

PRELIMINARY RESULTS: ASSESSMENT OF NEW SALVIA CHEMOTYPES FOR HERBAL TEA INDUSTRY BY HYBRIDIZATION

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Abstract

Common sage (*S. officinalis* L.) and Anatolian sage (*S. fruticosa* Mill.) are the most used sage species in herbal tea industry. Besides that, Antioch sage (*S. aramiensis* Rech. fill.) naturally presents only in Hatay province of Turkey and used as herbal tea in the region. The risk of sage usage is toxicity from camphor and thujone content. *S. officinalis* known as its high content of thujone and camphor. In contrast *S. fruticosa* and *S. aramiensis* known as their high content of eucalyptol. Both *S. officinalis* and *S. fruticosa* has high essential oil content rather than *S. aramiensis*. The aim was to develop new chemotypes (low camphor and low thujone) by interspecific hybridization for health. Species were reciprocal crossed except for *S. officinalis*. It was used just as mother for all crosses due to male sterility. Although the chromosome numbers of the species were the same, general crossing ability was very low. Essential oil contents of the hybrids were ranged 0.75-4.21%. Camphor, thujone and eucalyptol contents were evaluated in the crossed population.

Key words: hybrids, thujone, camphor, sage.

INTRODUCTION

One of the most important members of the Lamiaceae family, the genus *Salvia*, with close to 1000 species, is widely distributed in eco-systems and used for different purposes (food, perfumery, ornamental plant, medicine etc.) (Kintzios, 2000; Walker & Sytsma, 2007; Kahraman et al., 2009). In Turkey, the *Salvia* genus has 97 species, 4 subspecies and 8 varieties, of which 55 are endemic (Hedge, 1982; Davis et al., 1988; İpek & Gürbüz, 2010).

S. officinalis L. is the most commonly used herbal tea and spice among the sage species. 1.8 cineole, camphor, thujone, pinen and borneol are the most common components in the essential oil of *Salvia* species used as herbal tea and spices (Lamaison et al., 1991; Cuvelier et al., 1994; Lawrence, 1998). Several studies conducted on *S. officinalis* showed that the main component of the essential oil is thujon and the ratio of 1.8 cineole is lower. In contrast, *S. fruticosa* essential oil has been shown to be rich in 1.8 cineole content and low in thujone content (Bazina et al., 2008; Herraiz-Penalver et al., 2015; Ayanoğlu et al., 2012; Bayram, 1998; Cvetkovikj et al. 2015; Baydar, 2005). *S.*

aramiensis Rech. fil., used as herbal tea, is a species with low camphor ratio, little or no thujone. It grows only in Hatay in Turkey. Studies have shown that the camphor rate of *S. aramiensis* essential oil is between 1.0-1.5% and the rate of thujone varies between 0-1.1% (Demirci et al., 2002; Karaman et al., 2007; Aşkun et al., 2010; Kelen & Tepe, 2008; Ayanoğlu et al., 2012; Ertaş et al., 2017). Camphor and thujone are the most important factors limiting their usage as herbal tea and spices, although each of them has many usages in the field of medicine and cosmetics. Sage can be added to foodstuffs if the thujone content in the final product does not exceed 0.5 mg/kg (Böszörményi et al., 2009). In food industry, *Salvia* chemotypes containing low thujone should be preferred (Bielenberg, 2007; Pelkonen et al., 2013). Thujone consumption in *S. officinalis* essential oil should not exceed 5 mg per day and is not recommended for those under 18 years of age (European Medicines Agency, 2010). Both thujone and camphor are known to be very toxic when used for long-term treatment (Millet et al. 1981, De Vincenzi & Mancini, 1997). In particular, even when taken in small amounts, camphor can cause serious or fatal consequences for young

children (Liebelt & Shannon, 1993; Theis & Koren, 1995; Shahabi et al., 2012).

Salvia species are divided into various groups according to the similarity of species to each other. *S. officinalis*, *S. fruticosa* and *S. aramiensis* are in the same group (*Salvia*). *S. officinalis* and *S. fruticosa* species have $2n = 14$ chromosomes (Hedge, 1982; Doğan et al., 2008). The chromosome number of *S. aramiensis* was determined as $2n = 14$ in our study. *S. officinalis*, *S. fruticosa* and *S. aramiensis* are cross pollinated species moreover natural hybridization between *S. officinalis* and *S. fruticosa* has been recorded (Herraiz-Penalver, 2015; Radosavljevic et al., 2019). Artificial interspecific crossing of *Salvia* genotypes also studied but most of them were floriculture except one *S. officinalis* and *S. fruticosa* crossing research (Haque & Goshal, 1981; Putievsky et al., 1990; Tychonievich & Warner, 2011).

A very large variation could be obtained in the first generation (F1) in cross pollination between the species. This increases the probability of genotypes having the desired properties (Macukanovic-Jocic et al., 2011; Subaşı & Güvensen, 2011). The results of the studies conducted in which the genetic structure of *Salvia* genotypes associated with essential oil components suggest that genetic factors may be more effective than environmental factors on essential oil components (Skoula et al., 1999; Bazina et al., 2008; Böszörmenyi et al., 2009).

The aim of the study was to reveal the variation among hybrids from three species in the sight of essential oil composition especially eucalyptol, thujone and camphor.

MATERIALS AND METHODS

In the study, parent plants from *S. officinalis*, *S. fruticosa* and *S. aramiensis* were propagated by stem cuttings from Mustafa Kemal University Plant Collection Garden. Species were both used as mother and father plant except for *S. officinalis*. *S. officinalis* flowers were male sterile. *S. fruticosa* plants started flowering followed by *S. officinalis* and the last one was *S. aramiensis*. Pollens of the species were collected until the flowering period of mother species. Crosses were made by emasculation and hand pollination. In the emasculation,

process anthers were removed before inflorescence and blooming (opened) flowers were removed. Petals were removed to facilitate the pollination. The flowers were pollinated once and bagged with net covers until harvest for seeds.

After seeds set, approximately 6 weeks after hand pollination, flower branches were harvested further stages. Before sowing seeds soaked in 300 ppm GA3 solution for 24 hour to improve germination. Later seeds were sown in petri dishes. Germination starts in 7 days and continues 4 weeks, after 4 weeks seeds were washed with water and treated replicated. Germinated seeds were planted in plastic viols and plants were placed in green house. The hybrids were placed in pots after extend length almost 20 cm. In summer time pots were moved outside of the green house. Planting material was peat and perlite mix. The hybrids were harvested to obtain their essential oil ratio. For each hybrid, dry leaf samples were weighed and water distilled for 3 hours with Clevenger apparatus. Essential oil ratios are the mean value from dry plant material weight and expressed in g/100 g dry weight percentage.

Essential oils were kept amber vial at +4 °C until analysis. Essential oil components were analysed with GC-MS (Gas Chromatography-Mass Spectrometry) device Thermo Scientific ISQ Single Quadrupole. 5 µl of essential oil was diluted in 2 ml cyclo hexan. Column model was TG-Wax MS (5% Phenyl Polysilphenylene-siloxane, 0.25 mm inner diameter * 60 m length, 0.25 µm film thickness). The ionization energy was calibrated as 70 eV, and the mass interval was m/z 1.2- 1200 amu. The scan mode was used as the screening more in data collection. MS transfer line temperature was 250°C, MS ionization temperature was 220°C, and whereas colon temperature was 50°C at the beginning, then it was increased up to 220°C with 3°C/min rate of temperature increase. The structure of each component was defined using mass spectrums (Wiley 9) with Xcalibur software.

RESULTS AND DISCUSSIONS

Sage flowers have 4-lobed superior ovary, could have maximum 4 nutlets from one flower. Seed set of pollinated plants was very low. Germination ratio was varied in different

crosses as 4-15%. The essential oil ratios and components were determined from hybrid plants and their parent plants. All the hybrids and their parents cultivated in the same agricultural conditions and harvested at the same time in July. Mean values of essential oil ratio, components, and variation between parental plant species and hybrid genotypes were given in Table 1. The results showed a high variation among the analysed plants. Some hybrid genotypes gave higher essential oil ratio results than their parent species. Highest essential oil ratio in parent species was from *S. fruticosa* as 3%, in the hybrid plant of *S. officinalis* (mother) x *S. aramiensis* (father) and *S. officinalis* (mother) x *S. fruticosa* (father) gave the highest essential oil ratio results respectively, 4.21% and 4.08%. Lowest

essential oil ratio found in *S. aramiensis* (mother) x *S. fruticosa* (father) hybrid plant as 0.75%. Essential oil ratios of hybrids (43 *S. aramiensis* x *S. fruticosa* hybrids, 15 *S. fruticosa* x *S. aramiensis* hybrids, 14 *S. officinalis* x *S. aramiensis* hybrids and 10 *S. officinalis* x *S. fruticosa* hybrids) were given in Table 2. *S. aramiensis* x *S. fruticosa* hybrids showed the lowest mean essential oil ratio (2.16%) value compare to all other hybrid combinations. Highest mean values were obtained from *S. officinalis* x *S. fruticosa* hybrids (3.25%). Different from our results in some studies hybrids of different *Salvia* species showed intermediate essential oil ratio from their parents (Putievsky et al., 1990; Herraiz-Penalver et al., 2015).

Table 1. Ratio of main components in the essential oil of three *Salvia* species and their hybrids

Parents and hybrids	Essential Oil Ratio (%)	Eucalyptol (%)	Thujone (%)	Camphor (%)
<i>S. officinalis</i>	2,0	20-25	25-30	30-35
<i>S. fruticosa</i>	3,0	45-55	N.D.	15-20
<i>S. aramiensis</i>	1,5	55-60	N.D.	5-15
<i>S. officinalis</i> x <i>S. fruticosa</i>	2,5-4,08	16,66-71,30	0,04-26,31	0,35-32,15
<i>S. officinalis</i> x <i>S. aramiensis</i>	1,71-4,21	12,49-61,91	0,84-21,58	0,25-47,11
<i>S. fruticosa</i> x <i>S. aramiensis</i>	1,76-3,84	8,71-60,11	1,19-14,62	8,71-60,11
<i>S. aramiensis</i> x <i>S. fruticosa</i>	0,75-3,97	4,02-60,20	0,02-23,77	0,42-57,04

N.D.=Not detected

Table 2. Essential oil ratios of the hybrid plants (%)

Hybrid Name	Essential Oil Ratio	Hybrid Name	Essential Oil Ratio	Hybrid Name	Essential Oil Ratio
<i>S. ara.</i> x <i>S. fru.</i> -1	1,40	<i>S. ara.</i> x <i>S. fru.</i> -29	2,50	<i>S. fru.</i> x <i>S. ara.</i> -14	3,15
<i>S. ara.</i> x <i>S. fru.</i> -2	1,46	<i>S. ara.</i> x <i>S. fru.</i> -30	3,26	<i>S. fru.</i> x <i>S. ara.</i> -15	2,90
<i>S. ara.</i> x <i>S. fru.</i> -3	3,29	<i>S. ara.</i> x <i>S. fru.</i> -31	2,97	<i>S. off.</i> x <i>S. ara.</i> -1	1,79
<i>S. ara.</i> x <i>S. fru.</i> -4	2,57	<i>S. ara.</i> x <i>S. fru.</i> -32	2,57	<i>S. off.</i> x <i>S. ara.</i> -2	2,26
<i>S. ara.</i> x <i>S. fru.</i> -5	1,52	<i>S. ara.</i> x <i>S. fru.</i> -33	2,79	<i>S. off.</i> x <i>S. ara.</i> -3	2,69
<i>S. ara.</i> x <i>S. fru.</i> -6	2,05	<i>S. ara.</i> x <i>S. fru.</i> -34	1,79	<i>S. off.</i> x <i>S. ara.</i> -4	3,00
<i>S. ara.</i> x <i>S. fru.</i> -7	1,23	<i>S. ara.</i> x <i>S. fru.</i> -35	1,14	<i>S. off.</i> x <i>S. ara.</i> -5	4,21
<i>S. ara.</i> x <i>S. fru.</i> -8	2,50	<i>S. ara.</i> x <i>S. fru.</i> -36	2,00	<i>S. off.</i> x <i>S. ara.</i> -6	2,28
<i>S. ara.</i> x <i>S. fru.</i> -9	3,97	<i>S. ara.</i> x <i>S. fru.</i> -37	2,79	<i>S. off.</i> x <i>S. ara.</i> -7	1,85
<i>S. ara.</i> x <i>S. fru.</i> -10	3,14	<i>S. ara.</i> x <i>S. fru.</i> -38	1,57	<i>S. off.</i> x <i>S. ara.</i> -8	2,36
<i>S. ara.</i> x <i>S. fru.</i> -11	1,93	<i>S. ara.</i> x <i>S. fru.</i> -39	2,50	<i>S. off.</i> x <i>S. ara.</i> -9	2,11
<i>S. ara.</i> x <i>S. fru.</i> -12	2,14	<i>S. ara.</i> x <i>S. fru.</i> -40	2,61	<i>S. off.</i> x <i>S. ara.</i> -10	1,85
<i>S. ara.</i> x <i>S. fru.</i> -13	0,93	<i>S. ara.</i> x <i>S. fru.</i> -41	1,43	<i>S. off.</i> x <i>S. ara.</i> -11	1,81
<i>S. ara.</i> x <i>S. fru.</i> -14	2,79	<i>S. ara.</i> x <i>S. fru.</i> -42	1,14	<i>S. off.</i> x <i>S. ara.</i> -12	3,37
<i>S. ara.</i> x <i>S. fru.</i> -15	2,50	<i>S. ara.</i> x <i>S. fru.</i> -43	1,00	<i>S. off.</i> x <i>S. ara.</i> -13	3,57
<i>S. ara.</i> x <i>S. fru.</i> -16	1,93	<i>S. fru.</i> x <i>S. ara.</i> -1	3,55	<i>S. off.</i> x <i>S. ara.</i> -14	1,71
<i>S. ara.</i> x <i>S. fru.</i> -17	0,75	<i>S. fru.</i> x <i>S. ara.</i> -2	2,25	<i>S. off.</i> x <i>S. fru.</i> -1	3,90
<i>S. ara.</i> x <i>S. fru.</i> -18	2,99	<i>S. fru.</i> x <i>S. ara.</i> -3	2,50	<i>S. off.</i> x <i>S. fru.</i> -2	3,79
<i>S. ara.</i> x <i>S. fru.</i> -19	2,62	<i>S. fru.</i> x <i>S. ara.</i> -4	1,76	<i>S. off.</i> x <i>S. fru.</i> -3	3,26
<i>S. ara.</i> x <i>S. fru.</i> -20	2,18	<i>S. fru.</i> x <i>S. ara.</i> -5	2,45	<i>S. off.</i> x <i>S. fru.</i> -4	4,08
<i>S. ara.</i> x <i>S. fru.</i> -21	2,48	<i>S. fru.</i> x <i>S. ara.</i> -6	3,15	<i>S. off.</i> x <i>S. fru.</i> -5	3,62
<i>S. ara.</i> x <i>S. fru.</i> -22	2,14	<i>S. fru.</i> x <i>S. ara.</i> -7	3,22	<i>S. off.</i> x <i>S. fru.</i> -6	2,64
<i>S. ara.</i> x <i>S. fru.</i> -23	1,14	<i>S. fru.</i> x <i>S. ara.</i> -8	3,84	<i>S. off.</i> x <i>S. fru.</i> -7	3,00
<i>S. ara.</i> x <i>S. fru.</i> -24	2,38	<i>S. fru.</i> x <i>S. ara.</i> -9	2,68	<i>S. off.</i> x <i>S. fru.</i> -8	2,50
<i>S. ara.</i> x <i>S. fru.</i> -25	1,92	<i>S. fru.</i> x <i>S. ara.</i> -10	2,60	<i>S. off.</i> x <i>S. fru.</i> -9	2,75
<i>S. ara.</i> x <i>S. fru.</i> -26	1,96	<i>S. fru.</i> x <i>S. ara.</i> -11	2,15	<i>S. off.</i> x <i>S. fru.</i> -10	3,00
<i>S. ara.</i> x <i>S. fru.</i> -27	2,05	<i>S. fru.</i> x <i>S. ara.</i> -12	2,60		
<i>S. ara.</i> x <i>S. fru.</i> -28	3,07	<i>S. fru.</i> x <i>S. ara.</i> -13	3,20		

* Essential Oil: SD=0,78;Max=4,21; Min=0,75; Mean=2,47

Table 3. Chemical composition of the hybrid plants essential oils (%)

Hybrid Name	Eucalyptol	Thujone	Camphor	Hybrid Name	Eucalyptol	Thujone	Camphor
<i>S. ara.</i> x <i>S. fru.</i> -1	19,38	0,26	25,71	<i>S. ara.</i> x <i>S. fru.</i> -42	19,01	0,73	5,83
<i>S. ara.</i> x <i>S. fru.</i> -2	16,76	0,54	22,61	<i>S. ara.</i> x <i>S. fru.</i> -43	31,18	1,25	26,35
<i>S. ara.</i> x <i>S. fru.</i> -3	5,21	0,49	19,60	<i>S. fru.</i> x <i>S. ara.</i> -1	49,15	14,62	0,42
<i>S. ara.</i> x <i>S. fru.</i> -4	20,12	23,77	31,54	<i>S. fru.</i> x <i>S. ara.</i> -2	32,93	10,46	18,67
<i>S. ara.</i> x <i>S. fru.</i> -5	22,35	1,03	24,42	<i>S. fru.</i> x <i>S. ara.</i> -3	25,41	8,45	21,03
<i>S. ara.</i> x <i>S. fru.</i> -6	29,35	0,43	21,88	<i>S. fru.</i> x <i>S. ara.</i> -4	30,17	9,54	17,31
<i>S. ara.</i> x <i>S. fru.</i> -7	21,16	1,02	15,09	<i>S. fru.</i> x <i>S. ara.</i> -5	21,75	2,55	24,22
<i>S. ara.</i> x <i>S. fru.</i> -8	20,35	0,02	35,05	<i>S. fru.</i> x <i>S. ara.</i> -6	59,11	4,71	1,43
<i>S. ara.</i> x <i>S. fru.</i> -9	22,44	7,65	18,94	<i>S. fru.</i> x <i>S. ara.</i> -7	27,56	7,14	15,63
<i>S. ara.</i> x <i>S. fru.</i> -10	26,38	0,40	23,06	<i>S. fru.</i> x <i>S. ara.</i> -8	25,64	11,35	17,16
<i>S. ara.</i> x <i>S. fru.</i> -11	14,34	1,04	57,04	<i>S. fru.</i> x <i>S. ara.</i> -9	8,71	1,19	2,36
<i>S. ara.</i> x <i>S. fru.</i> -12	46,55	0,28	5,14	<i>S. fru.</i> x <i>S. ara.</i> -10	60,11	3,18	2,97
<i>S. ara.</i> x <i>S. fru.</i> -13	55,99	0,34	4,06	<i>S. fru.</i> x <i>S. ara.</i> -11	40,93	2,17	22,37
<i>S. ara.</i> x <i>S. fru.</i> -14	57,54	0,33	3,86	<i>S. fru.</i> x <i>S. ara.</i> -12	42,67	5,39	19,04
<i>S. ara.</i> x <i>S. fru.</i> -15	11,39	0,34	36,63	<i>S. fru.</i> x <i>S. ara.</i> -13	39,05	2,52	27,19
<i>S. ara.</i> x <i>S. fru.</i> -16	12,49	0,35	36,20	<i>S. fru.</i> x <i>S. ara.</i> -14	53,53	2,40	9,60
<i>S. ara.</i> x <i>S. fru.</i> -17	4,02	0,36	38,79	<i>S. fru.</i> x <i>S. ara.</i> -15	34,79	1,27	31,36
<i>S. ara.</i> x <i>S. fru.</i> -18	30,03	0,25	24,00	<i>S. off.</i> x <i>S. ara.</i> -1	12,49	19,07	45,85
<i>S. ara.</i> x <i>S. fru.</i> -19	20,11	0,02	30,12	<i>S. off.</i> x <i>S. ara.</i> -2	42,72	0,84	4,43
<i>S. ara.</i> x <i>S. fru.</i> -20	12,29	0,66	21,88	<i>S. off.</i> x <i>S. ara.</i> -3	17,85	21,58	27,79
<i>S. ara.</i> x <i>S. fru.</i> -21	34,25	1,03	27,69	<i>S. off.</i> x <i>S. ara.</i> -4	17,04	18,65	47,11
<i>S. ara.</i> x <i>S. fru.</i> -22	22,67	0,70	25,81	<i>S. off.</i> x <i>S. ara.</i> -5	61,91	5,65	0,25
<i>S. ara.</i> x <i>S. fru.</i> -23	32,27	0,67	18,97	<i>S. off.</i> x <i>S. ara.</i> -6	35,64	15,37	15,25
<i>S. ara.</i> x <i>S. fru.</i> -24	15,93	0,51	23,99	<i>S. off.</i> x <i>S. ara.</i> -7	34,81	20,76	18,40
<i>S. ara.</i> x <i>S. fru.</i> -25	12,92	0,45	44,49	<i>S. off.</i> x <i>S. ara.</i> -8	43,84	1,09	3,36
<i>S. ara.</i> x <i>S. fru.</i> -26	9,67	0,23	38,45	<i>S. off.</i> x <i>S. ara.</i> -9	48,82	3,24	8,19
<i>S. ara.</i> x <i>S. fru.</i> -27	8,43	0,49	22,69	<i>S. off.</i> x <i>S. ara.</i> -10	37,29	11,22	18,50
<i>S. ara.</i> x <i>S. fru.</i> -28	25,98	1,30	21,30	<i>S. off.</i> x <i>S. ara.</i> -11	32,58	16,31	11,03
<i>S. ara.</i> x <i>S. fru.</i> -29	10,43	0,39	37,71	<i>S. off.</i> x <i>S. ara.</i> -12	41,35	14,72	19,56
<i>S. ara.</i> x <i>S. fru.</i> -30	19,73	0,32	24,51	<i>S. off.</i> x <i>S. ara.</i> -13	38,93	9,67	7,16
<i>S. ara.</i> x <i>S. fru.</i> -31	26,91	0,17	23,89	<i>S. off.</i> x <i>S. ara.</i> -14	35,62	19,42	12,45
<i>S. ara.</i> x <i>S. fru.</i> -32	20,64	0,03	35,76	<i>S. off.</i> x <i>S. fru.</i> -1	47,58	2,30	7,78
<i>S. ara.</i> x <i>S. fru.</i> -33	15,00	0,91	28,24	<i>S. off.</i> x <i>S. fru.</i> -2	39,48	2,76	16,64
<i>S. ara.</i> x <i>S. fru.</i> -34	59,21	1,04	1,96	<i>S. off.</i> x <i>S. fru.</i> -3	71,30	2,66	0,35
<i>S. ara.</i> x <i>S. fru.</i> -35	53,78	0,79	0,53	<i>S. off.</i> x <i>S. fru.</i> -4	55,03	6,03	0,66
<i>S. ara.</i> x <i>S. fru.</i> -36	46,54	0,81	10,19	<i>S. off.</i> x <i>S. fru.</i> -5	23,12	25,77	32,15
<i>S. ara.</i> x <i>S. fru.</i> -37	21,84	0,43	19,37	<i>S. off.</i> x <i>S. fru.</i> -6	16,66	20,28	16,99
<i>S. ara.</i> x <i>S. fru.</i> -38	25,57	0,49	29,71	<i>S. off.</i> x <i>S. fru.</i> -7	22,20	0,04	28,07
<i>S. ara.</i> x <i>S. fru.</i> -39	42,25	0,25	16,39	<i>S. off.</i> x <i>S. fru.</i> -8	21,17	26,31	23,51
<i>S. ara.</i> x <i>S. fru.</i> -40	60,20	0,07	1,05	<i>S. off.</i> x <i>S. fru.</i> -9	25,94	19,65	14,63
<i>S. ara.</i> x <i>S. fru.</i> -41	32,71	0,18	37,67	<i>S. off.</i> x <i>S. fru.</i> -10	28,71	15,95	9,06

Eucalyptol: SD=15,57; Max=71,30; Min=4,02; Mean=30,72 *Thujone: SD=7,43; Max=26,31; Min=0,02; Mean=5,35

****Camphor: SD=12,64; Max=47,11; Min=0,25; Mean=19,98

Results of gas chromatography analysis from essential oils were given in Table 3. The aim of the study was to determine whether different chemotypes could obtain by interspecific crossing or not. Especially low camphor and thujone, high eucalyptol levels were important. *S. aramiensis* as a parent has the highest eucalyptol level as 60%, followed by *S. fruticosa*. In all combinations similar or even higher eucalyptol ratios were obtained. Highest eucalyptol ratio observed from the hybrid of *S. officinalis* x *S. fruticosa* crossing as 71.30%. Thujone level was ranged between 0-30% in parents, in hybrids lowest thujone in all

combinations observed. Furthermore, low thujone (0,04%) bearing *S. officinalis* x *S. fruticosa* hybrid obtained. Highest thujone level also found in *S. officinalis* x *S. fruticosa* hybrids as 26.31%. The highest camphor bearing parent species was *S. officinalis* with 35% however in hybrids higher camphor ratio were observed as 60.11%. *S. officinalis* parental genotype with low camphor (0.25%) was also observed. Putievsky et al. (1990), conducted that essential oil components of *S. officinalis*, *S. fruticosa* and *S. tomentosa* hybrids were varied and in some case components resembled or between their parents. Study from Herraiz-

Penalver et al., 2015 showed that natural hybrid of *S. officinalis* and *S. lavandulifolia* essential oil components also effected parental species and in some cases both separate main components of parents could occur as 2 main components in their hybrids. Chromatogram sample of the one hybrid from *S. officinalis* x *S. fruticosa* were given in Figure 1.

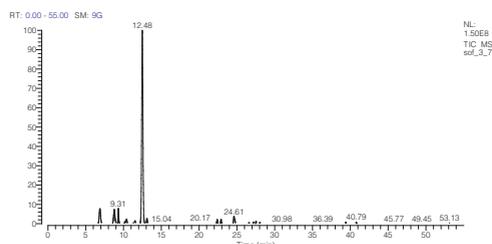


Figure 1. Chromatogram of *S. officinalis* x *S. fruticosa*-3 hybrid

CONCLUSIONS

The study was preliminary results of interspecific hybridisation of *S. officinalis*, *S. fruticosa* and *S. aramiensis*. The hybrids were distinguished from their parent species among essential oil ratios and components. *S. aramiensis* x *S. fruticosa* hybrids 14, 34 and 40; *S. officinalis* x *S. aramiensis* hybrid 5; *S. fruticosa* x *S. aramiensis* hybrid 10 and *S. officinalis* x *S. fruticosa* hybrid 3 were selected regarding to essential oil components. Selected hybrids will cultivate for further studies. In the ongoing study morphological characteristics will also be evaluated.

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