

Seed Fatty Acid Amounts of Some *Salvia* L. Taxa in Elazig

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Abstract

Fatty acid amounts in mature seeds of thirteen *Salvia* L. taxa were determined by using gas chromatography in this study. Palmitic acid (C 16:0; 4.2-11.7 %) was major saturated fatty acid among in the studied *Salvia* species. Results of present study indicated that the seed oils of studied *Salvia* L. taxa have oleic acid (C 18:1 n-9), linoleic acid (C18:2 n-6) and linolenic acid (C 18:3 n-3) as unsaturated major fatty acids. The highest oleic acid (C 18:1 n-9) amount is found in *S. tricholoda* Bentham (30.7 %) but it is found at the lowest level in *S. verticillata* L. subsp. *verticillata* (11.3 %). Also, linoleic acid (C 18:2 n-6) amount was highest in *S. euphratica* var. *leicaliyeina* (60.4 %) but it was found at the lowest levels in *S. aethiopsis* (12.1 %). However, linolenic acid (C18:3 n-3) amount of the *Salvia* L. seeds studied showed the greatest variation (0.5-57.8 %). As a result, present study determined that *Salvia* L. species had the highest unsaturated fatty acid amounts (81.5-94.4 %) and low saturated fatty acid amounts (5.8-18.3 %).

Key words: Gas chromatography, *Salvia* L., Saturated fatty acids, Unsaturated fatty acids

Elazığ'daki Bazı *Salvia* L. Taksonlarının Tohum Yağ Asit Kompozisyonları

Özet

Bu çalışmada, on üç *Salvia* L. taksonu tohumlarındaki yağ asidi miktarları gaz kromatografisi kullanılarak tespit edildi. Çalışılan *Salvia* türleri arasında palmitik asit (C:16 0; % 4.2-11.7) başlıca doymuş yağ asididir. Bu çalışmanın sonuçları çalışılan *Salvia* L. taksonlarının tohumlarında major doymamış yağ asitleri olarak oleik asit (C 18: 1 n-9), linoleik asit (C 18: 2 n-6) ve linolenik asitin (C 18: 3 n-3) olduğunu göstermiştir. En yüksek oleik asit (C 18: 1 n-9) miktarı *S. tricholoda* Bentham'da (% 30.7) iken en düşük oleik asit miktarı *S. verticillata* L. subsp. *verticillata*'da (% 11.3) bulunmuştur. Ayrıca, linoleik asit (C 18:2 n-6) miktarı en yüksek oranda *S. euphratica* var. *leicaliyeina* (% 60.4)'da bulunurken en düşük oranda ise *S. aethiopsis* (12.1 %)'te bulunmuştur. Bununla birlikte çalışılan *Salvia* tohumlarının linolenik asit (C18:3 n-3) miktarları büyük varyasyon göstermiştir (% 0.5-57.8). Sonuç olarak bu çalışma *Salvia* L. türlerinin yüksek oranda doymamış yağ asidi miktarına (% 81.5-94.4) ve düşük oranda doymuş yağ asidi miktarına (% 5.8-18.3) sahip olduklarını belirlemiştir.

Anahtar kelimeler: Gaz kromatografisi, *Salvia* L., Doymamış yağ asitleri, Doymuş yağ asitleri

1. Introduction

Salvia L. is one of the most important aromatic and medicinal genera of the Lamiaceae (subfamily *Nepetoideae*) and comprises nearly 1000 species organized in five subgenera [1-6]. Turkey is an important country in terms of export and usage of *Salvia* L. species in the world [7]. Hedge (1982) described the 86 species

in the first revision of *Salvia* L. in Turkey [8-10]. Since then, six more species have been recorded as new species from Turkey [11-13]. Endemism ratio of *Salvia* L. species in Turkey is 48 % and Anatolia is a major centre for the genus in Asia [3]. The Lamiaceae has been characterized by the occurrence of linolenic, linoleic and oleic acids in their seeds [3, 14]. The main fatty acid amounts of species of *Salvia* L. were also

reported as palmitic acid, stearic, oleic, linoleic and linolenic acids [3, 14-15]. Furthermore, more recently, several studies demonstrated that fatty acid amounts of seeds has been frequently used as a tool in biochemical systematics and it has proven to be valuable in studies of some plant [15-19]. The objective of present study was to determine fatty acid amounts of thirteen *Salvia* L. taxa growing in Elazig (Baskil).

2. Material and Methods

In the present study, fatty acid amount in mature seeds of thirteen *Salvia* L. taxa [*S. suffruticosa* Montbret & Aucher ex Benth; *S. trichoclada* Benth; *S. euphratica* Montbret & Aucher ex Benth var. *leiocalycina* (Rech. Fil.) Hedge; *S. multicaulis* Vahl; *S. candidissima* Vahl subsp. *candidissima*; *S. microstegia* Boiss. & Bal.; *S. russellii* Benth; *S. verticillata* L. subsp. *verticillata*; *S. frigida* Boiss.; *S. virgata* Jacq.; *S. aethiopsis* L.; *S. ceratophylla* L.; *S. syriaca* L.] were examined. Sample plants were collected from the natural habitats and details about the seed materials are given Table 1.

2.1. Extraction of the seed oils and fatty acid analysis

2 gram seed materials were homogenized, mixed with hexane-isopropanol (3:2, v/v)

according to Hara & Radin method [20]. The mixture was filtered, and most of the solvents were removed by rotary evaporator. The remaining lipid residues were taken by using in hexane-isopropanol and nonlipid contaminants were removed by washing with 0.88 % KCl solution. Fatty acids in the lipid extracts were converted into methyl esters by means of 2 % sulphuric acid (v/v) in methanol [21]. The fatty acid methyl esters were extracted three times with n-hexane.

2.2. Analysis of mixtures of acid methyl esters

The methyl esters were separated and quantified by gas chromatography and flame-ionization detection (Shimadzu GC 17 Ver.3) coupled to a Glass GC 10 software computing recorder. Chromatography was performed with a capillary column (25m in length and 0.25 mm in diameter, Permabound 25, Machery-Nagel, Germany) using nitrogen as a carrier gas (flow rate 0.8ml/min). The temperature of the column, detector and injection valve were 150-220, 240, 280°C, respectively. Fatty acids were determined and calculated based on standards. Standard and sample mixtures analysed under the same conditions.

Table 1. Localities of studied *Salvia* L.

Taxa	Province	Locality
<i>S. suffruticosa</i> Montbret & Aucher ex Benth	Elazig	Baskil district, marble factory around, railway near, 1330 m
<i>S. trichoclada</i> Benth	Elazig	Baskil district, 1450m
<i>S. euphratica</i> Montbret & Aucher ex Benth var. <i>leiocalycina</i> (Rech. Fil.) Hedge	Elazig	Baskil district, marble factory around, railway near, 1330 m
<i>S. multicaulis</i> Vahl	Elazig	Baskil district, Bolucuk village, 1490 m
<i>S. candidissima</i> Vahl subsp. <i>candidissima</i>	Elazig	Baskil district, Hacı Mustafa village, 1750 m
<i>S. microstegia</i> Boiss. & Bal.	Elazig	Baskil district, Hacı Mustafa village, 1900 m
<i>S. russellii</i> Benth	Elazig	Baskil district, Quercus forest around, 1400 m
<i>S. verticillata</i> L. subsp. <i>verticillata</i>	Elazig	Baskil district, Bolucuk village, 1490 m
<i>S. frigida</i> Boiss.	Elazig	Baskil district, Hacı Mustafa village, 1850 m
<i>S. virgata</i> Jacq.	Elazig	Baskil district, Bolucuk village, 1500m
<i>S. aethiopsis</i> L.	Elazig	Baskil district, Bolucuk village, 1490 m
<i>S. ceratophylla</i> L.	Elazig	Baskil district, Bolucuk village, 1350 m
<i>S. syriaca</i> L.	Elazig	Baskil district, 1450 m

3. Results and Discussion

The results for the *Salvia* L. species studied indicated that the dominant fatty acids were palmitic acid (C 16:0), oleic acid (C 18:1 n-9), linoleic acid (C 18:2 n-6) and α -linolenic acid (C 18:3 n-3). The fatty acid amounts of thirteen species of the *Salvia* L. are given in Table 2.

Table 2. Fatty acid compositions of studied *Salvia* species (%)

Fatty acid compositions	1	2	3	4	5
15:0	-----	-----	-----	-----	-----
16:0	7.0	6.7	6.2	7.7	5.4
16:1 n9	0.7	0.4	0.5	0.6	0.5
18:0	-----	-----	-----	2.1	2.0
18:1 n9	25.7	30.7	26.5	22.7	15.1
18:2 n6	59.3	56.5	60.4	59.7	28.9
18:3 n3	0.9	0.5	0.5	2.8	41.8
18:3 n6	4.7	3.9	5.0	3.6	2.1
18:4 n3	-----	-----	-----	0.2	3.5
20:0	0.9	0.6	0.6	0.6	0.6
22:1 n9	0.3	0.3	0.2	-----	-----
22:2	0.2	-----	-----	-----	-----
22:4	-----	0.3	0.1	-----	-----
24:0	0.4	0.1	-----	-----	-----
Σ Saturated	8.3	7.4	6.8	10.4	8.0
Σ Unsaturated	91.8	92.6	93.0	89.6	91.9
Σ MUFA ^a	26.7	31.4	27.2	23.3	15.7
Σ PUFA ^b	65.1	61.2	65.8	66.3	76.3
$\Sigma\omega$ 3	0.9	0.5	0.5	3.0	45.3
$\Sigma\omega$ 6	64.0	60.4	65.4	63.3	31.0
Fatty acid compositions	6	7	8	9	10
15:0	0.3	-----	-----	-----	-----
16:0	6.7	4.2	5.0	8.5	6.7
16:1 n9	0.4	0.4	0.2	-----	0.7
18:0	2.5	1.0	1.7	2.6	1.9
18:1 n9	23.7	15.7	11.3	18.6	18.5
18:2 n6	22.5	41.2	25.4	26.4	24.8
18:3 n3	41.2	31.7	51.4	37.0	44.9
18:3 n6	-----	3.9	1.3	-----	1.6
18:4 n3	-----	-----	2.8	-----	-----
20:0	0.8	0.3	0.3	0.6	0.5
22:1 n9	0.7	0.2	0.3	5.2	0.3
22:2	-----	0.1	-----	-----	-----
22:4	1.1	1.2	0.1	1.0	-----
24:0	-----	0.2	-----	-----	0.1
Σ Saturated	10.3	5.8	7.0	11.7	9.1
Σ Unsaturated	89.6	94.4	92.8	88.2	90.9
Σ MUFA ^a	24.8	16.3	11.8	23.8	19.5
Σ PUFA ^b	64.8	78.1	81.0	64.4	71.4
$\Sigma\omega$ 3	41.2	31.7	54.2	37.0	44.9
$\Sigma\omega$ 6	22.5	45.1	26.7	26.4	26.4
Fatty acid	11	12	13		

compositions			
15:0	-----	-----	0.9
16:0	4.9	6.0	11.7
16:1 n9	0.5	0.3	2.5
18:0	1.7	1.7	3.9
18:1 n9	16.3	15.3	26.7
18:2 n6	12.1	28.4	31.9
18:3 n3	57.8	45.8	16.9
18:3 n6	1.0	1.6	-----
18:4 n3	4.7	-----	-----
20:0	0.6	0.4	1.8
22:1 n9	0.2	0.3	3.0
22:2	0.1	0.2	0.5
22:4	0.1	-----	-----
24:0	-----	0.1	-----
Σ Saturated	7.2	8.2	18.3
Σ Unsaturated	92.8	91.9	81.5
Σ MUFA ^a	17.0	15.9	32.2
Σ PUFA ^b	75.8	76.0	49.3
$\Sigma\omega$ 3	63.5	45.8	16.9
$\Sigma\omega$ 6	13.1	30.0	31.9

a-Monounsaturated fatty acids

b-Polyunsaturated fatty acids

- 1- *S. suffruticosa*, 2- *S. trichoclada*, 3- *S. euphratica*,
 4- *S. multicaulis*, 5- *S. candidissima*, 6- *S. microstegia*,
 7- *S. russellii*, 8- *S. verticillata*, 9- *S. frigida*,
 10- *S. virgata*, 11- *S. aethiopsis*, 12- *S. ceratophylla*
 13- *S. syriaca*

Total saturated fatty acid amount of the *Salvia* L. species studied ranged from 5.8 % (*S. russellii*) to 18.3 % (*S. syriaca*). The findings demonstrated that saturated fatty acids such as pentadecanoic acid (C 15:0), lignoceric acid (C 24:0) were absent or present in trace amounts. *S. multicaulis* (10.4 %), *S. frigida* (11.7 %) and *S. syriaca* (18.3 %) have the highest saturated fatty acid amount. Palmitic acid (C 16:0) was the major saturated fatty acid in the *Salvia* species studied (4.2-11.7 %). Stearic acid (C 18:0), the second major saturated fatty acid, ranged from 1.0 % (*S. russellii*) to 3.9 % (*S. syriaca*). But *S. suffruticosa*, *S. trichoclada* and *S. euphratica* didn't have stearic acid (C 18:0). Eicosanoic acid (C 20:0) was present in all studied species (0.3-1.8 %). Several previous studies showed that palmitic acid (C 16:0) and stearic acid (C 18:0) were dominant fatty acids of *Salvia* species and that eicosanoic acid (C 20:0) and behenic acid (C22:0) were absent or present in trace amounts [3, 14-15, 22]. In contrast, Habibvash et al. found that eicosanoic acid was the major saturated fatty acid of nine *Salvia* L. species (4.7-26.9 %). Also they determined that palmitic

acid (2.8-6.4 %) and stearic acid (0.4-1.9 %) were the low [23].

The present findings showed that thirteen *Salvia* L. species had higher saturated fatty acid amount than the genera *Nepeta*, *Origanum*, *Stachys* of the Lamiaceae [24-26]. Akpinar et al. identified two individual saturated fatty acid components from five *Nepeta* species as: palmitic acid (4.3-5.8 %), stearic acid (0.9-1.7 %) [24].

Azcan et al. indicated that two *Origanum* species contained palmitic acid (5.5-6.5 %) and stearic acid (2.1-2.4 %) as their principle fatty acids [25]. A previous study of *Stachys* species found that palmitic acid (3.0-7.6 %) and stearic acid (0.6-2.5 %) were the predominant saturated fatty acids [26]. However, Goren et al. determined two *Satureja* species (*S. thymbra* and *S. cunefolia*) of the Lamiaceae had the highest palmitic acid (11.4-34.6 %) and stearic acid (1.8-14.1 %) amounts in terms of saturated fatty acid amounts [27]. The present study determined that unsaturated fatty acid amount was greater than that of saturated fatty acids. This is a characteristics of the seed oils of the Lamiaceae [14].

The results of the present study show that linoleic acid (C 18:2 n-6) and α -linolenic acid (C 18:3 n-3) were the predominant polyunsaturated fatty acids. The third polyunsaturated fatty acid is γ -linolenic acid (C 18:3 n-6; 0-5.0 %) in the current study. Furthermore, stearidonic acid (C 18:4 n-3), docosadonic (C 22:2) and docosatetraenoic (C 22:4) acids were absent or present in trace amounts in the current study. Linoleic acid (C 18:2 n-6) amount was highest in *S. euphratica* var. *leicaliyeina* (60.4 %), *S. multicaulis* (59.7 %), *S. suffruticosa* (59.3 %), *S. trichoclada* (56.5 %), *Salvia russellii* (41.2 %), but it was found at the lowest levels (12.1-31.9 %) in other studied species. The α -linolenic acid (C18:3 n-3) amount of the *Salvia* L. seeds studied showed the greatest variability (0.5-57.8 %). It was found that α -linolenic acid amount of *S. suffruticosa*, *S. trichoclada* and *S. euphratica* was scanty (0.5-2.8%). But other *Salvia* L. species studied have highest α -linolenic acid amount (16.9-57.8 %). A study by Azcan et al. found that linoleic acid amount varied from 19.2 to 60.8 % and linolenic acid amount varied from 0.4 to 38.6 %. Kilic et al. indicated that the

linoleic acid amounts of studied three *Salvia* L. species were 20.8 %, 64.3 %, 73.4 % and the linolenic acid amounts were 2.9 %, 3.8 % and 18.5 %, respectively [22]. Another study by Kilic et al. determined that the linoleic acid amount of thirteen *Salvia* L. species ranged from 12.8 % to 52.2 % and that linolenic acid amount was between 3.2 % and 45.2 % [28].

Similarly, Goren et al. found that the *Salvia* L. species studied had a linoleic acid amount between 24.3 and 51.2 % [3]. They also found that the linolenic acid amount of the studied species was variable (1.4-37.2 %). Habibvash et al. found that the linoleic acid amount of nine *Salvia* L. species ranged from 0.4 % to 40.2 % and that the linolenic acid amount varied from 0.6 % to 34.3 % [23].

4. Conclusions

The present study showed that palmitic acid (C 16:0) was the major saturated fatty acid was detected in all studied taxa, and that stearic acid (C 18:0) was the second major saturated fatty acid in the *Salvia* L. taxa. The *Salvia* L. species had the highest unsaturated fatty acid amount (81.5-94.4 %) and low saturated fatty acid amount (5.8-18.3 %). *S. russellii* had the highest unsaturated fatty acid amount (94.4 %) while *S. syriaca* had the highest saturated fatty acid amount (18.3 %) among thirteen *Salvia* L. species. The main monounsaturated fatty acid was found to be oleic acid (C 18:1 n-9) in *Salvia* L. species. It was found that studied *Salvia* L. species were more variable oleic acid and α -linolenic acid amounts. Linoleic acid (C 18:2 n-6) and α -linolenic acid (C 18:3 n-3) were the major polyunsaturated fatty acids.

5. References

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