ESSENTIAL AND FIXED OIL CHEMICAL PROFILES OF *Salvia aegyptiaca* L. FLOWERS AND SEEDS

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ABSTRACT

The essential oil content in the flowers of *Salvia aegyptiaca* growing wild in south of Iran was found to be 0.1% (v/w). The essential oil was analyzed by GC and GC–MS. Ten constituents, representing 98.7 % of the flowers essential oil were identified. The major component of *S. aegyptiaca* flowers essential oil was identified as octane (60.7%). The fixed oil content and fatty acid composition of the seeds were also analyzed in order to determine their potential for human or animal consumption. The oil content in these edible seeds was found to be 16.2 %. The oil was analyzed by GC and GC/MS and twenty six components identified which constituted 84.6 % of the oil. The main compounds of the seeds oil were characterized as n-dodecane (23.9%), tetradecane (15.6%) and n-decane (10.5%).

Keywords: *Salvia aegyptiaca,* Lamiaceae, Flowers, Essential oil, Seeds, Fixed oil

INTRODUCTION

The largest genus of the Lamiaceae family, the genus *Salvia* L. represents an enormous and cosmopolitan assemblage of nearly 1000 species displaying remarkable variation. It has undergone marked species radiations in three regions of the world: Central and South America (500 spp.), Central Asia/ Mediterranean (250 spp.) and Eastern Asia (90 spp.) [1]. Iran, particularly, is one of the centers of origin of the genus *Salvia* with 67 species, here called with the common Persian name of "Maryam-Goli" and about 53% of endemics [2]. Some species of the genus *Salvia* are used as flavorings, food condiments and perfume additives and cultivated for the aromatic characteristics [3]. *Salvia* species have been widely used in folk medicine as anticancer, antiviral, antimicrobial, antioxidant, anti-inflammatory and spasmolytic treatments and further have been used in relief of mental, nervous and gastrointestinal disorders [4].

Abietane, labdane, ictexane, neoclerodane and phenalenone types of diterpenoids [5,6], triterpenoids and sterols [7], phenolic acids, anthocyanins, flavonoids, coumarins and polysaccharides and their derivatives [4] were reported as major constituents of *Salvia* species. Most *Salvia* species are rich in essential oils, and various biologically active monoterpenoid/sesquiterpenoid have been reported in them possessing diverse biological activities such as antioxidant [8,9], anti-inflammatory [9,10], analgesic [11], anticonvulsant, anti-ulcerogenic, tranquillizing activities [12] and antibacterial activities [13]. Furthermore, the *Salvia* species, often pleasantly aromatic plants of potential economic interest, comprise the majority of the essential oil rich genera of the Lamiaceae, and particularly tend to accumulate monoterpenoid-rich essential oils.

Salvia aegyptiaca L. is a native plant which is found just in south of Iran and grows up to a height of about 70-90 cm. This plant is extensively exploited as a medicinal plant and locally called "Maryam-Goli Mesri". It is used as antiseptic, carminative, digestive and analgesic in Iranian folk medicine. Significant antibacterial, cytotoxic and antioxidant potential of *S. aegyptiaca* has also been identified [14]. Literature survey revealed several reports from the essential oil composition of *S. aegyptiaca* aerial parts [15-17] but there was no attempt to study the essential oil of *S. aegyptiaca* flowers up to now. Regarding it and the pleasant odor of the flowers, we were prompted to investigate the volatile components of *S. aegyptiaca* flowers for the first time. Since there was no phytochemical investigation on the seeds oil, the chemical profile of *S. aegyptiaca* seeds oil was also studied.

EXPERIMENTAL

Plant material

Flowers of *S. aegyptiaca* were collected in July 2014 from Abmah village, north of Bandar Abbas, Hormozgan Province, Iran: (27°11' N 56°16' E, 900m). Specimen was identified by R. Asadpour and voucher was deposited in the Herbarium of Faculty of Pharmacy, Pharmaceutical Sciences Branch, Islamic Azad University (IAUPS), Tehran under code number 504-PMP/A.

Essential oil extraction

Flowers (100 g) were submitted to hydrodistillation in a Clevenger-type apparatus for 3 hours. At the end of distillation the essential oil was collected, dried with anhydrous Na_2SO_4, measured, and transferred to clean glass vials and kept at a temperature of −18°C for further analyses.

Fixed oil extraction

Fixed oil extraction was performed with a Soxhlet apparatus using n-hexane as the solvent. 100 g of powdered seeds was extracted for 6 h and then the solvent was evaporated by using a rotary evaporator at 30 °C. The pure oil was transferred into a small glass vial, flushed with nitrogen and maintained at -18°C until analyzed for fatty acid composition.

Fatty acid methyl esterification

Fatty acid methyl esters of the extracted oil were prepared according to the method previously reported by Metcalfe et al. [18]. 1 g of the oil was weighed into a volumetric flask. Then, 25 ml of 0.5 N methanolic potassium hydroxide was added and placed in the boiling water for 20 min. Then 12 ml boron trifluoride (BF3) was added and boiled again for 3 min. After that, the flask was cooled and 5 ml n-hexane and adequate saturated NaCl solution were added. The flask was shaken vigorously and left to stand for 5 min. the fatty acid methyl esters were prepared and dissolved in n-hexane (the upper layer). 2 ml of upper layer was transferred to a small vial and stored at0 °C until analyzed by GC/MS.

Analysis of the essential oil and fatty acid methyl esters

Essential oil and fatty acid samples analyses were separately performed on a Hp-6890 gas chromatograph (GC) equipped with a FID and a DB-5 capillary column, 30 m × 0.25 mm, 0.25 µm film thickness, temperature programmed as follows: 60°−240°C at 4°C/min. The carrier gas was N_2 at a flow of 2.0 ml/min; injector port and detector temperature were 250°C and 300°C, respectively. Samples were separately injected by splitting and the split ratio was 1:10.

GC/MS analysis was performed on a Hewlett-packard 6890 /5972 system with a DB-5 capillary column (30 m × 0.25 mm; 0.25 µm film thickness. The operating conditions were the same conditions as described above but the carrier gas was He. Mass spectra were taken at 70 eV. Scan mass range was from 40-400 m/z at a sampling rate of 1.0 scan/s. Quantitative data were obtained from the electronic integration of the FID peak areas. The components of the samples were identified by their retention time, retention indices, relative to C_9-C_{28} *n*-alkanes, computer matching with the WILEY275.L library and as well as by comparison of their mass spectra with data already available in the literature [19,20]. The percentage of composition of the identified compounds was computed from the GC peaks areas without any correction factors and was calculated relatively. The result of each oil analysis is the average of three replicates.

RESULTS

The hydrodistillation of *S. aegyptiaca* flowers gave pale yellow essential

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oil with pleasant odor and yields of 0.1% (v/w). Table 1 shows the list of compounds whose GC/MS concentration is not less than 0.1% of total peak concentration. According to Table 1, ten components were identified in the flowers essential oil which represented about 98.7% of the total composition. The major component of *S. aegyptiaca* flowers essential oil was identified as octane (60.7%). The studied essential oil comprised three hydrocarbon (69.9%), three monoterpenoids (6.3%) and four sesquiterpenoids (22.5%).

Table 1: GC-MS analysis of *S. aegyptiaca* flowers essential oil.

Compound[a]	KI[b]	KI[c]	Content (%)
Octane	898	900	60.7
α-Pinene	938	939	3.1
Camphene	951	954	0.7
Decane	998	1000	7.3
Limonene	1032	1029	2.5
Dodecane	1996	1200	1.9
β-Bourbonene	1389	1384	0.9
Spathulenol	1574	1578	5.7
Caryophyllene oxide	1585	1583	8.4
β-Eudesmol	1649	1651	7.5
Total			98.7

[a]Compounds listed in order of elution.

[b]KI (Kovats index) measured relative to *n*-alkanes (C_9-C_{28}) on the non-polar DB-5 column under condition listed in the experimental section.

[c]KI, (Kovats index) from literature.

In this study, the chemical profile of *S. aegyptiaca* seeds oil was also determined. The extracted oil was viscous and yellow in color with the total content of 16.2%. According to the Table 2, seed oil consists mainly of hydrocarbons. *n*-Dodecane (23.9%), tetradecane (15.6%) and *n*-decane (10.5%) were found to be in maximum in *S. aegyptiaca* seeds oil, followed by hexadecane (6.6%) and palmitic acid (5.7%) while other components were in minor proportions.

Table 2: Fatty acid composition of *S. aegyptiaca* seeds oil.

Compound[a]	KI[b]	KI[c]	Content (%)
Nonane, 5-methyl	963	960	0.6
Nonane, 3-methyl	966	968	0.8
n-Decane	994	1000	10.5
Undecane, 5-methyl	1155	1154	1.5
Undecane, 3-methyl	1172	1169	1.6
Cyclopentane,1-hexyl-3-methyl	1189	1192	2.6
Dodecane	1197	1200	23.9
Naphtalene,decahydro-2,3-dimethyl	1283	1285	1.0
Naphtalene,decahydro-2,3-dimethyl	1298	1296	1.1
Tridecane	1304	1300	0.5
Tridecane, 3-methyl	1370	1372	0.8
Tetradecane	1395	1400	15.6
Pentadecane, 3-methyl	1566	1570	0.3
Hexadecane	1593	1600	6.6
Octadecane	1797	1800	2.7
Heptadecanal	1900	1897	0.2
Palmitic acid (C16:0)	1980	1984	5.7
Linoleic acid (C18:2)	2071	2076	0.4
Linolenic acid (C18:3)	2111	2108	1.0
Tetracosane	2406	2400	0.7
Hexacosane	2593	2600	0.7
Heptacosane	2698	2700	1.2
Octacosane	2807	2800	0.6
Nonacosane	2895	2900	2.0
Hentriacontane	3104	3100	2.0
Total			84.6

[a]Compounds listed in order of elution.

[b]KI (Kovats index) measured relative to *n*-alkanes (C_9-C_{28}) on the non-polar DB-5 column under condition listed in the experimental section. Reported KIs were calculated based on the fatty acid methyl esters.

DISCUSSION

Identification of the compounds was made by comparing their mass spectra retention indices with those given in the literature. As the Table 1, five compounds were represented in the flowers essential oil at greater than 5% namely: octane (60.7%), caryophyllene oxide (8.4%), β-eudesmol (7.5%), decane (7.3%) and spathulenol (5.7%). Presence of high amounts of octane in the seeds essential oil was noticeable.

Lamiaceae family has been characterized by the occurrence of linoleic and linolenic acids in their seed oils and their importance as chemotaxonomic markers, for the cosmetic, nutritional and medicinal industries has also been demonstrated [21]. According to the Table 2, the oil from *S. aegyptiaca* seeds showed a low potential for use in food and medicine industries due to their fatty acids profile.

CONCLUSIONS

In conclusion, the current study is a contribution to the chemical compositions of the essential oil from *S. aegyptiaca* flowers and its seeds oil grown wild in Iran. Due to the presence of octane as the main component of the flowers essential oil, future studies on the biological and pharmacological properties of the studied oil are suggested. The present study also revealed that *S. aegyptiaca* seeds oil could not be a new source of unsaturated fatty acid rich edible oil.

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