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VITAMIN CONTENTS OF SOME *Salvia* L. TAXA GROWING IN TURKEY

Aysel Sari,[1*] Murat Kursat,[2] Semsettin Civelek,[2] and Irfan Emre[3]

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The genus *Salvia*, with about 900 species, is one of the most widespread members of the family Lamiaceae. Some of them are used worldwide as flavoring and in folk medicines and are listed in modern pharmacopoeias [1–3]. Turkey is an important country for export and usage of *Salvia* species in the world [4]. There are 89 species and 98 taxa of *Salvia* recorded in the flora of Turkey [5–8]. The ratio of endemism of the genus *Salvia* species in Turkey is 51% and Anatolia is a major center for the genus in Asia [7, 8].

Many medicinal herbs contain a wide variety of free radical scavenging molecules, such as phenolic compounds, terpenoids, and vitamins, and some other endogenous metabolites that possess antioxidant activity [9]. There is increasing interest in the antioxidant effects of compounds derived from plants, which could be relevant in relation to their nutritional incidence and their role in health and disease [10]. *Salvia* species are most important sources of antioxidant used as a preventive and they have wider implications with respect to dietary intake of natural antioxidants [4, 11]. When antioxidant vitamins are decrease in cells, free radical molecules destroy the cell components [12].

There is increasing interest in natural antioxidant products for use as medicines and food additives. Vitamin C, vitamin E, and carotenoids are some of these widely used natural antioxidants [13]. Consumption of foods containing antioxidants may prevent some diseases, and, therefore, it is very important to determine their antioxidant capacity in order to estimate their effect on oxidative stress in living things [14]. In this study, we determined the vitamin content (lipid-soluble vitamins and water-soluble vitamins such as vitamin C) of nine *Salvia* taxa by HPLC (Table 1). The examined *Salvia* taxa contain vitamin D2, vitamin D3, α-tocopherol, α-tocopherol acetate, vitamin K1, vitamin K2, and vitamin C (water-soluble vitamin), but retinol and retinol acetate were present in the trace amounts or absent in the studied taxa. Among the studied *Salvia* taxa, *S. virgata* and *S. euphratica* have the highest vitamin D2 content (10.0 and 15.0 μg/g, respectively), while *S. russellii* (101.8 μg/g), *S. virgata* (93.8 μg/g), *S. ceratophylla* (90.8 μg/g), and *S. verticillata* (90.2 μg/g) have the highest vitamin D3 content.

The tocopherols are recognized as the important antioxidants in vegetable oils mainly because of their lipophilicity, and it is agreed that scavenging of peroxyl radicals is the main mechanism responsible for tocopherol′s action [15, 16]. α-Tocopherol acetate was found in greater proportion than α-tocopherol in the studied *Salvia* seeds. α-Tocopherol acetate was found in all the investigated taxa and has the highest levels in seeds of *S. trichoclada* (38.2 μg/g), *S. russellii* (26.2 μg/g), *S. suffruticosa* (25.2 μg/g), and *S. candidissima* (16.58 μg/g), whereas the α-tocopherol contents of the studied *Salvia* taxa were lowest (except for *S. trichoclada*; 35.6 μg/g) or absent. The present results disagree with the findings of Bagci et al., who found that the studied *Salvia* species have an α-tocopherol content between 2.72±0.11 and 71.61±0.00 μg/g [17]. In addition, the vitamin K1 contents of the studied taxa were 1.2–13.6 μg/g, but the vitamin K2 contents of the studied *Salvia* taxa were the highest (apart from *S. trichoclada* and *S. euphratica,* which do not have vitamin K2 content). *S. suffruticosa* (80.6 μg/g), *S. virgata* (36.0 μg/g), and *S. candidissima* (27.74) have the highest vitamin K2 content. Moreover, we determined the vitamin C contents in the present study. Vitamin C acts as a catalyst in oxidation-reduction reactions and as a reducing agent that neutralizes free radicals [18]. The studied *Salvia* taxa have similar vitamin C contents. *S. aethiopis* (23.99 μg/g) has the highest vitamin C content, while *S. verticillata* (17.00 μg/g) has the lowest vitamin C content.

1) Firat University, Faculty of Science and Arts, Department of Chemistry, 23169, Elazig, Turkey, fax: +90 424 2330062, e-mail: ayselsari@hotmail.com; 2) Firat University, Faculty of Science and Arts, Department of Biology, 23169, Elazig, Turkey; 3) Firat University, Faculty of Education, Department of Primary Education, 23169, Elazig, Turkey. Published in Khimiya Prirodnykh Soedinenii, No. 6, pp. 784–785, November–December, 2009. Original article submitted May 2, 2008.

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TABLE 1. Vitamin Contents of Studied *Salvia* Taxa (Baskil district Province)

Taxa	1	2	3	4	5	6	7	8	9
S. suffruticosa	–	–	7.2	32.8	–	25.2	1.2	80.6	17.80
S. trichoclada	–	–	2.4	19.8	35.6	38.2	7.4	–	17.78
S. euphratica	–	–	15.0	18.0	–	7.4	7.8	–	22.58
S. candidissima	–	–	–	73.16	–	16.58	8.83	27.74	21.03
S. russellii	–	0.4	3.2	101.8	5.0	26.2	11.6	17.8	19.89
S. verticillata	0.4	–	–	90.2	–	5.2	2.4	16.4	17.00
S. virgata	–	–	10.0	93.8	3.6	13.2	13.6	36.0	18.17
S. aethiopis	0.2	–	–	21.8	4.2	7.0	10.6	11.0	23.99
S. ceratophylla	–	–	4.8	90.8	4.2	9.2	9.0	15.4	18.49

1 – Retinol (Vitamin A); 2 – Retinol acetate; 3 – Vitamin D2; 4 – Vitamin D3; 5 – α-Tocopherol (Vitamin E); 6 – α-Tocopherol acetate; 7 – Vitamin K1; 8 – Vitamin K2; 9 – Vitamin C.

Plant Materials. Sample plants were collected from different habitats and details about the seed materials are given (Table 1).

Chromatographic Analysis and Quantification of Lipid- Soluble Vitamins. The extracted lipids of seed material were dissolved in acetonitrile/methanol (75/25 v/v), and 50 μL was injected into an HPLC instrument (Shimadzu, Kyota Japan). The column used was a Supelcosil ^{TM} LC18 (250×4.6 mm, 5 μm, Sigma, USA). The mobile phase was acetonitrile–methanol (75:25, v/v), and the elution was performed at a flowrate of 1 mL/min. The temperature of the analytical column was kept at 40°C. Detection was performed at 320 nm for retinol (vitamin A) and retinol acetate, at 215 nm for δ-tocopherol, vitamin D2 and D3, α-tocopherol, and α-tocopherol acetate, and at 235 nm for vitamin K1. Identification of the individual vitamins was performed by frequent comparison with authentic external standard mixtures analyzed under the same conditions. Class Vp 6.1 software assisted in workup of the data [19]. Results of analysis are expressed as μg/g for samples.

Vitamin C Analysis. Vitamin C and other fat-soluble vitamins were analyzed using a VP series fully automatic high performance liquid chromatography (HPLC) instrument (Shimadzu, Kyoto, Japan). One gram of seed material was finely ground in a mill and then homogenized with 3 mL ultradeionized water [20]. The mixture was mixed with 2 mL cold 5% (w/v) metaphosphoric acid (MPA) and then centrifuged at 10.000 g for 5 min. The supernatant (50 μL) was injected via an autosampler into an HPLC instrument. The column used was a Discovery RP-AmideC16 column (150 × 4.6 mm, 5 μm, Supelco USA). The mobile phase of the HPLC system was 5 mM 1-hexane sulfonic acid sodium salt + % 0.1 phosphoric acid (pH 2.5), and the flow rate was 1 mL/min. Vitamin C was detected at UV 244 nm. Different concentrations of L-ascorbate in 5% MPA were used as vitamin C standards. The retention time for L-ascorbate was 2.5 min. Integration was done by peak area, and quantification was achieved with the external standard method. Class Vp 6.1 software assisted in workup of the data [19].

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