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THE ESSENTIAL OIL AND YIELD COMPONENTS FROM VARIOUS PLANT PARTS OF *SALVIA FRUTICOSA*[1]

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ABSTRACT.—The essential oil content and dry leaf percentage were the highest in the summer, while the green yield matter was the highest in the spring, of cultivated clone of *Salvia fruticosa*. During the stage of full blooming, the stem contains a low level of essential oil, compared with its content in the leaves and inflorescences. The composition of the essential oil was similar in the stems and in the inflorescences but differed from that found in the leaves.

Three-lobed sage (*Salvia fruticosa* Mill.) (synonym, *Salvia triloba* L.) (Labiatae) is an important herb used mainly in the Mediterranean region for tea and as a spice in meat and poultry dishes (1). On the world market, the three-lobed sage, called Turkish or Greek sage, is used as a substitute or additive to *Salvia officinalis* L. (true sage) (2) and for oil production (3). The main suppliers of the three-lobed sage are Turkey, Greece, Albania, and some islands in the Mediterranean (mainly Cyprus and Crete) (4). In these countries, plants are collected from wild populations once a year starting between the end of the flowering stage and the beginning of seed formation (5). Under cultivated conditions (including herbicide application, irrigation, fertilization, etc.), the first harvest takes place in the spring at the flowering stage, but for the two other harvests (in the summer and autumn) there is no phenological evidence and, therefore, the plants are harvested when the old leaves start to shed.

In the present study the yield components and the essential oil in different plant parts at flowering were studied in a pure clone of three-lobed sage growing under cultivated conditions.

MATERIALS AND METHODS

During the winter of 1979-80, 400 plants of *S. fruticosa* were transferred from wild populations in Israel to an experimental field at the Newe Ya'ar Agricultural Experiment Station. Ten plants, covering the range of variation obtained in the original population, were marked and propagated vegetatively. One plant (25/16) was selected according to its high yield of dried leaves and essential oil. From this clone, 500 stem cuttings were planted in October 1982, at a spacing of 0.5×0.6 m. Herbicide application, irrigation, and fertilization were as practiced with other plants of the Labiatae family (6). There were four harvests per year in March, May, July, and October. In the third year of growth, six samples were taken in mid-April instead of March. In April, plants were in full bloom, and leaves, stems, and inflorescesces were hand separated.

At each harvest, the plants were hand-cut 30 cm above the ground, and the fresh matter was weighed. Samples of about 2 kg were dried for 48 h at 40°. The dried leaves were separated and weighed, and four samples, 100-200 g each, were hydro-distilled in a Clevenger-type apparatus for 2 h.

The essential oil was cooled and separated from the cohobated water, and a 0.1-μl sample was analyzed on a Varian 3700 gas liquid chromatograph with a flame ionization detector and a Hewlett-Packard 3390 integrator. The column, Carbowax 20M on Chromosorb W 80-100 mesh, 3 m× ¼″ (i.d.), with a gas flow of 30 ml N_2/min, was held at 80° for 3 min, then programmed to 210° at 6°/min, and held at 210° for 5 min.

Identification of the main components was done by comparison of the retention times to those of authentic standards and by gc/ms using a 25 m carbowax 20M fused silica capillary column (7).

RESULTS AND DISCUSSION

The yield of fresh matter in the first year of growth increased in each harvest, but

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from the second year there was a special pattern (Figure 1). In the spring, the fresh yield was the highest (2.0 kg/m^2), the percentage of dried leaves (11% from fresh weight), and essential oil content (1.0% from dried leaves) were quite low. In the summer the fresh yield was somewhat lower, while the dried leaf percentage (13%-19% from fresh weight) and the essential oil content (1.4%-3.8% from dried leaves) were high. The situation in the autumn was intermediate. The fresh yield (0.8 kg/m^2) and the essential oil content (3.0% from dried leaves) were reduced, but the dried leaf percentage (20% from fresh weight) was increased.

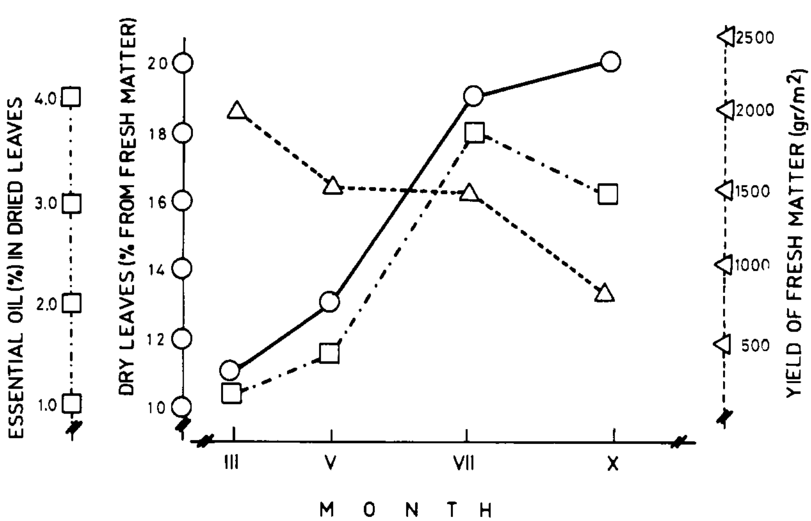

FIGURE 1. Essential oil content, percentage of dry leaves, and fresh matter yield in the second and the third years of growth, at different harvest dates, of a clone of *Salvia fruticosa*.

The same pattern of yield components' variation in different seasons was obtained in other aromatic species of the Labiatae family, like oregano (6) and sage (8).

Flowering in *S. fruticosa* starts in mid-March and ends in late May. For almost an entire month (April) plants are in full bloom, and in this stage the fresh matter is at its maximum level (2 kg/m^2). At this stage the proportion of leaves and stems is very similar (41% and 45% of the fresh weight), while the proportion of inflorescences is low (14%). The essential oil content is very low in fresh stems (0.02%), high in the inflorescences (0.22%), and somewhat lower in the leaves (0.18)%.

The composition of the main components in the essential oil from the fresh herb is similar to that obtained in other studies (2,7).

The chemical composition of the essential oil in the leaves and in green matter is similar because the percentages of oil contributed by the leaves is 65%.

The content of monoterpene and sesquiterpene hydrocarbons is high in stems and inflorescences (54%) compared with leaves (40%). The percentage of oxygenated monoterpenes is higher in leaves (51%) than in stems and inflorescences (41%) (Table 1).

A high content of α-pinene and camphor was obtained in stems and inflorescences, while the content of 1,8-cineole and myrcene was higher in leaves.

Werker *et al.* (9) mentioned the large differences in the structure of the glandular hairs between leaves and flowering parts. Burbott and Loomis (10) found influences of day length, light intensity, and temperature on essential oil composition. These factors may be the cause of the differences obtained in the essential oil composition of the various plant parts.

TABLE 1. Essential Oil Content and Components in Various Fresh Plant Parts at the Full Bloom Stage in a Clone of *Salvia fruticosa*

Component	Content (% of the essential oil)			
	fresh matter	leaves	stem	inflorescences
mono- and sesquiterpene hydrocarbons				
α-pinene	26.8	18.6	37.3	31.5
camphene	2.3	2.1	2.7	3.1
β-pinene	5.5	5.0	7.0	6.6
myrcene	1.7	3.4	0.1	0.8
caryophyllene	10.4	11.3	7.6	10.4
oxygenated monoterpenes				
1,8 cineole	37.9	44.0	31.5	30.8
camphor	4.6	3.3	6.8	5.6
borneol	1.1	1.1	1.0	1.3
α-terpinyl acetate	2.7	2.8	2.0	3.4
Essential oil content (%) from fresh weight	0.15	0.18	0.02	0.22

LITERATURE CITED

1. Z. Yaniv, A. Dafni, and D. Palevitch, in: "Aromatic Plants: Basic and Applied Aspects, "Ed. by N. Margaris, A. Koedam and D. Vokou, Martinus Nijhoff Publ., The Hague., 1982, p. 265.
2. A.O. Tucker, M.J. Maciarello, and J.H. Howell, *Econ. Bot.*, **34**, 16, (1980).
3. B.M. Lawrence, "Essential Oils 1976-1978," Allured Publ. Co., Wheaton, Il., 1979.
4. M. Grieve, "A Modern Herbal," Penguin Books, New York, 1977.
5. P. Greenhalgh, "The Market for Culinery Herbs," Report of Tropical Products Institute, No. G.-121, London, 1979.
6. E. Putievsky, U. Ravid, and S.Z. Hussain, in: "Essential Oils and Aromatic Plants," Ed. by A. Baerheim Svendsen and J.J.C. Scheffer, Martinus Nijhoff Dr. W. Junk Publ., Dordrecht, 1985, p. 185.
7. U. Ravid and E. Putievsky, in: "Essential Oils and Aromatic Plants," Ed. by A. Baerheim Svendsen and J.J.C. Scheffer, Martinus Nijhoff Dr. W. Junk Publ., Dordrecht, 1985, p. 155.
8. E. Putievsky, U. Ravid, and N. Dudai, *J. Nat. Products*, **49**, 326, (1986).
9. E. Werker, U. Ravid, and E. Putievsky, *Israel. J. Bot.*, **34**, 31 (1985).
10. A.J. Burbott and W.D. Loomis, *Plant Physiol.*, **42**, 20 (1967).

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