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FATTY ACID COMPOSITION OF THE LEAVES OF SOME *Salvia* TAXA FROM TURKEY

Adil Bakoglu,[1] Omer Kilic,[2] and Kagan Kokten[3]*

The genus *Salvia* L. includes more than 900 species and is mostly found in both subtropical and temperate parts of the world; the two largest genetic centers of *Salvia* L. are in America and Southwest Asia [1, 2]. In Turkey the endemism ratio of *Salvia* is 48%; thus Turkey is a major genetic center for the genus *Salvia* [3]. This genus is named "*Salvia*," derived from the Latin "Salveo," which means to "save, to recover" [4].

The seed oils of six *Salvia* taxa (*S. brachyantha* (Bordz.) Pobed., *S. candidissima* Vahl. subsp. *candidissima*, *S. trichoclada* Benth., *S. verticillata* L. subsp. *amasiaca* (Freyn & Bornm.) Bornm., *S. virgata* Jacq., *S. ceratophylla* L. amounted 69.2% to 58.5% for linoleic acid. The other studied *Salvia* taxa had ca. 22.9–44.19% content of this component. The linolenic acid contents of these genera showed very different compositional patterns between species. Whereas some species had linolenic acid content lower than 10%, others ranged from ca. 20.8–55.5%. The main differences between groups in *Salvia* taxa are very interesting. Oleic acid had similar concentrations between the studied *Salvia* taxa (16.8–23.1%) except *S. virgata* Jacq. (10.1%). Oleic acid was the third abundant and more constant component in the studied taxa [5].

Fatty acid amounts of plant materials are frequently used as a tool in biochemical systematics and has proved to be valuable in studies of some plant [6–10]. The objective of the present study was to determine the fatty acid amounts of the leaves of six *Salvia* taxa growing in Bingol.

The results of the studied *Salvia* taxa indicated that the dominant fatty acids were α-linolenic acid (18:3), linoleic acid (18:2), oleic acid (18:1), eicosanoic acid (20:0), palmitic acid (16:0), and stearic acid (18:0). The fatty acid amounts of six taxa of the *Salvia* are given in Table 1. The fatty acid compositions of *Salvia* taxa show different saturated and unsaturated fatty acid concentrations.

The results of the present study showed that α-linoleic acid, linolenic acid, oleic acid, paullinic acid, and palmitoleic acid were the unsaturated fatty acids in *S. virgata* was rich in oleic (30.02%) and paullinic acid (3.5%) concentrations (Table 1). In other *Salvia* taxa, the highest concentrations were linolenic acid (22.1%) in *S. brachyantha*; oleic acid (34.3%) and eicosanoic acid (13.9%) in *S. trichoclada*, and palmitoleic acid (6.3%) in *S. candidissima* Vahl. subsp. *candidissima* (Table 1). The present study showed that the unsaturated fatty acid amount was greater than that of saturated fatty acids. These are characteristics of the plant oils of the Lamiaceae family [11].

The present findings showed that leaves of six *Salvia* taxa had higher saturated fatty acid amounts than the genera *Nepeta*, *Origanum*, *Stachys*, and *Salvia* of the *Lamiaceae* [12–14]. Kursat et al. [6] demonstrated that palmitic acid (4.2–11.7%) and stearic acid (1.0–3.9%) were the major saturated fatty acids among the studied *Salvia* species. In another study, two individual saturated fatty acid components from five *Nepeta* species were identified as palmitic acid (4.3–5.8%) and stearic acid (0.9–1.7%) [15]. But Habibvash et al. [16] found that eicosanoic acid was the major saturated fatty acid of nine *Salvia* taxa (4.7–26.9%). Also they determined that palmitic acid (2.8–6.4%) and stearic acid (0.4–1.9%) were present in the lowest amounts. The present study showed similar results (Table 1).

Some studies [17–19] suggested that the unsaturated fatty acid contents of *Salvia* oils closely resemble each other and that the chief components are linoleic, oleic, and linolenic acid. Kilic et al. [20] indicated that the linoleic acid amounts of the three *Salvia* species studied were 20.8%, 64.3%, and 73.4% and the linolenic acid amounts were 2.9%, 3.8%, and 18.5%, respectively.

1) Program of Field Crops, Vocational School of Higher Education, University of Bingol, Turkey; 2) Department of Park and Garden Plants, Vocational School of Higher Education, University of Bingol, Turkey; 3) Department of Field Crops, Faculty of Agriculture, University of Bingol, Turkey, e-mail: kahafe1974@yahoo.com. Published in *Khimiya Prirodnykh Soedinenii*, No. 4, July–August, 2016, pp. 583–584. Original article submitted July 7, 2014.

TABLE 1. Leaf Fatty Acid Composition of Six *Salvia* Taxa, %

Fatty acid	1	2	3	4	5	6
6:0	–	0.21	–	0.49	–	0.15
8:0	0.20	–	0.15	–	0.30	–
10:0	1.70	0.8	2.31	–	0.90	1.02
12:0	–	0.2	–	0.49	–	0.10
14:0	2.45	–	–	0.76	0.96	1.12
15:0	0.34	–	–	4.06	–	–
16:0	6.5	16.9	8.53	14.58	10.13	12.06
16:1	5.20	6.3	–	1.07	–	2.92
17:0	1.21	–	2.12	–	0.12	–
18:0	14.50	2.88	3.25	5.07	2.50	22.54
18:1	15.90	18.73	34.30	13.14	30.02	21.16
18:2	21.62	27.42	14.72	21.13	27.61	14.80
18:3	22.1	15.33	13.70	32.82	12.46	13.05
20:0	5.98	6.25	13.9	4.32	7.25	5.27
20:1	–	0.67	2.82	1.02	3.46	–
22:0	–	–	–	–	2.05	1.00
24:0	2.06	1.26	–	–	–	–
25:0	–	3.05	4.02	–	2.24	4.67
26:0	0.25	–	0.18	1.05	–	0.14
ΣTSFA	29.20	25.30	20.60	26.50	19.20	42.80
ΣTUSFA	70.80	74.70	79.40	73.50	80.80	57.20

1 – *S. brachyantha*, 2 – *S. candidissima* subsp. *candidissima*, 3 – *S. trichoclada*, 4 – *S. verticillata* subsp. *amasiaca*, 5 – *S. virgata*, 6 – *S. ceratophylla*.

Another study determined that the linoleic acid amount of 13 *Salvia* taxa ranged from 12.8% to 52.2% and that the linolenic acid amount was between 3.2% and 45.2% [20]. The seed oils of 13 of the studied *Salvia* taxa amounted to 12.1–60.4% for linoleic acid, 2.1–57.6% for linolenic acid, and 11.3–30.7% for oleic acid [6].

Similarly, Goren et al. [14] found that the *Salvia* species studied had a linoleic acid amount between 24.3 and 51.2%. They also found that the linolenic acid amount of the studied species was variable (1.4–37.2%). In the literature, there are some phytochemical studies with *Salvia* taxa [21]. Habibvash et al. [16] found that the linoleic acid amount of nine *Salvia* species ranged from 0.4% to 40.2% and that the linolenic acid amount varied from 0.6% to 34.3%. The same results were obtained in this study.

Plant Samples. In this research, plant samples were collected from natural habitats in the Eastern Anatolian region of Turkey in the years 2012–2013. *S. trichoclada* was collected between Kirkagil-Topalan Village, *Quercus* Forest edge, 1370–1380 m, 10.06.2013, Kilic 4702; *S. verticillata* subsp. *amasiaca* was collected in the vicinity of Dikme upland, steppe, 1800–1850 m, 20.06.2013, Kilic 4763; *S. ceratophylla* was collected north of Yelesen Village, stony areas, 1800–1850 m, 26.06.2014, Kilic 4900; *S. virgata* was collected in the vicinity of Dikme upland, steppe, 1800–1850 m, 20.06.2013, Kilic 4768; *S. brachyantha* was collected in the vicinity of Saban Village, left of road, slopes, 1750–1800 m, 18.05.2014, Kilic 5681; *S. candidissima* subsp. *candidissima* was collected east of Asagicakmak Village, river edge, 1250–1300 m, 25.05.2010, Kilic 1793. The voucher specimens were deposited in the Department of Park and Garden Plants from Bingol, Turkey and Firat University Herbarium (FUH) from Elazig, Turkey. The results are shown in Table 1.

Oil Extraction and Preparation of Fatty Acid Methyl Esters (FAME). All plant samples were air-dried at room temperature in a shady place and kept from direct light. Lipids were extracted with hexane–isopropanol 2 v/v [22]. The lipid extracts were centrifuged at 10.0 g for 5 min and filtered. The solvent was removed on a rotary evaporator at 40°C.

Capillary GLC. Fatty acids in the lipid extracts were converted into methyl esters by means of 2% sulfuric acid (v/v) in methanol [12]. The fatty acid methyl esters were extracted with *n*-hexane. Then 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 (25 m in length and 0.25 mm in diameter, Permabound 25, Machery-Nagel, Germany) using nitrogen as carrier gas (flow rate 0.8 mL/min, the temperatures of column, detector, and injector valve were 130–220 and 240–280°C). Identification of the individual method was performed by frequent comparison with authentic standards mixtures that were analyzed under the same conditions.

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