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ARTICLE

Mineral elements in muscat sage plant (*Salvia sclarea* L.) and essential oil

Klára Szentmihályi[1]*, Éva Héthelyi[2], Viktória Virág[1,3], Mária Then[2]

[1]Institute of Materials and Environmental Chemistry, Chemical Research Center, Hungarian Academy of Sciences, Budapest, Hungary, [2]Institute of Pharmacognosy, Semmelweis University, Budapest, Hungary, [3]Lilly Hungaria Kft, Budapest, Hungary

ABSTRACT The authors investigated the element content of different parts of muscat sage plant (*Salvia sclarea* L.) by ICP-OES for 18 elements (Al, B, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, V, Zn) and the composition of muscat sage oil during distillation by GC-MS. The essential oil was obtained by steam distillation. High Li and Cr concentration was found in plant samples. The essential oil was characterized by four main components: linalool, carvon, linalyl acetate and geranyl acetate and the composition of oil was unchanged during distillation.
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KEY WORDS

Salvia sclarea L.
metal ion content
GC-MS
essential oil

Medicinal pants take a prominent part in phytotherapy for treatment of illnesses. Some herbs, as muscat sage (*Salvia sclarea* L.) generally used in cosmetic industry as well (Szentmihályi et al. 2001). It is most frequently applied in aromatization of candles for deodorization and against depression, stress. Its effect is affirmed with juniper, lemon, geranium, jasmine and spike oil.

Salvia sclarea is a cultivated, biennial plant in Central Europe. Sporadically it flowers in the first year, although usually only in the second year in June-July and later in September. The linalyl acetate content characterizes the fregrance of muscat sage oil which is the highest one during the first flowering period in the second year. The ester value, calculated as linalyl acetate and used for the standardization of the oil may be as high as 70%. Ester values of French and English oils are 54-70% and 34-53%, respectively. The free linalool, l-8-cineole and limonene contents are also characteristic compounds with their highest level in the second year as well.

The essential oil composition in leaves differs from that of in flowers. Main constituents of leaf oil are α-thujone, l.8-cineole and terpenic acid and bornyl acetate is a characteristic ester in it. At the same time the essential oil composition depends on the environment where the plant grown up and the extraction method as well (Bernáth et al. 1991). Supercritical fluid extraction gives essential oil of different quality (Illés et al. 1994; Simándi et al 1996).

Element content in flowering plant of muscat sage, aqueous and some alcoholic extracts determined earlier (Szentmihályi et al. 2004).

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*Corresponding author. E-mail: szklari@chemres.hu

The object of our investigations was to study the element content of different parts of muscat sage by ICP-OES and the characteristics of muscat sage oil by GC-MS.

Materials and Methods

The plant material (muscat sage, *Salvia sclarea* L. [8163]) originates from the Botanical and Economical Research Institute of the Hungarian Academy of Sciences, Vácrátót. The examined parts of muscat sages were as follows: leaf, stem, calyx-leaf, bracteol, petal and flowering shoot.

Essential oil was obtained by steam distillation by description of the Hungarian Pharmacopoeia (Ph.Hg.VIII).

The determination of polyphenol content and oil yield was measured by the description of Szőke and Kéry 2003).

Microscopical evaluation was occured with scanning microscope (Hitachi 264 ON).

Thin layer chromatogram of essential oil components was done according to Wagner and Blandt (1996). Toulene-ethyl acetate (95:5) was used for development of plate and the spray reagent was anillin-sulfuric acid.

GC-MS was performed with a coupled system Agilent 6890N GC, 5973N mass selective detector, the Chrom Card Server Ver. 1.2. equipped with A HP-5MS capillary column, 30 m long, 0.25 mm id., 0.25 µm film thickness was used. Carrier gas was Helium (pHe was 0.20 MPa), at 1ml/min flow rate: 1 µL (10 µL/mL essential oil in ethanol) was injected at 0.7 mg/ml velocity, splitless-type with an Agilent 7683 autosampler. Temperature of injector was 280°C, temperature of transfer line was 275°C. Oven temperature was programmed initially at 60°C for 3 min, then increased with a rate of 8°C/min to 200°C, then kept at 200°C for 2 min and also increased with a rate of 10°C/min to 250°C with a final isotherm at

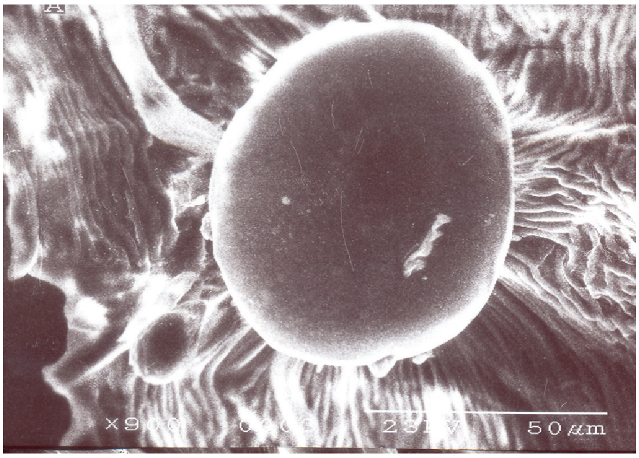

Figure 1. Surface of a grandular hair by scanning microscopy.

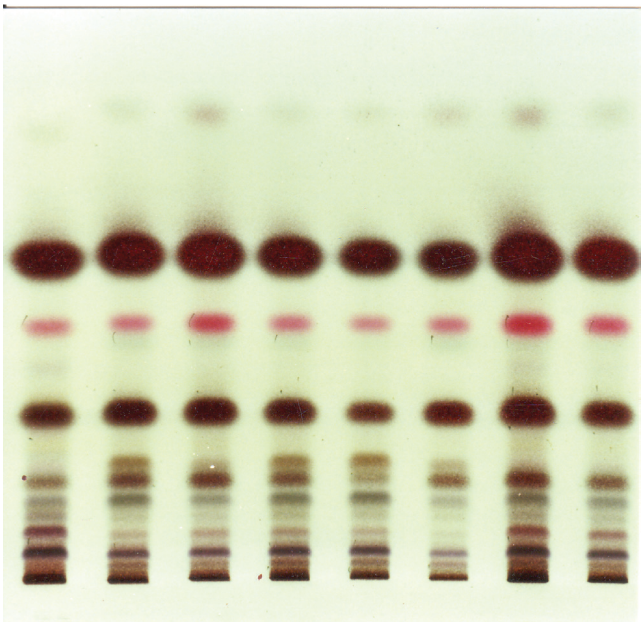

Figure 2. Thin layer chromatogram of sage oil during distillation (chromatography solvent system: toulene-ethyl acetate =95:5, spray reagent: vanillin-sulfuric acid).

250°C for 15 min. MS conditions: ionization energy was 70 eV, mass range was 40-500 m/z, 1 analysis / min was made. Identification of peaks was carried out by comparison with MS and retention data of standards, and spectra from the NIST library.

The element concentration of samples was determined by ICP-AES (inductively coupled plasma optical emission spectrmetry) by method of Then et al. (2003) Type of instrument: Atom Scan 25 (Thermo Jarrell Ash), a sequential plasma emission spectrometer. Sampling: The dry milled samples (0.5 g) were digested with a mixture of HNO_3 (5 cm^3) and H_2O_2 (3 cm^3) in teflon vessels After digestion the samples were diluted to 25 cm^3, from which the following 18 elements were determined in three parallel measurements: Al, B, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, V, Zn.

Results and Discussion

Elemental content of the samples was measured by ICP-OES and significant differences in the element contcentrations of the samples was found (Table 1). The lithium concentration of leaf and petal of sage samples are relatively very high compared to other medicinal plants (Kabata-Pendias and Pendias 1984; Kabata-Pendias and Mukherjee 2007; Szentmihályi and Then 2007). Relatively high Cr and Li content

Table 1. Element content (mg/kg) in parts of *Salvia sclarea* L.

Elements	Leaf	Bracteol	Fruit	Petal	Calyx-leaf
Al	174.2 ± 5.6	236.1 ± 2.2	9.4 ± 0.21	104.3 ± 1 6	345.5 ± 4.8
B	17.23 ± 1.13	44.01 ± 0.89	17.11 ± 1.02	24.02 ±	36
Ca	11925 ± 125	29165 ± 69	48574 ± 248	6628 ± 164	19169 ± 87
Cr	0.31 ± 0.11	0.51 ± 0.05	0.10 ± 0.01	0.13 ± 0.02	0.19 ± 0.01
Cu	7.1 ± 0.5	8.8 ± 0.2	15.2 ± 0.9	12. 6 ± 1.0	9.3 ± 0.6
Fe	289.3 ± 23	413.9 ± 31.1	43.5 ± 2.4	175.6 ± 9.5	486.6 ± 15.1
K	14758 ± 125	29268 ± 96	10014 ± 85	26058 ± 147	13237 ± 113
Li	9.91 ± 1.02	1.06 ±0.02	3.91 ± 0.21	11.05 ± 0.96	4.24 ± 0.11
Mg	2021 ± 16	4126 ± 54	3110 ± 97	2623 ± 114	3704 ± 99
Mn	14.2 ± 0.56	40. 9 ± 1.41	30.4 ± 1.36	20.1 ± 2.11	32.7 ± 0.98
Mo	0.42 ± 0.01	2.53 ± 0.14	0.73 ± 0.08	0.78 ± 0.03	0.51 ± 0.04
Na	390.2 ± 2.8	340.3 ± 6.8	62.6 ± 1.9	71.3 ± 4.7	390.9 ± 6.4
Ni	1.30 ± 0.05	0.69 ± 0.03	029 ± 0.04	3.11 ±.0.021	2.06 ±.0.07
P	2624 ± 114	3611 ± 96	6206 ± 75	3101 ± 165	2309 ± 54
Pb	1.91 ± 0.13	3.44 ± 0.31	0.15 ± 0.01	0.21 ± 0.02	4.06 ± 0.02
V	0.60 ±0.02	2.61 ± 0.09	0.14 ± 0.01	0.28 ± 0.01	0.65 ± 0.04
Zn	19.2 ± 1.0	121.5 ± 1.6	40.6 ± 2.7	24.9 ± 1.4	20.4 ± 0.9

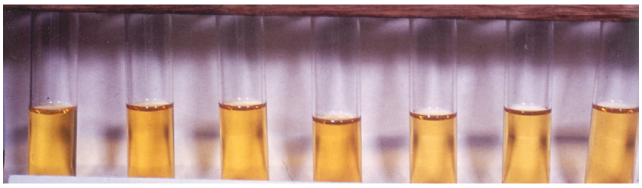

Figure 3. muskotályzsálya illóolaja desztillálás alatt.

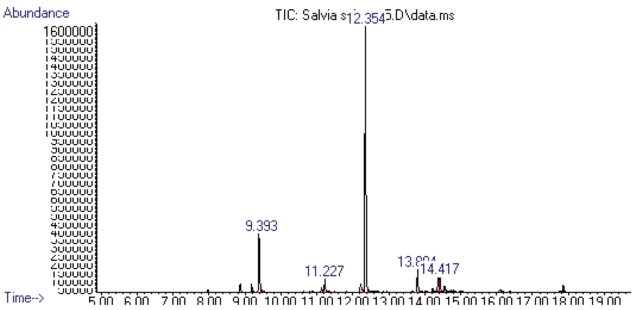

Figure 4. GC spectrrum of muscat sage oil.

was observed in the drug samples wich was published in some medicinal plants earlier (Müller et al. 1988; Then et al. 2004). Sage teas are used for exhaustion and nervosity. The high concentration of lithium of samples compared to the average plant concentration may serve as an explanation for this. Copper and boron content of *Salvia sclarea L.* is also significant, while zinc is accumulated in higher amount in bracteol. In each samples chromium was found in significant amount. The relatively high amount of Pb may be caused by the morphological characteristics of the plant. Trichomas (grandular and covering hair) of the plant surface characterize the muscat sage as it is a common morphological sign of the Lamiaceae family. Trichomes (Figures 1) of the sage may stick the pollutant which could not be removed by washing. Therefore sage samples frequently contain Pb in higher concentration than 2 mg/kg.

The polyphenol content of *S. sclarea* leaf (Table 2.) was in good agreement with the literature data (Szentmihályi et al. 2004; Then et al. 2004).

The volatile oil was obtained from leaf and flowering shoot of sage by steam distillation. The composition of oil of flowering shoot was examined during the distillation. It was obtained that the composition was almost the same during the distillation as we can see according to the thin layer chromatogram in Figure 2. The color of oil is also unchanged during the distillation (Figure 3). By the end of distillation higher amount of oil was obtained from the flowering shoot (Table 3).

The composition of essential oils was analysed by gas chromatographic mass spectrometric method. The qualitative and quntitative composition of leaf and flowering shoot oils are the same, only the percentage occurrences of the components varies. The characteristic gaschromatogram of muscat sage oil is presented on Figure 4.

The main components of muscat sage oil are linalool, carvon, linalyl acetate and geranyl acetate (Table 4).

The element content in flowering shoot (Table 5) is similar as that of the other part of muscat sage (Table 1). The essential

Table 2. Polyphenols content of *Salvia sclarea.*

Plant material		Polyphenol content (%)
S. sclarea	leaf	5.42
	flowering shoot	2.16

Table 3. Essential oil content of *Salvia sclarea.*

Plant material		Essential oil content (ml/100g)
S. sclarea	leaf	0.18
	flowering shoot	0.8

Table 4. Quantitative composition of muscat sage oil according to GC analysis.

Time (min)	Components	Area percentage (%)
9.39	Linalool	13.1
12.22	Carvon	2.5
12.36	Linalyl acetate	61.9
13.07	Geranyl acetate	4.2

Table 5. Element content of flowering shoot and different extracts ± standard deviation (mg/kg) made from flowering shoot of *Salvia sclarea* L.

Elements	Flowering shoot of plant	Essential oil	Plant rest of distillation
Al	124.1 ± 1.2	3.48 ± 2.2	33.1 ± 0.8
B	16.3 ± 0.6	10.71 ± 1.2	6.83 ±0.9
Ca	14582 ± 112	36.99 ± 3.21	7624 ± 100
Cr	4.50 ± 0.14	0.405 ± 0.054	<dl
Cu	128.2 ± 1.5	0.249 ± 0.131	17.98 ± 0.21
Fe	189.5 ± 1.9	2.95 ± 1.28	47.90 ± 4.00
K	23479 ± 159	2.66 ± 1.1	12702 ± 124
Li	26.56 ± 1.02	<dl	0.50 ± 0.09
Mg	2108 ± 5	8.05 ± 2.13	3557 ± 45
Mn	9.46 ± 0.09	0.061 ± 0.026	16.74 ± 0.32
Mo	0.66± 0.23	0.199 ± 0.017	<dl
Na	158.9 ± 7.1	22.26 ± 2.68	2680± 79
P	1750 ± 35	55.04 ± 12.11	3229 ± 15
Zn	18.32 ± 0.34	0.935 ± 0.439	<dl

<dl means under detection limit

oil also contains elements although in very low concentration. The plant rest of the distillation seems to enrich in Mg, Mn, Na and P.

In summarizing authors investigated the different plant parts of muscat sage herb. It has been stated that the muscat sage samples contains element in similar concentration then other medicinal plants. Relatively high Cr and Li content was observed in the drug samples wich was published in some medicinal plants earlier, nevertheless the Cr content of essential oil is also remarkable.

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