

## Use of *Stachys* Species (Mountain Tea) as Herbal Tea and Food

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**Abstract:** *Stachys* genus is one of the largest genera of the Labiatae (Lamiaceae) family and is widely distributed across Europe and East Asia, as well as in America. In this study the essential oil composition and consumption pattern of *Stachys* species as food are discussed. A survey of the literature found that the genus was consumed primarily as teas and that this was due to their essential oil and phenolics contents. Some species of the genus are also consumed in Europe and China as a carbohydrate source.

**Keywords:** *Stachys* L.; essential oil; carbohydrate source; stachyose; tea; food. ©2014 ACG Publications. All rights reserved.

### 1. Introduction

The genus *Stachys*, one of the largest genera of the Labiatae (Lamiaceae) family with around 300 taxa, is widely distributed across the world from tropical to subtropical regions [1,2]. The genus is geographically wide spread and found mostly in the Mediterranean, South Western Asia, North and South America and South Africa. The native species are, however, absent in New Zealand and Australia [3]. The species name originates from the Greek and means “an ear of grain” referring to the inflorescence spike found in many members. Many *Stachys* species are used in decoctions or infusions for the treatment of skin, stomach, ulcer, asthma, rheumatic disorders and vaginal tumors [4,5]. Some members of genus have been reported to be used as anti-inflammatory and antibacterial agents. Moreover, their antianxiety, antioxidant and antinephritic properties have also been reported [4,5]. In Mediterranean regions and Iran, the species are consumed as herbal remedies and wild tea (mountain tea) [4,5].

Despite the widespread consumption as herbal teas in these regions there is limited reports for use as foods or food supplements. However, roots of some species have been reported to be used as a food source in some parts of Europe and in China [6,7]. Several studies and ethno-botanical notes are available indicating the consumption of species like thyme in Mediterranean culture [8]. Although members of the species are widespread throughout North Europe and East Asia, most of the studies on essential oil compositions of *Stachys* species were carried out on the plants grown in Iran, Turkey, Greece, Italy, Serbia and Montenegro. In this review, essential oil patterns of the *Stachys* genus and their consumption as food and herbal remedies in Mediterranean region, particularly in Turkey, Greece and Italy will be discussed.

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## 2. Materials and Methods

### 2.1 Botanical Properties of Genus *Stachys* L.

The *Stachys* genus comprises approximately 300 species; they are observed to be in the form of perennial and annual herbs or small shrubs, sometimes suffruticose or rarely as dwarf shrubs. The indumentum is simple and rarely has stellate or dendroid hairs. Leaves are simple, petiolate or sessile. As it is common with other members of the Lamiaceae family there are verticillasters 2-25 (-40) flowered, dense or remote, with or without bracts and bracteoles. Pedicels may be present or absent and the calyx is tubular with 5-10 veins, usually smooth, rarely ridged, sub-bilabiate to regular, rarely bilabiate, teeth 5, usually subequal, sometimes posterior 3 distinct from 2 anterior. Corolla tube is subexserted or exserted, rarely included in calyx, annulate or exannulate; limb is bilabiate, upper lip is concave, entire or emarginate, rarely deeply bifid, lower lip is trilobed, middle lobe is much longer than 2 lateral lobes. Stamens 4 are exserted from corolla tube, posterior pair usually shorter than anterior; anther cells are ditheous, sometimes subparallel to parallel. Nutlets are obovoid to oblong or subglobose, sometimes flattened trigonous.



*Stachys sericantha*



*Stachys sericantha*



*Stachys cretica* ssp. *kutahyensis*



*Stachys cretica* ssp. *kutahyensis*



*Stachys vuralii*



*Stachys vuralii*

\*Photos were reproduced by courtesy Dr. Ekrem Akçiçek's

As shown in sample photos of some species of the genus *Stachys*, they exhibit very wide range of colors from white-pale yellow to pink or purple. Many healing properties have been attributed to the plants, and consequently some species of *Stachys*, such as *S. officinalis* and *S. byzantina*, were cultivated in monasteries and both private and public gardens for landscaping.

## 2.2 Usage and Applications

A review of the literature indicated that use of the species as herbal remedies is common. Dating back to Egyptian civilizations decoctions of *Stachys* species have been used in all cultures across the world. Although some species have extremely unpleasant taste and smell, most of the species are used to prepare teas and alcohol extracts for human consumption or treatment. Antioxidant, antibacterial, anti-ulcer, anti-anxiety, anti-inflammatory, anti-nephritic properties of the species are well described in the literature. *Stachys officinalis* was an official herb of the apothecary, believed to have magical healing powers and cultivated in gardens. Nowadays, in many European gardens, *S. byzantina*, lamb's ear, is cultivated rather than *S. officinalis*. *S. inflata* is widely used to treat infection and asthma, and in the treatment of rheumatic disease in Iran. Antibacterial and antifungal activity patterns of the essential oils of *Stachys* species from Turkey and Greece are reported. *Stachys* species are consumed in Mediterranean areas, including Turkey, Greece, Italy, Balkan countries and Lebanon due to the potential antibacterial activities. Many other *Stachys* species such as *Stachys pumila* Banks & Sol., are used as a wild tea in Anatolia due to their antibacterial and healing effects [9]. Generally, the tea is prepared from the whole part of the plant and the leaves for their sedative, antispasmodic, diuretic and emmenagogic properties. The species occasionally also used to cure diarrhea, sore throat, internal hemorrhage, and for weakness of liver and heart [10]. The anti-*Helicobacter pylori* effect of the species has also been reported [11] which corresponds with the ethnobotanical use for thousands of years against stomach ulcer around the world (Table 1). One of the *Stachys* species, *S. recta*, has been included in the European Pharmacopeia and *Stachys officinalis* reported in Anthroposophic Pharmaceutical Codex (APC). Although some of the species such as *S. sylvatica*, *S. recta* and *S. annua* are reported to be poisonous, their consumption in different countries has been reported (Table 1). These species are widely used as food rather than medicinal teas in China [12].

## 2.3 Essential oils composition

The essential oil compositions of the *Stachys* genus have been well documented in the literature, but not for all the species have been described in detail. The main components of the essential oil of the species were observed to be germacrene D, caryophyllenes, cadinene, spathuleneol and caryophyllene. The moderate antibacterial activity of  $\beta$ -caryophyllene and germacrene D were reported. Germacrenes were produced as antimicrobial and insecticidal agents from *Stachys* species [5,13].

The essential oil composition of the species gives a pleasant smell to tea. Diterpenoids are a significant component of the essential oil of *Stachys* species, for example labdane, abietane, kaurane and pimarane type diterpenoids [2]. These diterpenoids have been shown to have antibacterial, antifungal, anti-mycobacterium and anti-Alzheimer activities. In a recent review the diterpenoids were also found to have synergistic effects in the essential oil. Other component of the essential oil was found to be the widely known alkaloid, stachydrine, included in *Stachys* species such as *S. baicalensis*, *S. palustris*, *S. recta*, *S. betoniciflora* and *S. sylvatica* along with betaine, choline, allantoin and ruicine.

The essential oil composition of *Stachys* species mainly consists of sesquiterpenes and oxygenated sesquiterpenes. Moreover, the monoterpenes such as  $\alpha$ -pinene,  $\beta$ -pinene, phellandrene and carvacrol were also extracted from *Stachys* species. The essential oils of 22 *Stachys* species and their pure components;  $\alpha$ -pinene,  $\beta$ -caryophyllene, linalool oxide and caryophyllene oxide were tested against several bacterial strains and *Candida albicans* and it was found that they exhibited moderate antibacterial activity [5].

**Table 1.** Essential oil composition, and usage of *Stachys* Species in world

No	Plant species	Used part of species	Main Essential oil components	Used form	Medicinal Purpose/activity	Country	References	Oil yield (% v/dry weight)
1	<i>S. lavandulifolia</i> Vahl.	Flowers	$\alpha$ -pinene, $\beta$ -myrcene, 4-hydroxy-4-methyl-2-pentanone, hexadecanoic acid	Tea,	Stomach ailment, cold, cough	Iran, Iran, Azerbaijan	[25,26,15]	0,67
2	<i>S. setifera</i> C.A.Mey. subsp. <i>setifera</i>	Aerial parts	Pulegone, $\alpha$ -terpinyl acetate, piperitone oxide, tymol	Tea, hydroalcoholic extract	Genital tumors, antiinflammatory tuomors, cancer ulcers	Iran	[27-29]	
3	<i>S. schtschegleevii</i> Sosn. ex Grossh.	Aerial parts	Germacrene D, valancene, Bicyclogermacrene, 6,10,14-trimethyl pentadecanone	Tea	Cancer ulcers, antiinflammatory, antibacterial	Iran	[30,15]	0,2
4	<i>S. balansae</i> Boiss. & Kotschy	Aerial parts	Germacrene D, valeranone, Heneicosane	No report	No report	Iran, Turkey	[31-32]	0,3
5	<i>S. byzantina</i> K. Koch	Aerial parts	Piperitenone, 6,10,14, trimethyl pentadecan-2-one, tricosane	Tea	Cancer ulcers, antiinflammatory	Iran, Azerbaijan	[26,15]	0,52
6	<i>S. inflata</i> Benth.,	Aerial parts	Hexadecanoic acid, germacrene D, $\alpha$ -pinene, bicyclogermacrene, $\Delta$ -3-carene, limonene, linalool, spathulenol	Tea, hydroalcoholic extract	Antiinflammatory, infective and rheumatic disorders	Iran, Azerbaijan	[26,33,34]	0,26-0,56
7	<i>S. laxa</i> Boiss. & Buhse	Aerial parts	Germacrene D, 4-hydroxy-4-methyl-2-pentanone, 7- <i>epi</i> - $\alpha$ -selinene	No report	No report	Iran, Azerbaijan	[26]	0,63
8	<i>S. pubescens</i> Ten.	Aerial parts	Germacrene D, (z)- $\beta$ -ocimene, $\beta$ -bourbonene, $\alpha$ -pinene	No report	No report	Iran	[35]	0,08
9	<i>S. atherocalyx</i> K.Koch	Aerial aprts	$\beta$ -bourbonene, $\beta$ -pinene, linalool, linalyl acetate, $\alpha$ -pinene, $\alpha$ -terpineol	Tea, hydroalcoholic extract	Antiniflammatory, folk medicine	Iran	[31]	
10	<i>S. officinalis</i> (L.) Trevis	Aerial parts	Germacrene D, $\gamma$ -cadinene, $\delta$ -cadinene, caryophyllene	Tea, dried Leaves	Antibacterial, against headache, nerveous tension, anxiety, menopusal problems, tobacco, snuff	Serbia, Egypt, Montenegro	[35-37]	0,04

11	<i>S. germanica</i> L.	Aerial parts	Germacrene D , phenyl ethyl heptanoate, $\beta$ -pinene, Z- $\beta$ -Ocimene, Hexadecanoic acid, (Z,Z,Z)-9,12,15-ocatadecatrienoic acid,	Tea,	Antibacterial, Cancer ulcers, antiinflammatory	Serbia, Italy	[36,10]	0,02
12	<i>S. sylvatica</i> L.	Aerial parts	Germacrene D , (+)- <i>E</i> -caryophyllene, $\delta$ -cadinene, $\beta$ -calocerene, salvial-4(14)-en-1-one	Tea (unpleasant)	Antibacterial, Cancer ulcers, antiinflammatory antispasmodic, tradional medicine	Serbia, Italy, Kosovo,	[36, 38,39]	0,001-0,02
13	<i>S. plumosa</i> Griseb.	Aerial parts	$\alpha$ -pinene, $\beta$ -pinene, abietatriene, dehydroabietane	No report	Antibacterial,	Serbia	[36,40]	0,05-0,15
14	<i>S. recta</i> L.	Aerial parts	Germacrene D, germacrene A, (+)- <i>E</i> -caryophyllene, $\alpha$ -pinene, $\beta$ -pinene, oct-1-en-3-ol, linalool	Tea	Antibacterial, tradional medicine	Serbia, Turkey,	[32,35,36]	0,02-0,05
15	<i>S. balansae</i> Boiss.&Kotschy	Aerial parts	$\alpha$ -pinene, $\beta$ -pinene, myrcene, $\beta$ -caryophyllene	Tea	Antibacterial, tradional medicine	Turkey,	[32]	0,12
16	<i>S. athorecalyx</i> K. Koch	Aerial parts	Oct-1-en-3-ol, $\alpha$ -pinene, $\beta$ -pinene, linalool	Tea	Antibacterial, tradional medicine	Turkey	[32]	0,1
17	<i>S. scardica</i> (Griseb.) Hayek	Aerial parts	Germacrene D, $\alpha$ -amoprphene, $\delta$ -cadinene, $\alpha$ -cadinol, $\alpha$ -pinene, $\gamma$ -muurolene	No report	antibacterial	Serbia, Greece	[36]	0,02-0,53
18	<i>S. glutinosa</i> L.	Aerial parts	Terpine-4-ol, $\alpha$ -pinene, $\alpha$ -terpieneol, $\beta$ -phellandrene, $\gamma$ -terpinene	No report	No report	Italy	[35, 41]	
19	<i>S. obliqua</i> Waldst. & Kit.	Aerial parts	Germacrene D, thymol, limonene, borneol, $\alpha$ -pinene, isometnhol	Tea	No report	Turkey	[16]	0,075
20	<i>S. candida</i> Bory & Chaub.	Aerial parts	$\alpha$ -cadinol, manoyl oxide, caryophyllene oxide, <i>epi</i> - $\alpha$ -muurolol, $\beta$ -caryophyllene	No report	antibacterial	Greece	[42]	
21	<i>S. chrysantha</i> Boiss.&Heldr.	Aerial parts				Greece		
22	<i>S. yemenensis</i> Hedge	Leaves	$\alpha$ -Phellandrene, $\beta$ -Phellandrene, elemol, spathulenol, $\alpha$ -eudesmol, squalene	No report	Antifungal, antibacterial	Yemen	[43]	0,9 (SFE), 0,8 (HD)
23	<i>S. obtusirena</i> Boiss.	Aerial aprts	Spathulenol, 10- <i>epi</i> - $\gamma$ -eudesmol,	No report		Iran	[44]	

24	<i>S. cretica</i> L. subsp.vacillans Rech.f.	Aerial parts	Hexadecanoic acid, (Z,Z)-9,12- ocatadecanoic acid, germacrene D, spathulenol	No report	-	Lebanon	[10]	0,18
25	<i>S. nivea</i> Labill.	Aerial parts	Hexadecanoic acid, (Z,Z)-9,12- ocatadecanoic acid, (E)- caryophyllene, 4-vinylguaiacol, spathulenol	No report	-	Lebanon	[10]	0,2
26	<i>S. hydrophila</i> Boiss.	Aerial parts	Hexadecanoic acid, (Z,Z)-9,12- ocatadecanoic acid, (E)-tetradecanoic acid, caryophyllene, 4-vinylguaiacol,	No report	-	Greece	[10]	0,27
27	<i>S. palustris</i> L.	Aerial parts	Hexadecanoic acid, (Z,Z,Z)-9,12,15- ocatadecatrienoic, hexahydrofarnesyl acetone, acid,thymol, carvacrol,	No report	-	Italy	[10]	0,21
28	<i>S. spinosa</i> L.	Aerial parts	Carvacrol,thymol, hexadecanoic acid, (Z,Z,Z)-9,12,15-ocatadecatrienoic,	No report	-	Italy	[10]	0,10
29	<i>S. alopecuros</i> (L.) Benth.	Aerial parts	(+)-caryophyllene oxide, (-) (E)- caryophyllene,	No report	Antifungal, antibacterial	Greece	[45]	6,09
30	<i>S.cretica</i> L. subsp.cretica	Aerial parts	Germacrene D, pimaradiene, bicyclogermacrene, farnesol	No report	Antifungal, antibacterial	Greece	[45]	0,04
31	<i>S.germanica</i> L. subsp. <i>heldreichii</i> (Boiss.) Hayek	Aerial parts	Germacrene D, (+)-caryophyllene oxide, (-)-(E)-caryophyllene, $\alpha$ - copaene	No report	Antifungal, antibacterial	Greece	[45]	0,03-0,24
32	<i>S. spinulosa</i> Sm.	Aerial parts	Spathuleneol, germacrene D, (+)- caryophyllene oxide,	No report	Antifungal, antibacterial	Greece	[45]	0,01
33	<i>S.euboica</i> Rech..f.	Aerial parts	$\alpha$ -copaene, (E)-caryophyllene, $\delta$ - cadinene, (+)-caryophyllene oxide	No report	Antifungal, antibacterial	Greece	[45]	0,01
34	<i>S.menthifolia</i> Vis.	Aerial parts	Abietatriene, kaurene, 13- <i>epi</i> -manoyl oxide	No report	Antifungal, antibacterial	Greece	[45]	0,14
35	<i>S.cretica</i> L. subsp. <i>cassia</i> (Boiss.) Rech.f.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ - cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
36	<i>S. cretica</i> L. subsp. <i>garana</i> (Boiss.) Rech.f.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ - cadinene, spathulenol	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
37	<i>S. cretica</i> L. subsp. <i>lesbiaca</i> Rech.f.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ - cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25

38	<i>S. cretica</i> L. subsp. <i>smyrnaea</i> Rech.f.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
39	<i>S. cretica</i> L. subsp. <i>kutahyensis</i> Akçiçek	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
40	<i>S. viticina</i> Boiss.	Aerial parts	$\beta$ -Caryophyllene, germacrene D caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
41	<i>S. obliqua</i> Waldst.& Kit.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
42	<i>S. balansae</i> Boiss. & Kotschy	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
43	<i>S. sericantha</i> P.H.Davis	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
44	<i>S. pinetorum</i> Boiss. Balansa	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
45	<i>S. bayburtensis</i> R.Bhattacharjee	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
46	<i>S. huber-morathii</i> R.Bhattacharjee	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
47	<i>S. huetii</i> Boiss.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
48	<i>S. tmolea</i> Boiss.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
49	<i>S. germanica</i> L. subsp. <i>heldreichii</i> (Boiss.) Hayek	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25

50	<i>S. bithynica</i> Boiss.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
51	<i>S. cretica</i> L. subsp. <i>anatolica</i> Rech.f.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
52	<i>S. cretica</i> L. subsp. <i>bulgarica</i> Rech.f.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
53	<i>S. spectabilis</i> Choisy & ex DC.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
54	<i>S. thirkei</i> K.Koch	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
55	<i>S. carduchorum</i> (R.Bhattacharjee)Rech.f.	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25
56	<i>S. longispicata</i> Boiss. & Kotschy	Aerial parts	$\beta$ -Caryophyllene, germacrene D, $\alpha$ -cadinene, spathulenol, caryophyllene oxide	Tea	Antibacterial, Antifungal	Turkey	[5]	0,1-0,25

\*SFE: Supercritical fluid extraction; HD; Hydrodistillation

## 2.4 Usage and Applications in Food Science

According to ethnobotanical studies and the literature survey, a similar pattern of consumption of *Stachys* species throughout Europe to the East Asia has been documented. From Europe to Iran, it is generally consumed as herbal tea due to its volatile components and phenolic species. However, it is generally consumed as a rich carbohydrate source in East Asia.

In Poland, *Stachys palustris* is used as a food source because of the presence of large amount of edible tubers which are used as soup and vodka additives, in salads and raw as snacks [7]. Similar consumptions were also observed in Sweden, Ukrain and Great Britain. During food shortages in Europe the dried powder of the *Stachys* species was used as an additive for bread [7]. Therefore, the species is also called “mayday flour”. The cooked form of *S. palustris* is slightly sweet because of its high and digestible carbohydrate content which provide a reason to be consumed against diabetes. A similar use was also reported in China for the species *S. floridana* Schuttl.ex. Benth [12]. The tubers are of nutritional value, not only to human but also wild pigs foraging in forests in Europe.

In China and Japan another species, *S. affinis* Bunge is cultivated for consumption of its tubers. As they are rich in carbohydrate content they are called *Chinese artichoke*. The cooking processes are similar to European countries. Similarly, another species, *S. kouyangensis* (Vaniot) Dunn var. *francheitiana* is also consumed by Tibetans as a wild food source in boiled and stir-fried forms [4]. The species in China, *S. geobombycis*, known as *DongChongXiaCao*, has been used for medical applications and as tonic for thousands of years. Interestingly, this species also use in Europe, China and Japan for similar properties.

A careful overview of Table 1 indicates that the ethnobotanical use of genus is widely as a herbal tea particularly in the region covering from Mediterranean to Iran. Similarly, this type of consumption of the species is observed in South America. For example, in Peru, decoctions of the aerial parts of *Stachys* sp. LAM has been consumed as traditional medicine for thousands of years [14]. This is a very interesting example of similar behaviors of people living in different geographies toward an opportunity offered by the nature.

Essential oil compositions of *S. lavandulifolia* Vahl, *S. setifera* C.A.Mey. subsp. *iranica*, *S. schtschegleevii* Sosn, *S. balansae* Boiss & Kotschy, *S. byzantina* C. Koch, *S. laxa* Boiss. & Buhse and *S. pubescens* Ten. *S. obtusirena* species were reported in Iran. Generally, infusion or decoction (as tea) form of at least nine different species have been reported in the literature (Table 1). The leaves of *S. inflata* Benth and *S. schtschegleevii* Sosn are consumed against asthma, rheumatism and infectious diseases. It is also used as an anti inflammatory agent against influenza. The other species, *S. byzantina* K. Koch, is used for the treatment of infected wounds. *S. turcomanica* Trautv is used for the treatment of foot inflammation, bronchitis, toothache and influenza. The purpose of the applications of the species is very similar to sage and thyme in the same regions. Together with their phenolic composition, the essential oil content of the species have an important role against the disorders and several types of pain (Table 1). The most common applications of *S. lavandulifolia* Vahl species are against fever, spasm, gastrodynia, dyspepsia, and flatulence. They also have sedative and anxiolytic effects. In Iran, the species *S. germanica* is a traditional medicine used in the treatment of painful menstruation and gastrodynia [15]. Consumption of the tea form of *S. lavandulifolia* Vahl, *S. balansae* Boiss & Kotschy, *S. laxa* Boiss. & Buhse is also reported in Azerbaijan (Table 1).

In Turkey, the following *Stachys* species *S. balansae*, *S. recta*, *S. balansae*, *S. atherocalyx*, *S. obliqua*, *S. cretica* subsp. *cassia*, *S. cretica* subsp. *garana*, *S. cretica* subsp. *lesbiaca*, *S. cretica* subsp. *smyrnaea*, *S. cretica* subsp. *kutahyensis*, *S. viticina*, *S. obliqua*, *S. balansae*,, *S. sericantha*, *S. pinetorum*, *S. bayburtensis*, *S. huber-morathii*, *S. huetii*, *S. tmolea*, *S. germanica* subsp. *heldreichii*, *S. bithynica*, *S. cretica* subsp. *anatolica*, *S. cretica* subsp. *bulgarica*, *S. spectabilis*, *S. thirkei*, *S. carduchorum* and *S. longispicata* are widely used as herbal teas due to their antibacterial properties. Especially, the species such as *S. cretica* subsp. *anatolica*, *S. cretica* subsp. *mersinaea*, *S. lavandulifolia* subsp. *lavandulifolia*, *S. annua* subsp. *annua* var. *lycaonica*, *S. iberica* subsp. *georgica*, *S. cretica* subsp. *smyrnaea*, and *S. obliqua* are used in the form of herb, infusion and decoction as a remedy for the treatment of cold, stomach ailments, fever and cough [16-22]. The pleasant smelling species are also used as topic over the plates in Turkey. Essential oil composition of the species is one

of the main reasons of their consumption as tea in Anatolian ethnobotany, however, the species also consists of glycosides, saponins, polyphenols, tannins, phenolic acids, flavonoids and diterpenoids together with essential oils, mono and sesquiterpenoids. Therefore, the synergetic effects of the component chemicals could be the main reason of consumption of their flowers and aerial parts as tea in Anatolian culture.

In Italy, the essential oil composition of *S. sylvatica*, *S. glutinosa*, *S. palustris*, and *S. spinosa* has reported, however, the species do not appear to have a significant ethnobotanical use as a food or tea. Although use of *S. sylvatica* as a tea has been reported, it was said to have an unpleasant smell. The bitter taste of the some *Stachys* species such as *S. annua*, *S. balansae* and *S. byzantina* could be common for their bitter diterpenic bicyclic keto-diols, which were reported to be Stachysolone, Annuanone, Stachone and Stachylone [23]. The essential oil compositions of *S. candida*, *S. alopecuros*, *S. cretica* subsp. *cretica*, *S. germanica* subsp. *heldreichii*, *S. spinulosa*, *S. euvoica* and *S. menthifolia* from Greece were reported without any information on their consumption. However, some taxa of the species such as *S. cretica* were reported to be used as tea in Turkey. It could be concluded that the species are also consumed as herbal tea in Greece, but more information is required for such a conclusion (Table 1).

The aerial parts of *S. sylvatica*, *S. plumosa*, *S. recta* and *S. scardica* are consumed as herbal teas in Serbia. The properties of *S. sylvatica* were also reported in Kosovo. Additionally, *S. officinalis* are consumed as dried leaves and sprinkled over plates of food in Serbia; similar consumption was reported in Montenegro and Egypt (for references see Table 1).

According to the above information, it is clear that the species of *Stachys* is consumed mostly in tea form and some of the species are used as a carbohydrate source. The species *S. floridana* Schuttl. ex. Benth., also named as “yinmiao”, is an important traditional Chinese vegetable for human consumption. The roots of *S. floridana* are high in the tetrasaccharide stachyose. It consists of glucose, fructose and two galactose molecules. Some extraction methods for this compound have been developed and yield up to 47% stachyose. This tetrasaccharides plays an important role as a freezing protectant in the roots of the species. Generally, this kind of saccharides can be used as a potential sugar substitute and recommended as a healthy food [12,24].

Considering the moderate antibacterial and antifungal activities of essential oil of *Stachys* species [5], and potential antioxidant activities of several extracts, the species of *Stachys* may be used as an alternative protecting agent for food industry. The extracts and essential oils of some of the species from Lamiaceae family have been used as traditional medicine for some diseases, as a food source and food preservative for thousands of years. *Stachys* species are one of those species. In tea form the bicyclic diterpenoid compounds of some *Stachys* species produce an unpleasant smell, however, the essential oil of *S. pubescens*, *S. fruticulosa*, *S. annua*, *S. inflata* and some other species have a pleasant lemon odor [23]. Moreover, essential oil contents of some species are used as an additive to improve the taste and flavor of yogurt.

In conclusion, the yield of essential oil of *Stachys* species is lower than other Lamiaceae family members (e.g. *Origanum*, *Satureja*, *Sideritis*, *Salvia*, *Thymus*) however, the consumption pattern of the species is reported to be quite similar to the other members of the family. Although, a small number of species of *Stachys* have an unpleasant smell, due to essential oil composition, most of them have a pleasant smell. They are consumed as herbal tea in the major parts of the world, and due to their moderate antibacterial, antifungal, anti-inflammatory and anti-oxidant capacity, they are widely used as herbal remedy in alternative medicine. Tubers or roots of the species are rich in carbohydrates and are used as a main dish in some part of the world.

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