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CULTIVATION POTENTIAL OF *Salvia tomentosa* AND *S. aramiensis* UNDER THE EASTERN MEDITERRANEAN CONDITIONS

Mehmet ARSLAN

Erciyes University, Agriculture Faculty, Department of Agricultural Biotechnology, Kayseri, Turkey

Corresponding author email: mehmetarslan@erciyes.edu.tr

Abstract

Salvia aramiensis and S. tomentosa species are naturally grown salvia species in Hatay province of Turkey. There has not been any attempt to cultivate these two species in Turkey. A two-year study was conducted to determine cultivation possibility of S. aramiensis and S. tomentosa under the eastern Mediterranean conditions in the 2011 and 2012 growing seasons in Hatay, Turkey. The measured plant parameters were plant height, herbage yield, essential oil content and components. Plant heights of S. tomentosa were 102.3 and 95.60 cm and plant heights of S. aramiensis were 88.35 and 97.40 cm in 2011 and 2012, respectively. Salvia tomentosa had the highest herbage yield with 40.45 g/plant while S. aramiensis had the lowest herbage yield with 37.30 g/plant in 2011. In the second year of the study, the herbage yield of S. aramiensis and S. tomentosa were 42.50 and 43.05 g/plant, respectively. Essential oil contents of S. aramiensis and S. tomentosa varied between 1.25 and 1.35% in 2011 and 1.30 and 1.20% in 2012, respectively. The major essential oil components of S. aramiensis were 1.8-cineole, camphor, para-cymeme, sabinene, germacrene-D, thujone, camphene and borneol. The major essential oil components of S. tomentosa were a-pinen, b-pinen, limonen, eucalyptol, linalool, b-mirsen, camfen, 1,8-cineole, camphor, β-caryophyllene α-humulene. With respect to herbage yield and essential oil content, Salvia aramiensis and S. tomentosa can be successfully cultivated under the eastern Mediterranean conditions.

Key words*: essential oil, herbage yield sage, Saliva tomentosa, Salvia aramiensis.*

INTRODUCTION

The genus *Salvia* (family Lamiaceae) is an annual, biannual or perennial shrubby herb consist of about 1000 species in the word and represented in the Turkish flora by 94 taxa belonging to 89 species with 45 are endemic (Davis, 1982; Güner, 2000). *Salvia* species are largely collected wild especially in Mediterranean basin and then sold in local markets or exported to the world markets. *Salvia aramiensis*, and *S. tomentosa* grown in *Pinus brutia* woodlands, rocky places and limestones in Hatay province,are perennial, evergreen and sub-shrub with woody stems. The dried leaves of thesespecies are used as herbal tea and in folk medicine to treat cold, diabetes, skin diseases and their essential oils are of economic importance worldwide due to their utilization mainly in food flavoring, perfumery and cosmetics (Yesilada et al., 1993; Demirci et al., 2002). Essential oil of these salvia species have wide range of biological activities (Haznedaroglu 2001; Kelen and Tepe, 2008; Askun et al., 2010). Many of *Salvia* species become rare and endangered due to increased domestic and foreign demands. Therefore, there is a rising trend for cultivation of *Salvia* species. Essential oil content and compositions of these three *Salvia* species were determined but their production potential has not been extensively studied yet. The essential oil content and composition of *S. aramiensis*, and *S. tomentosa* were studied extensively by many researchers (Demirci et al., 2002; Karaman et al., 2007). The objective of the current study was to determinethe herbage yield, essential oil content and essential oil component of *S. aramiensis*, and *S. tomentosa*. The interest in the commercial cultivation of sage suited for the sage market in Turkey is increasing and only few studies on the cultivation of these two species have been undertaken.

The purposes of the present study are to determine the yield potential of *Saliva tomentosa*and *S. aramiensis* under eastern Mediterranean conditions and to determine the growing possibilities of *Saliva tomentosa* and *S. aramiensis* as an alternative crop in the region.

MATERIALS AND METHODS

Salvia aramiensis and *Salvia tomentosa* plants were collected from Amanos mountains in the Eastern Mediterranean part of Turkey. The high yielding selected genotypes were vegetatively propagated by stem cuttings. The rooted cuttings were transferred in 4-row, 5 m long plots with 35 intra-row spacing at the experimental field of the Mustafa Kemal University. The crops were fertilized with 75 kg ha/ha of N and 75 kg/ha of P_2O_5 kg/ha. Drip irrigation was applied during the growing period. The soil of experimental plots was a clay silt loam with pH of 7.4, having 1.1% organic matter, 0.11% total nitrogen content, and water holding capacity of 0.36 cm^3. The long-term monthly mean temperatures from January to December were 8.2, 9.6, 13.2, 17.2, 21.2, 24.8, 27.2, 27.7, 25.6, 20.9, 14.0 and 9.4 °C, respectively. The long-term monthly mean precipitations from January to December were 172.7, 156.8, 141.3, 101.5, 90.4, 21.9, 21.9, 8.0, 39.8, 74.0, 114.2 and 172.1 mm, respectively.

The above ground parts of the plants were harvested at the onset of the flowering in the first week of May 2009 and 20010. At harvest, a sample of 10 plants was randomly selected from each plot to determine plant height, dry leaf weight/plant and dry stem weight/plant. Essential oil content, herbage and essential oil yield were determined by harvesting central two rows of the 4-row plots. The dried leaf samples (50 g) were subjected to steam distillation for 3 h using a Clevenger-type apparatus. The essential oil percentage was expressed as v/w with respect to dry matter of the initial material. GC-MS analysis: Analysis of the essential oils carried out by using Thermo Scientific Focus Gas Chromatograph equipped with MS, auto sampler and TGWAX-MS (5% Phenyl Polysilphenylene-siloxane, 0.25 mm x 30 m i.d, film thickness 0.25). The carrier gas was helium (99.9%) at a flow rate of 1 mL/min; ionization energy was 70 eV. Mass range m/z 50-650 amu. Data acquisition was scan mode. MS transfer line temperature was 250^{o}C, MS Ionization source temperature was 220^{o}C, the injection port temperature was 220^{o}C. The samples were injected with 250 split ratio. The injection volume was 1 µl. Oven temperature was programmed in the range of 50°C to 220°C at 3^{o}C/min. The structure of each compound was identified by comparison with their mass spectrum (Wiley9). The data were handled using Xcalibur software program. The retention indices (RIs) were calculated for all volatile constituents using a homologous series of n-alkane standard solutions C8-C20 (Fluka, product no. 04070) and C21-C40 (Fluka, product no. 04071).

RESULTS AND DISCUSSIONS

The climatic data indicate that the mean air temperatures January to December 2011 and 2012 were similar to the long-term mean. In July 2011 and 2012, the temperatures were slightly higher than the long-term mean. Consequently, the thermal conditions favored the growth and development of herbal plant. The long-term monthly mean precipitations from January to December in 2011 and 2012 was similar and being slightly lower than the multi-year average.

Salviatomentosa and *S.aramiensis* grow widely on the slopes at altitudes of 25 up to 450 m in the East Mediterranean region of Turkey. There is not any report on the commercial production of the plant in Turkey, since almost all of the domestically consumed *Salviatomentosa* and *S. aramiensis* have been gathered from the nature (Table 1). Plant heights varied between 88.35 and 102.3 cm in 2011 and 95.60-97.40 cm in 2012. *Salvia tomentosa* had the highest plant height than *S. aramiensis* in both years. When herbage yield was considered *S.tomentosa* had the highest herbage yield with 45.40 and 43.057 g/plant 2011 and 2012, respectively. Essential oil content did not significantly vary between two *Salvia* species. Essential oil content varied between 1.20 % and 1.35.

The constituents of *S. aramiensis* oil grown at two locations were given in Table 2. Thirty essential oil components were detected in the essential oil of *S. tomentosa* (Table 2). The major essential oil components of *S. tomentosa* were α-pinene, camphene, β-pinene, α-myrcene, 1,8 cineole, D-limonene, eucalyptol, β-thujone, thujone, limonene, camphor, and borneol. Thirty three essential oil components were detected in the essential oil of *S. aramiensis* (Table 3). The major essential oil components of *S. aramiensis* were α-pinene, camphene, β-pinene, limonene, eucalyptol, ocimene, linalool, thujone, α-humulene, palustrol, veridiflorol and carvacrol. This is in accordance with others values found in literature, which reported yields of 1.1 to 2.8% (Demirci et al., 2002; Karaman et al., 2007; Aşkun et al., 2010). The essential oil from widely cultivated common sage (*Salvia officinalis*) contained α- and β-thujone (50-70%), low camphor (less than 10%) and 1,8-cineole as the main components (Zawiślak and Dyduch, 2006; Boelens and Boelens, 1997; Chalchat et al., 1998; Pino et al., 1997; Putievsky et al., 1986).

Table 1. Plant height, herbage yield and essential oil content of *S. aramiensis* and *S. tomentosa*

Species	Plant Height(cm)		Herbage yield(g/plant)		Essential oil content (%)	
	2011	2012	2011	2012	2011	2012
S.aramiensis	88.35	97.40	37.30	42.50	1.25	1.30
S.tomentosa	102.3	95.60	45.40	43.05	1.35	1.20
LSD (0.05)	13.90	14.20	53.86	42.60	0.24	0.24

Table 2. Essential oil components of *S. tomentosa*

Compound Name	RT	RI	Area %	
			S.tomentosa	*S.aramiensis*
δ.3-Carene	3.46	1014	0.28	-
α-Pinene	3.65	1029	11.89	23.75
Camphene	4.37	1073	6.67	1.47
β-Pinene	5.17	1113	5.67	4.84
Dimethylsiloxane pentamer	6.30	1162	0.79	0.16
Cyclopentasiloxane, decamethyl	6.31	1163	-	0.16
α-Myrcene	6.53	1171	1.69	-
1,8 cineole	6.92	1185	1.31	1.97
α-Terpinene	6.93	1252	-	0.41
D-Limonene	7.45	1202	2.30	1.97
Eucalyptol	7.64	1210	9.39	9.94
Sabinene	8.87	1252	0.38	-
γ-Terpinene	8.88	1252	-	0.77
β-Cymene	9.70	1276	1.25	0.11
Ocimene	9.71	1277	-	2.54
Cis-Ocimene	10.07	1276	0.18	0.11
β-Ocimene	10.08	1287	-	2.54
Linalool	12.46	1287	0.77	2.11
β-Thujone	14.96	1356	10.74	-
Thujone	15.69	1421	8.86	20.67
Limonene	16.19	1441	1.18	-
Camphor	18.38	1455	17.68	-
Tetradecamethylcycloheptasiloxane	19.24	1510	0.81	-
Hept-6-ynyl malonic acid	19.52	1533	0.11	-
Bornyl acetate	20.93	1541	1.84	0.31
Trans-Caryophyllene	21.43	1577	1.23	2.92
Terpinen-4-ol	21.82	1589	0.55	-
10,12-Octadecadiynoic acid	23.71	1599	0.20	-
α-Humulene	24.10	1652	1.01	3.29
Lcosapent	24.89	1662	0.32	-
Borneol	25.41	1682	4.75	3.96
Hexadecamethylcyclooctasiloxane	25.70	1696	0.94	0.45
Palustrol	33.19	1917	-	0.97
2,5-Octadecadiynoic acid, methyl ester	34.90	1969	0.21	-
α-Ionol	36.76	2027	-	1.85
Veridiflorol	38.28	2076	1.29	5.47
Carvacrol	42.65	2240	-	1.35
Tetraoxatetradecan-1-ol, 14 phenoxy	54.60	2651	0.53	--
Total			94.82	94.09

CONCLUSIONS

It can be concluded from these results that the eastern Mediterranean environments are suitable for cultivation of *S. tomentosa* and *S. aramiensis*. The essential oils of *S.tomentosa* and *S. aramiensis* could have desirable chemical characteristics for domestic and international trade due to the similar concentrations of its major constituents. Most of the exported *S. tomentosa*and *S. aramiensis* were gathered from the nature. In order to meet domestic and international marked criteria such as herbage quality, essential oil content and composition, *S. tomentosa* and *S. aramiensis* must be cultivated.

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