The essential oil content in these species is high and sesquiterpenes predominate in it (Cavalerio et al. 2002; Kucuk et al. 2006; Hachicha et al. 2007; Saroglou et al. 2007). In addition to sesquiterpenes, the essential oil of *Teucrium* species is a great source of neoclerodane diterpenes, in fact one of the richest, with over 220 diterpenes described so far (Piozzi et al. 2005).

The yield of essential oil in *Teucrium* species varies from species to species, but ranges from 0.5% to 1.5%, while the proportion of the main chemical constituents (primarily monoterpene/sesquiterpene hydrocarbons and oxygenated sesquiterpenes) also varies dramatically (Kovačević et al. 2001; Saroglou et al. 2007). Some of the differences in the chemical composition of the essential oil are believed to be linked to different subspecies and/or the plants' geographical origin and a range of environmental factors (Menichini et al. 2009).

Used widely due to their antioxidant and antidiabetic properties, the essential oils and volatile constituents extracted from *Teucrium* species also have a part to play in the prevention and treatment of a whole variety of human disorders, ailments and diseases, including cancer, cardiovascular problems, such as atherosclerosis and thrombosis, and bacterial and viral infections (Leyel 1984; Bruneton 1995; Edris 2007). They are also of interest ecologically, being used as antifeedants, inhibiting attack by different species of insects, due to the properties of their components, especially the diterpenes (Piozzi et al. 2005).

The chemical composition of the essential oil largely determines the medicinal properties of a plant and hence its uses. In this chapter, analysis of 72 ethnobotanical studies showed that the following species were used most, and as such, were the most popular among the human population: *Teucrium chamaedrys, T. polium* and *T. montanum*.

### *5.4.1* Teucrium chamaedrys *(Wall Germander)*

A perennial herbaceous plant with a half-ligneous and shrub-like low stem, *Teucrium chamaedrys* (section *Chamaedrys*) grows up to 30 cm high. It is found in rocky limestone areas, dry mountain meadows and pastures, and on the edges of sparse oak and pine forests, up to 1000 m above sea level in Central Europe, the Mediterranean region and Western Asia. Flowering and harvesting takes place between July and September, while fruiting occurs from August to September (Tutin et al. 1972; Diklić 1974; Fig. 5.4). *Teucrium chamaedrys* has a very wide range of uses in traditional medicine, particularly in its centres of distribution, as is confirmed by 34 of the analysed ethnobotanical studies. It is mainly the aerial parts that are used, most frequently when the plant is flowering, as then it has the greatest

**Fig. 5.4** *Teucrium chamaedrys* L. (Photo P. Lazarević)

concentrations of active substances. It is prepared in the form of an infusion, decoction, and fresh juice, while it is usually used internally, and more rarely externally (as a compress).

It is used as a painkiller and to treat stomach pains, gastric pains, indigestion, digestive complaints, haemorrhoids, toothache, kidney pains, kidney stones, heart disease, hypertension, mouth sores, poisoning, rheumatism, insomnia, colds and flu, itching, eczema, malaria, diarrhoea, spasms, anaemia, earache, childlessness, rheumatism and arthritis. Furthermore, it is used as a stomachic, antidiabetic, analgesic, sedative, antispasmodic, febrifuge, aphrodisiac, haemostatic, tonic, and stimulant, as well as an appetizer (Table 5.1). In addition, it is used in veterinary ethnomedicine for foot-and-mouth disease in cloven-hoofed animals (Table 5.2). Nencini et al. (2014) stated that it is used as Portland Powder in traditional medicine in England for the treatment of rheumatism and gout.

The chemistry of *Teucrium chamaedris* has been thoroughly researched due to its proven in vitro antioxidant activity (Kadifkova-Panovska et al. 2005) and also as there have been several cases of hepatotoxicity arising from the use of this species (Kouzi et al. 1994; Stickel et al. 2000; Perez Alvarez et al. 2001). Namely, it is very rich in phenolic compounds, exhibiting very strong biological activity and antioxidative effects (Ozgen et al. 2006; Gursoy and Tepe 2009; Stanković et al. 2010). In a study by Prescott et al. (2011), teucrioside was identified as the main active ingredient of the plant, which was shown in preclinical research to be effective in inhibiting calcineurin, meaning it could aid in the reduction of inflammatory states.

### *5.4.2* Teucrium polium *(Felty Germander)*

*Teucrium polium* (section *Polium*) is a perennial, aromatic plant, 20–50 cm high, appearing from June to August, and found abundantly in Southwestern Asia, Europe (the Mediterranean region), and North Africa (Diklić 1974; Djabou et al. 2012; Fig. 5.5). It grows on well-drained land, hillsides, sands, in stony mountains, and in sunny regions with a semiarid and arid bio-climate. The aerial parts of this plant are characterised by a pleasant aroma and a bitter taste (Barceloux 2008).

Numerous ethnobotanical studies (23) have highlighted the major ethnomedicinal importance of this species, mainly in the treatment of abdominal pain (digestive problems, stomach and intestinal pain and inflammation, and diarrhoea), kidney and liver diseases, kidney stones, diabetes, haemorrhoids, oedema, rheumatism, tuberculosis, and sunstroke. Moreover, it is used as an analgesic, an anti-inflammatory, an orexigenic, a carminative, a haemostatic, a digestive, an antispasmodic, and in human nutrition (Table 5.1). The medicinal properties of *Teucrium polium* for treating most of these health problems have been confirmed by laboratory research, which justifies its use in traditional medicine. Likewise, numerous in vivo and in vitro studies have confirmed the various biological activities of this species. These include anti-inflammatory and antirheumatic (Tariq et al. 1989), hypoglycemic (Kasabri et al. 2011), antipyretic and antibacterial (Autore et al. 1984), antioxidant and antimicrobial (Ilhami et al. 2003; Balmekki et al. 2013), hypolipidemic (Rasekh et al. 2001), and antihypertensive properties (Suleiman et al. 1988), as well as its benefits for treating stomach disorders (Malakov and Papanov 1983; Aqel et al. 1990), improving mental performance (Perry et al. 1996), and aiding weight loss (Gharaibeh et al. 1988).

Research by Kadifkova-Panovska et al. (2005) showed that different *Teucrium polium* extracts exhibit significant free radical scavenging activity, hydroxyl radical

**Fig. 5.5** *Teucrium polium* L. (Photo M. Stanković)

scavenging, and antioxidant activity in vitro. These antioxidative properties of *Teucrium polium* are the result of the presence of flavonoids (rutin, apigenin, apigenin-4, 7-dimethylether, cirsimaritin, cirsiliol, luteolin, etc.) (Sharififar et al. 2009), which has been confirmed by in vitro and in vivo studies (Djeridane et al. 2006; Hasani et al. 2007). In his research, Rajabalian (2008) demonstrated that the methanol extract of *Teucrium polium* could potentially be used as an effective and safe chemo-sensitizer agent in cancer chemotherapy. In addition, laboratory research confirmed that the ethanol extract also exhibited potent antibacterial activity against Gram (+) and Gram (−) microorganisms, while the aqueous extract of *Teucrium polium* inhibits the growth of *Saccharomyces cerevisiae* and *Yarrowia lipolytica* (Autore et al. 1984; Rojas et al. 1992; Aggelis et al. 1998; Essawi and Srour 2000; Darabpour et al. 2010). Due to the presence of sterols and flavonoids, *Teucrium polium* exhibits anti-inflammatory properties (Tariq et al. 1989), while its analgesic properties are the result of the presence of essential oils (Abdollahi et al. 2003). The antispasmodic activity of *Teucrium polium* can be put down to the high level of sesquiterpene alcohols (Kamel and Sandra 1994). In experimental conditions, it was established that the aqueous extract of the aerial parts of this species brought about a significant reduction in serum triglycerides and cholesterol in hyperlipidemic rats (Rasekh et al. 2001). Moreover, Movahedi et al. (2014) demonstrated that a decoction of *Teucrium polium* can protect liver cells against hepatocellular carcinoma in carcinogenesis-induced animal models. In one study, burn wounds healed more quickly through the topical application of *Teucrium polium* extract (Ansari et al. 2013). Similarly, the anti-inflammatory effects of this plant were demonstrated through it inhibiting carrageenan-induced inflammation in an animal study and its methanol and ethanol extracts have also been shown to be effective on veterinary pathogens (Darabpour et al. 2010).

### *5.4.3* Teucrium montanum *(Mountain Germander)*

The species *Teucrium montanum* (section *Polium*) is a perennial, shrub-like plant that is native to the Mediterranean region of Europe and North Africa, and to the Middle East (Tutin et al. 1972; Diklić 1974; Lakušić and Lakušić 2014; Fig. 5.6). It has half-ligneous branches, grows up to 25 cm high and can be found on thermophilic limestone and serpentine rocks, in dry mountain meadows and on the edges of forests. It flowers between June and September.

According to the ethnomedicinal data available, *Teucrium montanum* is used for digestive disorders, biliary tract purification, liver (cirrhosis) and stomach diseases, diabetes, spasms and blood purification, lung cancer, tuberculosis, rheumatism, arthritis, and headaches (in some regions, for "male" headaches), to improve appetite, as an antipyretic, to strengthen the immune system, as a hangover cure, and as a tonic (tea) (Table 5.1). The dominant method of preparation is an infusion, while in some areas it is used in the form of a decoction or balm. In Bosnia and Herzegovina and Serbia, *Teucrium montanum* is one of the most popular plants in traditional

**Fig. 5.6** *Teucrium montanum* L. (Photo M. Stanković)

medicine and according to local people's beliefs "heals every disease" (Redžić 2010; Jarić et al. 2015a).

Phytochemical studies have shown that *Teucrium montanum* is very rich in phenolic compounds, exhibiting very strong biological activity and antioxidative effects (Čanadanović-Brunet et al. 2006; Stanković et al. 2011b), which justifies its use in traditional medicine. Furthermore, data promoting the use of *Teucrium montanum* in ethnomedicine confirms the free-radical scavenging activity of flavonoids and phenolic acids in extracts made from different solvents (Djilas et al. 2006).

## 5.5 Potentially Toxic Effects of *Teucrium* Species

The use of *Teucrium* species in traditional medicine spanning several centuries points unequivocally to its medicinal properties. However, there have been instances when the long-term use of preparations made from these plants can have unwanted side effects. An illustrative example of the toxic effects of one species of the genus *Teucrium* was reported by a 33-year-old woman who drank *Teucrium chamaedrys* tea every day for 2 weeks. It was found that she had symptoms of acute icteric hepatitis and all other causes of acute hepatitis were ruled out. When she stopped drinking the tea, the patient made a clinical recovery and her serum bilirubin, aminotransferase and alkaline phosphatase levels returned to normal within 9 weeks (Ural et al. 2011). This case indicates that *Teucrium chamaedrys* can cause acute icteric hepatitis, which can clinically mimic acute viral hepatitis. Similar hepatotoxicity was observed during the use of preparations made from other species of the *Teucrium* genus (Chitturi and Farrell 2008; Kotsiou and Tesseromatis 2017) with most patients presenting with very high liver aminotransferases or developing jaundice. Hepatitis and intrahepatic cholestatic liver disease were the etiology of liver

damage in these cases. *Teucrium* species are rich in neoclerodane diterpenoids, which may be the cause of hepatotoxicity (Sundaresan et al. 2006). Therefore, those suffering from hepatic abnormalities should be careful when using *Teucrium* species (Perez Alvarez et al. 2001). Likewise, taking high doses of *Teucrium* species or using them over a longer period of time might cause the gradual deterioration in neuromuscular coordination, as is supported by histopathological and biochemical evidence (Tanira et al. 1996, 1997).

## 5.6 Conclusions

A comprehensive analysis of the traditional use of *Teucrium* species from the ethnobotanical and ethnomedicinal points of view took in 72 ethnobotanical studies from different parts of the world. It revealed a wide range of uses for different species of this genus, but for the purposes of this chapter the traditional use of 20 species of the genus *Teucrium* has been presented. Nineteen of these species are used in ethnomedicine and 3 in veterinary ethnomedicine, while 4 are used for other purposes. It has been established that these species are most frequently used traditionally in the treatment of abdominal problems, followed by problems related to the functioning of the heart, blood vessels, and endocrine glands, muscular and skeletal problems, and skin diseases. Those species which stand out for their wide range of uses are *Teucrium chamaedrys, T. polium* and *T. montanum*.

The medicinal properties of *Teucrium* species and their favourable impact on numerous ailments is undeniable, as has been confirmed by many studies. On the one hand, this justifies their use in ethnomedicine; on the other hand, it leads to the need for caution, particularly in terms of dosage and treatment duration and the overall health of the patient must be taken into consideration. Namely, histopathological and biochemical studies have revealed that when *Teucrium* species are taken in high doses or over a long period of time, they might cause progressive deterioration in neuromuscular coordination and hepatic damage, which may or may not be irreversible. Therefore, it is necessary to undertake further research aimed at isolating and characterizing the constituents of *Teucrium* species so as to obtain suitable drugs.

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## References

Abdollahi M, Karimpour H, Monsef-Esfehani HR (2003) Antinociceptive effects of *Teucrium polium* L. total extract and essential oil in mouse writhing test. Pharmacol Res 48:31–35

Aburjai T, Hudaib M, Tayyem R, Yousef M, Qishawi M (2007) Ethnopharmacological survey of medicinal herbs in Jordan, the Ajloun Heights region. J Ethnopharmacol 110:294–304

Adams M, Berset C, Kessler M, Hamburger M (2009) Medicinal herbs for the treatment of rheumatic disorders – a survey of European herbals from the 16th and 17th century. J Ethnopharmacol 121:343–359

Aggelis G, Athanassopoulos N, Paliogianni A, Komaitis M (1998) Effect of a *Teucrium polium* L. extract on the growth and fatty acid composition of *Saccharomyces cerevisiae* and *Yarrowia lipolytica*. Antonie Van Leeuwenhoek 73:195–198

Ahmad N, Anwar S, Fazal H, Abbasi BH (2013) Medicinal plants used in indigenous therapy by people of Madyan Valley in district Swat, Pakistan. Int J Med Arom Plant 3:47–54

Akgul A, Akgul A, Senol SG, Yildirim H, Secmen O, Dogan Y (2018) An ethnobotanical study in Midyat (Turkey), a city on the silk road where cultures meet. J Ethnobiol Ethnomed 14:12. https://doi.org/10.1186/s13002-017-0201-8

Ali-Shtayeh MS, Yaniv Z, Mahajna J (2000) Ethnobotanical survey in the Palestinian area: a classification of the healing potential of medicinal plants. J Ethnopharmacol 73:221–232

Ali-Shtayeha MS, Jamousa RM, Jamousa RM (2012) Complementary and alternative medicine use amongst Palestinian diabetic patients. Complement Ther Clin Pract 18:16–21

Al-Quran S (2014) Used Ethnobotany of medicinal plants by inhabitants of Al-Mafraq, Jordan. Arnaldoa 21:119–126

Altundag E, Ozturk M (2011) Ethnomedicinal studies on the plant resources of east Anatolia, Turkey. Procedia Soc Behav Sci 19:756–777

Ansari R, Sahinfard N, Namjou A, Rafieian M, Shirzad H, Rafieian-Kopaei M (2013) Ameliorative property of *Teucrium polium* on second degree burn. J Herbmed Pharmacol 2:9–11

Aqel M, Gharaibeh M, Salhab A (1990) The calcium antagonistic effect of the volatile oil of *Teucrium polium*. Pharm Biol 28:201–207

Ari S, Temel M, Kargıoğlu M, Konuk (2015) Ethnobotanical survey of plants used in Afyonkarahisar – Turkey. J Ethnobiol Ethnomed 11:84. https://doi.org/10.1186/s13002-015-0067-6

Arnold N (1985) Contribution á la connaissance ethnobotanique et mèdicinale de la flore de Chypre, vol 3. Universitè Renè Descartes de Paris, Paris, pp 1203–1210

Autore G, Capasso F, De Fusco R, Fasulo MP, Lembo M, Mascolo N, Menghini A (1984) Antipyretic and antibacterial actions of *Teucrium polium* (L.). Pharmacol Res Commun 16:21–29

Bahmani M, Shirzad H, Majlesi M, Shahinfard N, Rafieian-Kopaei M (2014) A review study on analgesic applications of Iranian medicinal plants. Asian Pac J 7:S43–S53

Balmekki N, Bendimerad N, Bekhechim C, Fernandez X (2013) Chemical analysis and antimicrobial activity of *Teucrium polium* L. essential oil from Western Algeria. J Med Plant Res 7:897–902

Baluchnejadmojarad T, Roghani M, Roghani-Dehkordi F (2005) Antinociceptive effects of *Teucrium polium* leaf extract in the diabetic rat formalin test. J Ethnopharmacol 97:207–210

Barceloux DG (2008) Medical toxicology of natural substances: foods, fungi, medicinal herbs, plants, & venomous animals. Wiley, Hoboken

Baydoun S, Lamis C, Helena D, Nelly A (2015) Ethnopharmacological survey of medicinal plants used in traditional medicine by the communities of Mount Hermon, Lebanon. J Ethnopharmacol 173:139–156

Bekut M, Brkić S, Kladar N, Dragović G, Gavarić N, Božin B (2018) Potential of selected Lamiaceae plants in anti(retro)viral therapy. Pharmacol Res 133:301–314

Benítez G, González-Tejero MR, Molero-Mesa J (2010) Pharmaceutical ethnobotany in the western part of Granada province (southern Spain): Ethnopharmacological synthesis. J Ethnopharmacol 129:87–105

Bruneton J (1995) Pharmacognosy, phytochemistry, medicinal plants. Lavoisier Publishing, Paris
Bulut G, Tuzlaci E (2013) An ethnobotanical study of medicinal plants in Turgutlu (Manisa – Turkey). J Ethnopharmacol 149:633–647
Bulut G, Tuzlaci E (2015) An ethnobotanical study of medicinal plants in Bayramiç (ÇanakkaleTurkey). Marmara Pharm J 19:268–282
Cakilcioglu U, Turkoglu I (2010) An ethnobotanical survey of medicinal plants in Sivrice (Elazığ-Turkey). J Ethnopharmacol 132:165–175
Čanadanović-Brunet JM, Djilas SM, Ćetković GS, Tumbas VT, Mandić AI, Čanadanović VM (2006) Antioxidant activities of different *Teucrium montanum* L. extracts. Int J Food Sci Technol 41:667–673
Carrió E, Vallès J (2012) Ethnobotany of medicinal plants used in Eastern Mallorca (Balearic Islands, Mediterranean Sea). J Ethnopharmacol 141:1021–1040
Cavaleiro C, Salgueiro LR, Antunes T, Sevinate-Pinto I, Barroso JG (2002) Composition of the essential oil and micromorphology of trichomes of *Teucrium salviastrum*, an endemic species from Portugal. Flavour Fragr J 17:287–291
Chitturi S, Farrell GC (2008) Hepatotoxic slimming aids and other herbal hepatotoxins. J Gastroenterol Hepatol 23:366–373
Codd LE (1977) The South African species of *Teucrium* (Lamiaceae). Bothalia 12:177–179
Cornara L, La Rocca A, Terrizzano L, Dente F, Mariotti MG (2014) Ethnobotanical and phyto-medical knowledge in the North-Western Ligurian Alps. J Ethnopharmacol 155:463–484
Darabpour E, Motamedi H, Nejad SMS (2010) Antimicrobial properties of *Teucrium polium* against some clinical pathogens. Asian Pac J Trop Med 3:124–127
Di Novella R, Di Novella N, De Martino L, Mancini E, De Feo V (2013) Traditional plant use in the National park of Cilento and Vallo di Diano, Campania, Southern, Italy. J Ethnopharmacol 145:328–342
Di Sanzo P, De Martino L, Mancini E, De Feo V (2013) Medicinal and useful plants in the tradition of Rotonda, Pollino National Park, Southern Italy. J Ethnobiol Ethnomed 9:19. https://doi.org/10.1186/1746-4269-9-19
di Tizio A, Łuczaj Ł, Quave C, Redžić S, Pieroni A (2012) Traditional food and herbal uses of wild plants in the ancient South-Slavic diaspora of Mundimitar/Montemitro (Southern Italy). J Ethnobiol Ethnomed 8:21. https://doi.org/10.1186/1746-4269-8-21
Diklić N (1974) Teucrium. In: Jakovljević S (ed) Flore de la Republique Socialiste de Serbie VI, 1st edn. Serbian Academy of Sciences and Arts, Belgrade, pp 349–357
Dinç M, Duran A, Pinar M, Őztürk M (2008) Anatomy, palynology and nutlet micromorphology of Turkish endemic *Teucrium sandrasicum* (Lamiaceae). Biologia 63:637–641
Dinç M, Doğu S, Bilgili B, Duran A (2009) Comparative anatomical and micromorphological studies on *Teucrium creticum* and *Teucrium orientale* var. *orientale* (T. sect. *Teucrium*, Lamiaceae). Nord J Bot 27:251–256
Djabou N, Muselli A, Alkali H, Dib ME, Tabti B, Varesi L, Costa J (2012) Chemical and genetic diversity of two Mediterranean subspecies of *Teucrium polium* L. Phytochemistry 83:51–62
Djeridane A, Yousfi M, Nadjemi B, Boutassouna D, Stocker P, Vidal N (2006) Antioxidant activity of some Algerian medicinal plants extracts containing phenolic compounds. Food Chem 97:654–660
Djilas SM, Markov SL, Cvetković DD, Čanadanović-Brunet JM, Ćetković GS, Tumbas VT (2006) Antimicrobial and free radical scavenging activities *of Teucrium montanum*. Fitoterapia 77:401–403
Dolatkhahi M, Dolatkhahi A, Nejad JB (2014) Ethnobotanical study of medicinal plants used in Arjan – Parishan protected area in Fars province of Iran. Avicenna J Phytomed 4:402–412
Dolina K, Łuczaj Ł (2014) Wild food plants used on the Dubrovnik coast (south-eastern Croatia). Acta Soc Bot Pol 83:175–181
Edris AE (2007) Pharmaceutical and therapeutic potentials of essential oils and their individual volatile constituents: a review. Phytother Res 21:308–323

El-Ghazali GE, Al-Khalifa KS, Saleem GA, Abdallah EM (2010) Traditional medicinal plants indigenous to Al-Rass province, Saudi Arabia. J Med Plant Res 4:2680–2683

El-Mokasabi FM (2014) Floristic composition and traditional uses of plant species at Wadi Alkuf, Al-Jabal Al-Akhder, Libya. Am Eurasian J Agric Environ Sci 14:685–697

Eshratifar M, Attar F, Mahdigholi K (2011) Micromorphological studies on nutlet and leaf indumentum of genus *Teucrium* L. (Lamiaceae) in Iran. Turk J Bot 35:25–35

Essawi T, Srour M (2000) Screening of some Palestinian medicinal plants for antibacterial activity. J Ethnopharmacol 70:343–349

Estrada-Castillón E, Villarreal-Quintanilla JA, Rodríguez-Salinas MM, Encinas-Domínguez JA, González-Rodríguez H, Figueroa GR, Arévalo JR (2018) Ethnobotanical survey of useful species in Bustamante, Nuevo León, Mexico. Hum Ecol 46:117–132

Fatiha BA, Ouafae B, Souad S, Fatima EH, Jamila D, Allal D, Lahcen Z (2017) Ethnobotany study of medicinal plants used in the treatment of respiratory diseases in the middle region of Oum Rbai. Int J Environ Agric Biotechnol 2:1460–1468

Ferrier J, Šačiragić L, Chen ECH, Trakić S, Saleem A, Alikadić E, Cuerrier A, Balick MJ, Arnason JT, Redžić S (2014) Ways the Lukomir highlanders of Bosnia and Herzegovina treat diabetes. In: Pieroni A, Quave CL (eds) Ethnobotany and biocultural diversities in the Balkans. Springer, NewYork/Heidelberg/Dordrecht/London, pp 13–27

Gharaibeh MN, Elayan HH, Salhab AS (1988) Hypoglycaemic effects of *Teucrium polium*. J Ethnopharmacol 24:93–99

Ghasemi Pirbalouti A, Momeni M, Bahmani M (2013) Ethnobotanical study of medicinal plants used by Kurd tribe in Dehloran and Abdanan districts, Ilam province, Iran. Afr J Tradit Complement Altern Med 10:368–385

Ghorbani A (2005) Studies on pharmaceutical ethnobotany in the region of Turkmen Sahra, north of Iran (Part 1): general results. J Ethnopharmacol 102:58–68

Gonzalez-Tejero MR, Casares-Porcel M, Sanchez-Rojas CP, Ramiro-Gutierrez JM, Molero-Mesa J, Pieroni A, Giusti ME, Censorii E, de Pasquale C, Della A, Paraskeva-Hadijchambi D, Hadjichambis A, Houmani Z, El-Demerdash M, El-Zayatf M, Hmamouchi M, ElJohrig S (2008) Medicinal plants in the Mediterranean area: synthesis of the results of the project Rubia. J Ethnopharmacol 116:341–357

Greuter W, Burdet HM, Long G (1986) Med-checklist 3. Trust of OPTIMA, Geneva

Gürdal B, Kültür Ş (2013) An ethnobotanical study of medicinal plants in Marmaris (Mugla, Turkey). J Ethnopharmacol 146:113–126

Gursoy N, Tepe B (2009) Determination of the antimicrobial and antioxidative properties and total phenolics of two "endemic" Lamiaceae species from Turkey: *Ballota rotundifolia* L. and *Teucrium chamaedrys* C. Koch. Plant Foods Hum Nutr 64:135–140

Güzel Y, Güzel M, Miski M (2015) Ethnobotany of medicinal plants used in Antakya: a multicultural district in Hatay Province of Turkey. J Ethnopharmacol 174:118–152

Hachicha SF, Skanji T, Barrek S, Ghrabi ZG, Zarrok H (2007) Chemical composition *Teucrium alopecurus* essential oil from Tunusia. Flavour Fragr J 22:101–104

Harley RM, Atkins S, Budantsev A, Cantino PH, Conn B, Grayer R, Harley MM, Kok R, Krestovskaja T, Morales A, Paton AJ, Ryding O, Upson T (2004) Labiatae. In: Kadereit JW (vol ed), Kubitzki K (ed) The families and genera of vascular plants VII. Springer, Berlin/Heidelberg, pp 167–275

Hasani P, Yasa N, Vosough-Ghanbari S, Mohammadirad A, Dehghan G, Abdollahi M (2007) In vivo antioxidant potential of *Teucrium polium*, as compared to alpha-tocopherol. Acta Pharma 57:123–129

Hasani-Ranjbar S, Nayebi N, Larijani B, Abdollahi M (2010) A systematic review of the efficacy and safety of *Teucrium* species; from anti-oxidant to anti-diabetic effects. Int J Pharmacol 6:315–325

Heywood VH, Brummitt RK, Seberg O, Culham A (2007) Flowering plant families of the world. Firefly Books, Ontario

Hussain W, Ullah M, Dastagir G, Badshah L (2018) Quantitative ethnobotanical appraisal of medicinal plants used by inhabitants of lower Kurram, Kurram agency, Pakistan. Avicenna J Phytomed 8:313–329

Ilhami G, Metin U, Munir O, Suktru B, Irfan K (2003) Antioxidant and antimicrobial activities of *Teucrium polium* L. J Food Technol 1:9–16

Irfan M, Nabeela I, Kamil M, Khan NA, Khan H, Khalil S, Ullah S, Shah M, Jan G, Murad W (2018) Ethnomedicinal plants uses of tehsil Khall, district Lower Dir, Khyber Pakhtunkhwa, Pakistan. Int J Biosci 13:219–229

Jaradat NA (2005) Ethnopharmacological survey of natural products in Palestine. An-Najah Univ J Res Nat Sci 19:13–67

Jarić S, Popović Z, Mačukanović-Jocić M, Djurdjević L, Mijatović M, Karadzić B, Mitrović M, Pavlović P (2007) An ethnobotanical study on the usage of wild medicinal herbs from Kopaonik Mountain (central Serbia). J Ethnopharmacol 111:160–175

Jarić S, Mitrović M, Pavlović P (2014) An ethnobotanical and ethnomedicinal study on the use of wild medicinal plants in rural areas of Serbia. In: Pieroni A, Quave CL (eds) Ethnobotany and biocultural diversities in the Balkans. Springer, New York/Heidelberg/Dordrecht/London, pp 87–112

Jarić S, Mačukanović-Jocić M, Djurdjević L, Mitrović M, Kostić O, Karadžić B, Pavlović P (2015a) An ethnobotanical survey of traditionally used plants on Suva planina mountain (south-eastern Serbia). J Ethnopharmacol 175:93–108

Jarić S, Mitrović M, Pavlović P (2015b) Review of ethnobotanical, phytochemical, and pharmacological study of *Thymus serpyllum* L. Evid Based Complement Alternat Med 2015:101978. https://doi.org/10.1155/2015/101978

Jurišić Grubešić R, Vladimir-Knežević S, Kremer D, Kaloera Z, Vuković J (2007) Trichome micromorphology in *Teucrium* (Lamiaceae) species growing in Croatia. Biologia 62:148–156

Kadifkova-Panovska T, Kulevanova S, Stefova M (2005) In vitro antioxidant activity of some *Teucrium* species (Lamiaceae). Acta Pharma 55:207–214

Kamel A, Sandra P (1994) Gas chromatography – mass spectrometry analysis of the volatile oils of two *Teucrium polium* varieties. Biochem Syst Ecol 22:529–532

Kargıoğlu M, Cenkci S, Serteser A, Konuk M, Vural G (2010) Traditional uses of wild plants in the middle Aegean region of Turkey. Hum Ecol 38:429–450

Kasabri V, Afifi FU, Hamdan I (2011) In vitro and in vivo acute antihyperglycemic effects of five selected indigenous plants from Jordan used in traditional medicine. J Ethnopharmacol 133:888–896

Kaval I, Behçet L, Cakilcioglu U (2014) Ethnobotanical study on medicinal plants in Geçitli and its surrounding (Hakkari-Turkey). J Ethnopharmacol 155:171–184

Khan MT, Ahmad L, Rashid W (2018a) Ethnobotanical documentation of traditional knowledge about medicinal plants used by indigenous people in the Talash Valley of Dir Lower, northern Pakistan. J Intercult Ethnopharmacol 7:8–24

Khan S, Jan G, Bibi H, Murad W, Ullah K, Ihsanullah (2018b) An ethnomedicinal survey of plants used in traditional medicine in arid and semi-arid zone of Bahadur Khel, District Karak, Khyber Pakhtunkhwa, Pakistan. Asian J Pharmacogn 2:41–44

Kotsiou A, Tesseromatis C (2017) Hepatotoxicity of herbal medicinal products. J Med Plant Stud 5:80–88

Kouzi SA, Mc Murtry RJ, Nelson SD (1994) Hepatotoxicity of germander (*Teucrium chamaedrys* L.) and one of its constituent neoclerodane diterpenes teucrin A in the mouse. Chem Res Toxicol 7:850–856

Kovačević N, Lakušić B, Ristić M (2001) Composition of the essential oils of seven *Teucrium* species from Serbia and Montenegro. J Essent Oil Res 13:163–165

Kucuk M, Gulec C, Yasar A, Ucuncu O, Yayli N, Coskuncelebi K, Terzioglu S, Yayli N (2006) Chemical composition and antimicrobial activities of the essential oils of *Teucrium chamaedrys* subsp. *chamaedrys*, *T. orientale* var. *puberulens* and *Teucrium chamaedrys* subsp. *lydium*. Pharm Biol 44:592–598

Lakušić B, Lakušić D (2014) Morpho-anatomical differentiation of the species *Teucrium montanum* (Lamiaceae) in the Central Balkan Peninsula. Bot Serb 38:109–120

Lans C, Turner N, Khan T, Brauer G, Boepple W (2007) Ethnoveterinary medicines used for ruminants in British Columbia, Canada. J Ethnobiol Ethnomed 3:11. https://doi.org/10.1186/1746-4269-3-11

Lardos A (2006) The botanical *materia medica* of the *Iatrosophikon* – a collection of prescriptions from a monastery in Cyprus. J Ethnopharmacol 104:387–406

Leonti M (2011) The future is written: impact of scripts on the congnition, selection, knowledge and transmission of medicinal plant use and its implications for ethnobotany and ethnopharmacology. J Ethnopharmacol 134:542–555

Lev E (2007) Drugs held and sold by pharmacists of the Jewish community of medieval (11-14th centuries) Cairo according to lists of *materia medica* found at the Taylor–Schechter Genizah collection, Cambridge. J Ethnopharmacol 110:275–293

Leyel CF (1984) A modern herbal by Mrs M. Grieve. Penguin Books, Harrnondsworlh

Maccioni S, Baldini R, Tebano M, Cioni PL, Flamini G (2007) Essential oil of *Teucrium scorodonia* L. ssp. *scorodonia* from Italy. Food Chem 104:1393–1395

Malakov PY, Papanov GY (1983) Furanoid diterpenes from *Teucrium polium*. Phytochemistry 22:2791–2793

Mashayekhan A, Pourmajidian MR, Jalilvand H, Gholami MR, Teimouri MS (2015) Ethnobotanical survey of herbal remedies traditionally used in North Khorasan Province of Iran. Med Aromat Plant 4:3. https://doi.org/10.4172/2167-0412.1000192

Máthé A (ed) (2015) Medicinal and aromatic plants of the world: scientific, production, commercial and utilization aspects. Springer, Dordrecht

Menichini F, Conforti F, Rigano D, Formisano C, Piozzi F, Senatore F (2009) Phytochemical composition, anti-inflammatory and antitumour activities of four *Teucrium* essential oils from Greece. Food Chem 115:679–686

Menković N, Šavikin K, Tasić S, Zdunić G, Stešević D, Milosavljević S, Vincek D (2011) Ethnobotanical study on traditional uses of wild medicinal plants in Prokletije Mountains Montenegro. J Ethnopharmacol 133:97–107

Meusel H, Jäger E, Rauschert S, Weinert E (1978) Vergleichende chorologie der Zentraleuropäischen fora II. Gustav Fischer, Jena

Milošević-Djordjević O, Stošić I, Stanković M, Grujičić D (2013) Comparative study of genotoxicity and antimutagenicity of methanolic extracts from *Teucrium chamaedrys* and *Teucrium montanum* in human lymphocytes using micronucleus assay. Cytotechnology 65:863–869

Mosaddegh M, Naghibi F, Moazzeni H, Pirani A, Esmaeili S (2012) Ethnobotanical survey of herbal remedies traditionally used in Kohghiluyeh va Boyer Ahmad province of Iran. J Ethnopharmacol 141:80–95

Movahedi A, Basir R, Rahmat A, Charaffedine M, Othman F (2014) Remarkable anticancer activity of Teucrium polium on hepatocellular carcinogenic rats. Evid Based Complement Alternat Med 2014:726724. https://doi.org/10.1155/2014/726724

Mustafa B, Hajdari A, Krasniqi F, Hoxha E, Ademi H, Quave CL, Pieroni A (2012) Medical ethnobotany of the Albanian Alps in Kosovo. J Ethnobiol Ethnomed 8:6. https://doi.org/10.1186/1746-4269-8-6

Navarro T, El Oualidi J (2000) Synopsis of *Teucrium* L. (Labiatae) in the Mediterranean region and surrounding areas. Fl Medit 10:349–363

Nedelcheva A, Draganov S (2014) Bulgarian medical ethnobotany: the power of plants in pragmatic and poetic frames in ethnobotany and biocultural diversities in the Balkans. In: Pieroni A, Quave CL (eds) Ethnobotany and biocultural diversities in the Balkans. Springer, New York/Heidelberg/Dordrecht/London, pp 45–65

Nedelcheva A, Pieroni A, Dogan Y (2017) Folk food and medicinal botanical knowledge among the last remaining Yörüks of the Balkans. Acta Soc Bot Pol 86:3522. https://doi.org/10.5586/asbp.3522

Nencini C, Galluzzi P, Pippi F, Menchiari A, Micheli L (2014) Hepatotoxicity of *Teucrium chamaedrys* L. decoction: role of difference in the harvesting area and preparation method. Indian J Pharmacol 46:181–184

Oybak-Dönmez E, Inceoğlu Ő (1988) Pollen morphology of some *Teucrium* L. (Labiatae) species. Commun Fac Sci Univ Ank Sér C 6:133–146

Özdemir E, Alpınar K (2015) An ethnobotanical survey of medicinal plants in western part of central Taurus Mountains: Aladaglar (Nigde – Turkey). J Ethnopharmacol 166:53–65

Ozgen U, Mavi A, Terzi Z, Yildirim A, Coskun M, Houghton PJ (2006) Antioxidant properties of some medicinal Lamiaceae (Labiatae) species. Pharm Biol 44:107–112

Özkan G, Kuleasan H, Çelik S, Göktürk RS, Ünal O (2007) Screening of Turkish endemic *Teucrium montbretii* subsp. *pamphylicum* extracts for antioxidant and antibacterial activities. Food Control 18:509–512

Paksoy MY, Selvi S, Savranc A (2016) Ethnopharmacological survey of medicinal plants in Ulukıs, la (Nigde-Turkey). J Herb Med 2016:1–7

Perez Alvarez JC, Saez-Royuela F, Pena EG, Morante AL, Oses AV, Lorente JLM (2001) Acute hepatitis due to ingestion of *Teucrium chamaedrys* infusions. Gastroenterol Hepatol 24:240–243

Perry N, Court G, Bidet N, Court J, Perry EK (1996) European herbs with cholinergic activities: potential in dementia therapy. Int J Geriatr Psychiatry 11:1063–1069

Pieroni A (2008) Local plant resources in the ethnobotany of Theth, a village in the Northern Albanian Alps. Genet Resour Crop Evol 8:1197–1214

Pieroni A, Quave CL (2005) Traditional pharmacopoeias and medicines among Albanians and Italians in southern Italy: a comparison. J Ethnopharmacol 101:258–270

Pieroni A, Quave CL, Santoro RF (2004) Folk pharmaceutical knowledge in the territory of the Dolomiti Lucane, inland southern Italy. J Ethnopharmacol 95:373–384

Pieroni A, Dibra B, Grishaj G, Grishaj I, Maçai SG (2005) Traditional phytotherapy of the Albanians of Lepushe, Northern Albanian Alps. Fitoterapia 76:379–399

Piozzi F, Bruno M, Rosselli S, Maggio A (2005) Advances on the chemistry of furano-diterpenoids from *Teucrium* genus. Heterocycles 65:1221–1234

Polat R, Satıl F (2012) An ethnobotanical survey of medicinal plants in Edremit Gulf (Balıkesir – Turkey). J Ethnopharmacol 139:626–641

Polat R, Cakilcioglu U, Satıl F (2013) Traditional uses of medicinal plants in Solhan (Bingöl – Turkey). J Ethnopharmacol 148:951–963

Prescott TAK, Veitch NC, Simmonds MSJ (2011) Direct inhibition of calcineurin by caffeoyl phenylethanoid glycosides from *Teucrium chamaedrys* and *Nepeta cataria*. J Ethnopharmacol 137:1306–1310

Rafieian-Kopaei M (2012) Medicinal plants and the human needs. J Herbmed Pharmacol 1:1–2

Rajabalian S (2008) Methanolic extract of *Teucrium polium* L. potentiates the cytotoxic and apoptotic effects of anticancer drugs of vincristine, vinblastine and doxorubicin against a panel of cancerous cell lines. Exp Oncol 30:133–138

Rajaei P, Mohamadi N (2012) Ethnobotanical study of medicinal plants of Hezar Mountain Allocated in South East of Iran. Iran J Pharm Res 11:1153–1167

Rasekh HR, Khoshnood-Mansourkhani MJ, Kamalinejad M (2001) Hypolipidemic effects of *Teucrium polium* in rats. Fitoterapia 72:937–939

Redžić S (2007) The ecological aspect of ethnobotany and ethnopharmacology of population in Bosnia and Herzegovina. Coll Antropol 31:869–890

Redžić S (2010) Wild medicinal plants and their usage in traditional human therapy (Southern Bosnia and Herzegovina, W. Balkan). J Med Plant Res 4:1003–1027

Rojas A, Hernandez L, Pereda-Miranda R, Mata R (1992) Screening for antimicrobial activity of crude drug extracts and pure natural products from Mexican medicinal plants. J Ethnopharmacol 35:275–283

Safa O, Soltanipoor MA, Rastegar S, Kazemi M, Nourbakhsh Dehkordi K, Ghannadi A (2013) An ethnobotanical survey on Hormozgan province, Iran. Avicenna J Phytomed 3:64–81

Said O, Khalil K, Fulder S, Azaizeh H (2002) Ethnopharmacological survey of medicinal herbs in Israel, the Golan Heights and the West Bank region. J Ethnopharmacol 83:251–265
Sargin SA (2015) Ethnobotanical survey of medicinal plants in Bozyazı district of Mersin, Turkey. J Ethnopharmacol 173:105–126
Šarić-Kundalić B, Dobeš C, Klatte-Asselmeyer V, Saukel J (2010a) Ethnobotanical study on medicinal use of wild and cultivated plants in middle, south and west Bosnia and Herzegovina. J Ethnopharmacol 131:33–55
Šarić-Kundalić B, Fritz E, Dobeš C, Saukel J (2010b) Traditional medicine in the Pristine Village of Prokoško Lake on Vranica Mountain, Bosnia and Herzegovina. Sci Pharm 78:275–290
Šarić-Kundalić B, Dobeš C, Klatte-Asselmeyer V, Saukel J (2011) Ethnobotanical survey of traditionally used plants in human therapy of east, north and north-east Bosnia and Herzegovina. J Ethnopharmacol 133:1051–1076
Saroglou V, Arfan M, Shabir A, Hadjipavlou-Litina D, Skaltsa H (2007) Composition and antioxidant activity of the essential oil of *Teucrium royleanum* Wall. ex Benth growing in Pakistan. Flavour Fragr J 22:154–157
Savić J, Mačukanović-Jocić M, Jarić S (2019) Medical ethnobotany on the Javor Mountain (Bosnia and Herzegovina). Eur J Intern Med 27:52–64
Šavikin K, Zdunić G, Menković N, Živković J, Cujić N, Tereščenko M, Bigović D (2013) Ethnobotanical study on traditional use of medicinal plants in south-western Serbia, Zlatibor district. J Ethnopharmacol 146:803–810
Sbai-Jouilil H, Fadli A, Zidane L (2017) Survey of ethnomedicinal plants used for the treatment of gastrointestinal disorders in Seksaoua region (western high Moroccan Atlas). Ann Res Rev Biol 16:1–9
Sezik E, Yeşilada E, Honda G, Takaishi Y, Takeda Y, Tanaka T (2001) Traditional medicine in Turkey X. Folk medicine in Central Anatolia. J Ethnopharmacol 75:95–115
Sghaier MB, Harizi H, Louhichi T, Krifa M, Ghedira K, Chekir-Ghedira L (2011a) Anti- inflammatory and antiulcerogenic activities of leaf extracts and sesquiterpene from *Teucrium ramosissimum* (Lamiaceae). Immunopharmacol Immunotoxicol 33:656–662
Sghaier MB, Skandrani I, Nasr N, Franca MG, Chekir-Ghedira L, Ghedira K (2011b) Flavonoids and sesquiterpenes from *Tecurium ramosissimum* promote antiproliferation of human cancer cells and enhance antioxidant activity: a structure-activity relationship study. Environ Toxicol Pharmacol 32:336–348
Sharififar F, Dehghn-Nudeh G, Mirtajaldini M (2009) Major flavonoids with antioxidant activity from *Teucrium polium* L. Food Chem 112:885–888
Shawahna R, Jaradat NA (2017) Ethnopharmacological survey of medicinal plants used by patients with psoriasis in the West Bank of Palestine. BMC Complement Altern Med 17:4. https://doi.org/10.1186/s12906-016-1503-4
Shtukmaster A, Ljubuncic P, Bomzon A (2010) The effect of an aqueous extract of *Teucrium polium* on glutathione homeostasis in vitro*:* a possible mechanism of its hepatoprotectant action. Adv Pharmacol Sci 2010:938324. https://doi.org/10.1155/2010/938324
Stanković MS, Topuzović M, Solujić S, Mihailović V (2010) Antioxidant activity and concentration of phenols and flavonoids in the whole plant and plant parts of *Teucrium chamaedrys* L. var. *glanduliferum* Haussk. J Med Plant Res 4:2092–2098
Stanković M, Ćurčić M, Žižić J, Topuzović M, Solujić S, Marković S (2011a) *Teucrium* plant species as natural sources of novel anticancer compouds: antiproliferative, proapoptotic and antioxidant properties. Int J Mol Sci 12:4190–4205
Stanković M, Nićiforović N, Topuzović M, Solujić S (2011b) Total phenolic content, flavonoid concentrations and antioxidant activity, of the whole plant and plant parts extracts from *Teucrium montanum* L. var. *montanum*, f. *supinum* (L.) Reichenb. Biotechnol Biotechnol Equip 25:2222–2227
Stickel F, Egerer G, Seitz HK (2000) Hepatotoxicity of botanicals. Public Health Nutr 3:113–124
Suleiman MS, Abdul-Ghani AS, Al-Khalil S, Amin R (1988) Effect of *Teucrium polium* boiled leaf extract on intestinal motility and blood pressure. J Ethnopharmacol 22:111–116

Sundaresan PR, Slavoff SA, Grundel E, White KD, Mazzola E, Koblenz D, Rader JI (2006) Isolation and characterization of selected germander diterpenoids from authenticated *Teucrium chamaedrys* and *T. canadense* by HPLC, HPLC-mS and NMR. Phytochem Anal 17:243–250

Tanira MOM, Wasfi IA, Homsi MA, Bashir AK (1996) Neuromuscular and microvascular changes associated with chronic administration of an extract of *Teucrium stocksianum* in mice. J Pharm Pharmacol 48:1098–1102

Tanira MOM, Ali BH, Bashir AK, El-Sabban FF, Al Homsi M (1997) Neuromuscular and microvascular changes associated with chronic administration of an extract of *Teucrium stocksianum* in mice. J Pharm Pharmacol 49:301–304

Tariq M, Ageel AM, al-Yahya MA, Mossa JS, al-Said MS (1989) Antiinflammatory activity of *T. polium*. Int J Tissue React 11:185–188

Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA (eds) (1972) Flora Europaea III. Cambridge University Press, Cambridge

Ulubelen A, Topcu G, Sonmez U (2000) Chemical and biological evaluation of genus *Teucrium*. Stud Nat Prod Chem 23:591–648

Ural O, Satilmiş Ö, Ura G, Dikici N (2011) A case: acute hepatitis associated with herbal (*Teucrium chamaedrys*) ingestion. Turk Hij Den Biyol Derg 68:135–138

Uritu CM, Mihai CT, Stanciu GD, Dodi G, Alexa-Stratulat T, Luca A, Leon-Constantin MM, Stefanescu R, Bild V, Melnic S, Tamba BI (2018) Medicinal plants of the family Lamiaceae in pain therapy: a review. Pain Res Manag 2018:7801543. https://doi.org/10.1155/2018/7801543

Van Wyk BE, De Wet H, van Heerden FR (2008) An ethnobotanical survey of medicinal plants in the southeastern Karoo, South Africa. S Afr J Bot 74:696–704

Vokou D, Katradi K, Kokkini S (1993) Ethnobotanical survey of Zagori (Epirus, Greece), a renowned centre of folk medicine in the past. J Ethnopharmacol 39:187–196

Volpato G, Kourková P, Zelený V (2012) Healing war wounds and perfuming exile: the use of vegetal, animal, and mineral products for perfumes, cosmetics, and skin healing among Sahrawi refugees of Western Sahara. J Ethnobiol Ethnomed 8:49

Vuković N, Milošević T, Sukdolak S, Solujić S (2007) Antimicrobial activities of essential oil and methanol extract of *Teucrium montanum*. Evid Based Complement Alternat Med 4:17–20

Wielgorskaya T (1995) Dictionary of generic names of seed plants. Columbia University Press, New York

World Checklist of Selected Plant Families. https://wcsp.science.kew.org/qsearch.do

Yin G, Zeng H, He M, Wang M (2009) Extraction of *Teucrium manghuaense* and evaluation of the bioactivity of its extract. Int J Mol Sci 10:4330–4341

Zarshenas MM, Zargaran A, Muller J, Mohagheghzadeh A (2013) Nasal drug delivery in traditional persian medicine. Jundishapur J Nat Pharm Prod 8:144–148

Zlatković B, Bogosavljević S, Radivojević A, Pavlović M (2014) Traditional use of the native medicinal plant resource of Mt. Rtanj (Eastern Serbia): Ethnobotanical evaluation and comparison. J Ethnopharmacol 151:704–713