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SEASONAL VARIATION OF ESSENTIAL OIL YIELD AND COMPOSITION OF DALMATIAN SAGE, *SALVIA OFFICINALIS*

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ABSTRACT.—The leaves of *Salvia officinalis* L. were collected during the months of June to December 1981, from the same locality. The yield and composition of essential oil have been determined in seven samples with special reference to the content of thujone, 1,8-cineole, and camphor. It was found that the yield and composition of the oil changed from month to month. The maximum of essential oil in the leaves appeared during July. In order to obtain an essential oil with a maximum percentage of thujone, the harvest of sage leaves is recommended during October.

Salvia officinalis L. is a widespread plant in Yugoslavia and is one of the most significant plants of the coastal flora. It grows spontaneously on the sunny hillsides of the Dalmatian islands and adjacent coast zones (800-5000 m broad) of the Adriatic Sea (1). It is very abundant in the northern part of the Adriatic coast, where it sometimes covers a few square miles and is the only plant growing on the poor, rocky soil (Karst region).

Climatic and soil conditions, as well as methods and date of harvesting, influence the quality and purity of plant material collected for the market. Vernazza (2-4) has investigated the quality and quantity of sage leaves, as well as essential oil from different regions over a long period of time. Guenther (5) noted that the best type of aromatic sage plant is produced in the district of Dubrovnik, where harvesting starts early in June and continues to the beginning of September. Devetak (1) also reported on the quality and purity of plant material grown in the Doli-Ston district of Dubrovnik.

In order to find the best time of the year to collect sage leaves, we investigated the qualitative and quantitative changes in the essential oil composition, at different vegetation periods of plant growth. Generally, the harvest of sage leaves in Dalmatia starts on July 15th and lasts until December, weather conditions permitting. Our samples were collected in approximately the middle of the month from June to December, 1981, in the Doli-Ston district of Dubrovnik.

MATERIALS AND METHODS

The sage leaves from wild plants were collected and identified for their authenticity. The essential oil was obtained by steam distillation for 3 h in an apparatus, according to the Yugoslavian Pharmacopoeia (6). The yield of essential oil and refractive index for each sample is given in Table 1. The composition of the oil samples are given in Table 2. Gc analyses were performed using a Pye-Unicam gas chromatograph model 204, equipped with a flame ionization detector and a CDP-4 computing integrator. The fused silica WCOT column used was a Pye-Unicam 25 m×0.25 mm i.d. coated with FFAP. Split injection was used throughout the analyses 50:1. Other conditions of the instrument were as follows: initial temperature of the column, 70°; final temperature, 220°; injection block temperature, 250°; detector temperature, 300°; initial time, 1 min., rate 6°/min., and final time, 2 min. Carrier gas was hydrogen, working pressure 0.5 barr. Gc/ms analyses were done on Kratos MS-25 mass spectrometer combined with Data System DS 50S which was used for identication of components in essential oil.

TABLE 1. The Percentage of Essential Oil and Total Thujone of *Salvia officinalis* L. Collected in the Doli-Ston District of Dubrovnik during 1981

Sample	Date of harvest	Essential oil (% /v/w/)	Refractive index (20°)	Total thujone (%)
1	June 15	2.8	1.4668	48.12
2	July 8	3.1	1.4636	53.70
3	August 8	2.9	1.4631	52.39
4	September 9	2.4	1.4629	55.07
5	October 10	2.2	1.4631	57.72
6	November 10	2.1	1.4650	52.43
7	December 10	1.8	1.4662	46.44

TABLE 2. The Seasonal Variation of Components in Essential Oil (%)

Compounds	Date of harvest						
	June 15	July 8	August 8	September 9	October 10	November 10	December 10
unidentified	—	0.62	0.22	0.60	0.44	0.37	0.35
α-pinene	3.01	3.13	2.03	3.60	2.74	3.02	2.30
camphene	1.72	2.41	3.17	2.74	1.97	3.06	2.33
β-pinene	0.73	0.86	0.79	1.04	1.03	1.63	1.03
myrcene	1.02	1.24	0.97	1.03	0.95	1.12	0.87
limonene	1.04	1.17	1.52	1.19	0.91	1.03	1.15
1,8-cineole	13.17	10.75	8.55	9.06	8.68	5.75	7.23
γ-terpinene	—	0.44	0.26	0.30	0.36	0.44	0.32
p-cymene	—	0.99	1.02	1.12	0.97	0.59	0.58
α-thujone	23.10	33.14	12.26	22.39	22.89	27.30	10.86
β-thujone	25.02	20.56	40.13	32.68	34.83	25.11	35.58
camphor	9.53	8.63	16.37	9.55	7.12	11.96	11.18
linalool	0.49	0.36	0.51	0.28	0.25	0.30	0.31
linalyl acetate	0.75	0.71	0.62	0.43	0.26	0.47	0.42
bornyl acetate	0.91	0.48	0.58	0.41	0.57	0.62	1.14
unidentified	—	0.47	0.48	0.52	0.50	0.46	0.48
unidentified	—	—	9.76	0.29	0.29	—	1.33
unidentified	4.76	2.67	0.69	2.02	2.41	5.78	2.54
borneol	1.41	1.81	2.12	2.02	1.61	1.94	3.40
unidentified	—	—	—	0.28	0.31	—	0.41
unidentified	—	—	0.27	0.25	0.23	—	—
unidentified	1.21	1.16	0.61	1.57	1.56	1.22	1.40
unidentified	8.13	5.86	4.97	4.77	6.01	4.18	4.26
β-caryophyllene	0.55	0.66	0.28	0.53	0.46	—	0.22
humulene	1.24	1.85	0.83	1.31	2.33	3.43	2.94

RESULTS AND DISCUSSION

As shown in Table 1, the content of the essential oil fluctuated markedly from June to December. The highest percentage of oil in the sage leaves was found during July (3.1%) which was during the period of full vegetation. The content decreased in Autumn (October, 2.2% v/w), which is the period of latent vegetation. Our results were similar to those obtained by Vernazza and Nadali (2). These authors reported that the highest percentage of oil was obtained in July; the yield of oil decreased afterwards and was about 25% lower in October.

Burmeister and Guttenberg (7) postulated that the long dry period in the vegetation of sage was the basis for higher essential oil production in the plant, which is explained by the delayed approach of oxygen to the leaf tissue. The same is known from the experience of pluckers and exporters of sage in our country.

The data obtained in the qualitative and quantitative determinations of the oil samples are reported in Table 2. The analyses showed the highest percentage of 1,8-cineole to be in the June sample. In subsequent samples, the content of 1,8-cineole decreased, except for a slight increase in the September and December samples. The percentage of camphor was remarkably high in September and then it decreased in September and October, but increased in November and December (Figure 1).

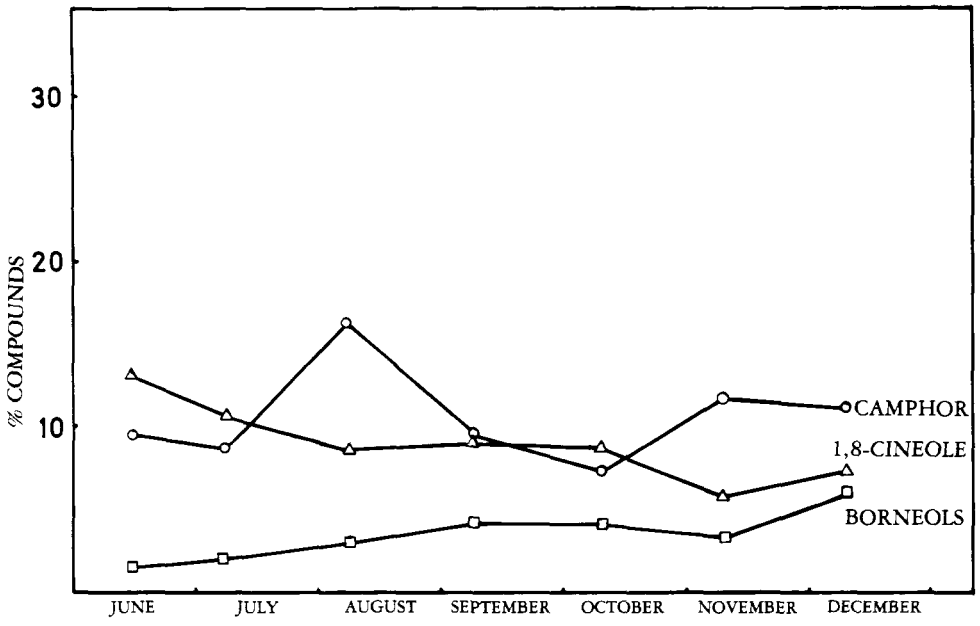

FIGURE 1. Seasonal variation of the content of 1,8-cineole, camphor and borneol in the sage oil samples investigated.

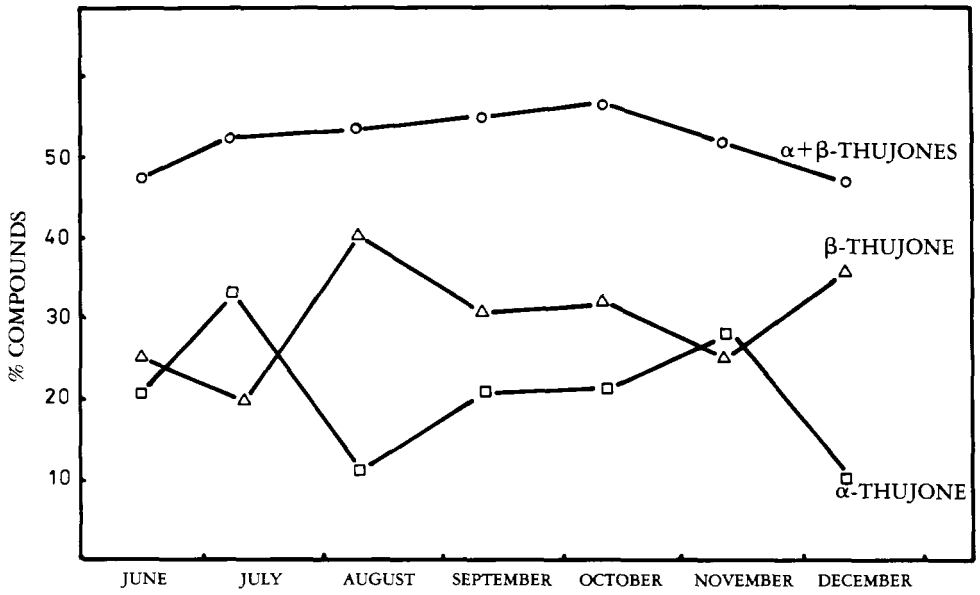

FIGURE. 2. Seasonal variation of thujone content in the sage oil samples investigated.

There is a decided difference in the content of α- and β-thujone. This can be observed in Figure 2.

In an attempt to obtain a better knowledge of the composition of the essential oil in the leaves of Dalmatian sage, we have collected samples of Dalmatian sage from one locality through the period of full and latent vegetation of the plant. From these investigations, it is possible to conclude the following. (1) Maximum percentage of essential oil in the leaf of Dalmatian sage was found in July. (2) To obtain the best quality of Dalmatian sage oil, the sage leaves should be harvested in October when the content of total thujone is the highest.

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