

# Variations in oil, fatty acid and tocopherol contents of some *Labiatae* and *Umbelliferae* seed oils

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Received: 23 May 2013 / Accepted: 26 October 2013

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## RESEARCH ARTICLE

### Abstract

In this study, the oil content, fatty acid and tocopherol contents of the seeds of some selected *Labiatae* and *Umbelliferae* species from Turkey were determined. The total lipid of the studied plant seeds were found between 12.74 (*Hyssopus officinalis*) to 28.95% (*Pimpinella anisum*). The highest percentages of oleic acid was determined in *Coriandrum sativum* (79.2%), *Foeniculum vulgare* (sweet) var. *dulce* (70.7%), *Petroselinum crispum* (68.9%), *P. anisum* (59.3%) and *Cuminum cyminum* (54.2%). Linoleic acid was determined as the major constituent of all the seed oils (except in *F. vulgare* and *P. crispum* seed oils). Linolenic acid in both family seed oils was generally found to be lower than 1.0%, except in a few samples like *Satureja hortensis* (60.4%), *H. officinalis* (50.7%), *Lavandula angustifolia* (64.8%) and *Melissa officinalis* (53.9%).

**Keywords:** aromatic plants, *Compositae*, fatty acid, *Labiatae*, seed oil, tocopherol

## 1. Introduction

Botanical family *Labiatae* and *Umbelliferae* include many species of plants, which are widespread in the temperate areas of the Northern terrestrial globe. A characteristic feature of the representatives of these families are that, besides the glyceride oils, the seeds contain essential oils with condiment (Zlatanov and Antova, 2004) or pharmacological characters (Sokolov and Zamotaev, 1984; Weiss, 1974). Some of them are cultivated and used as a source for obtaining honey, essential oils such as limonene, geraniol, citrol, etc., for perfumery and cosmetics (Georgiev *et al.*, 1989). The seeds and leaves are used as food condiments in the production of wine, liquors, for aromatisation of sausages, meat, salads, cheese, etc. (Baytop, 1984). The composition of vegetable oils plays an important part in their chemistry (Ayerza, 1995; Domokos and Peredi, 1993). This is determined by the ratio between saturated and unsaturated fatty acids. A high proportion of monounsaturated and polyunsaturated fatty acids is particularly desirable in the food products

(Ayerza, 1995; Liepa and Gorman, 1988). In the recent years investigations of the content and composition of the essential oils were carried out, but information about the composition of oil is scanty. In spite of this popularity plants, little recent study has determined composition of seed oil in these species, although their essential oil content has been widely analysed. So, the aim of this study was to establish the biological active substances such as fatty acid and tocopherols.

## 2. Materials and methods

### Material

Matured dry seeds of plants were provided from the Konya province in middle of Turkey. The investigation was carried out on air dried seeds in technical ripeness. Seeds were transported to the laboratory. They were cleaned in an air screen cleaner to remove all foreign matter such as dust, dirt and chaff, and immature and broken seeds. Studied

plant samples from different family and genera are listed in Table 1.

## Reagents

Petroleum ether (40–60 °C) was of analytical grade (>98%; Merck, Darmstadt, Germany). Heptane and tert-butyl methyl ether were of HPLC grade (Merck). Tocopherol and tocotrienol standard compounds were purchased from CalBiochem (Darmstadt, Germany).

## Oil content

The oil content was determined according to the method ISO 659:1998 (ISO, 1998). About 2 g of the seeds were ground in a ball mill and extracted with petroleum ether in a Twisselmann apparatus (C. Gerhardt GmbH & Co. KG, Königswinter, Germany) for 6 h. The solvent was removed by a rotary evaporator at 40 °C and 25 Torr. The oil was dried by a stream of nitrogen and stored at -20 °C until used.

## Fatty acid composition

The fatty acid composition was determined following the ISO standard ISO 5509:2000 (ISO, 2000). In brief, one drop of the oil was dissolved in 1 ml of *n*-heptane, 50 µg of sodium methylate was added, and the closed tube was agitated vigorously for 1 min at room temperature. After addition of 100 µl of water, the tube was centrifuged at 4,500×g for 10 min and the lower aqueous phase was removed. Then 50 µl of HCl (1 mol with methyl orange) was added, the solution was shortly mixed, and the lower aqueous phase was rejected. About 20 mg of sodium hydrogen sulphate (monohydrate, extra pure; Merck) was added, and after centrifugation at 4,500×g for 10 min, the top *n*-heptane phase was transferred to a vial and injected in a Varian 5890 gas chromatograph with a capillary column, CP-Sil 88 (100 m long, 0.25 mm ID, film thickness 0.2 µm). The temperature program was as follows: from 155 °C; heated

to 220 °C (1.5 °C/min), 10 min isotherm; injector 250 °C, detector 250 °C; carrier gas 36 cm/s hydrogen; split ratio 1:50; detector gas 30 ml/min hydrogen; 300 ml/min air and 30 ml/min nitrogen; manual injection volume less than 1 µl. The peak areas were computed by the integration software, and percentages of fatty acid methyl esters were obtained as weight percent by direct internal normalisation.

## Tocopherols

For determination of tocopherols, a solution of 250 mg of oil in 25 ml of *n*-heptane was directly used for the HPLC. The HPLC analysis was conducted using a Merck-Hitachi low-pressure gradient system, fitted with a L-6000 pump, a Merck-Hitachi F-1000 fluorescence spectrophotometer (Merck-Hitachi, Burladingen, Germany; detector wavelengths for excitation 295 nm, for emission 330 nm), and a D-2500 integration system. The samples in the amount of 20 µl were injected by a Merck 655-A40 auto-sampler onto a Diol phase HPLC column 25 cm × 4.6 mm ID (Merck) used with a flow rate of 1.3 ml/min. The mobile phase used was *n*-heptane/tert-butyl methyl ether (99:1, v:v) (Balz *et al.*, 1992).

## 3. Results and discussion

In this study, the oil content, fatty acid and tocopherol contents of the seed oils of some selected *Labiatae* and *Umbelliferae* species from Turkey were determined. The results of the oil content and fatty acid compositions belonging to both families are shown in Table 1 and 2. The total oil contents of the studied plant seeds were found between 12.74 (*Hyssopus officinalis*) to 28.95% (*Pimpinella anisum*) (Table 1). The oil contents of the studied seeds belonging to different species showed qualitative differences. Zlatanov and Antova (2004) reported that the oil content of seven seed species belonging to *Labiatae* were determined between 8.7 and 28.6%. The seeds of *Labiatae* family contain significant amounts of glyceride oil. Among the unsaturated fatty acids, oleic and linoleic acids were the major constituents of the studied seed oils. Oleic acid contents of *Foeniculum vulgare* (sweet) var. *dulce*, *Petroselinum crispum* and *Coriandrum sativum* samples were found higher compared with other samples. The highest percentages of oleic acid was determined in *C. sativum* sample (79.2%), *F. vulgare* (70.7%), *P. crispum* (68.9%), *P. anisum* (59.3%) and *Cuminum cyminum* (54.2%) (Table 2). *Salvia officinalis* (20.4%), *H. officinalis* (16.4%), *Lavandula angustifolia* (9.8%) and *Melissa officinalis* (6.0%) showed the lowest oleic acid in the seed oils. Linoleic acid was determined as the major constituent of all the seed oils (except *F. vulgare* and *P. crispum* seed oils). A high content of this component was found to be characteristic for the *Labiatae* seed oil. *F. vulgare* and *P. crispum* showed a wide variation in this component, and it was also found in small amounts (Table 2). Linolenic acids in the both

**Table 1.** Oil contents and studied plant samples from different family and genera.

Botanic names	Family	Oil percentage
<i>Salvia officinalis</i> L.	<i>Labiatae</i>	19.25
<i>Foeniculum vulgare</i> L. var. <i>dulce</i>	<i>Umbelliferae</i>	20.86
<i>Cuminum cyminum</i> L.	<i>Umbelliferae</i>	25.94
<i>Petroselinum crispum</i> L.	<i>Umbelliferae</i>	23.94
<i>Coriandrum sativum</i> L.	<i>Umbelliferae</i>	23.07
<i>Pimpinella anisum</i> L.	<i>Umbelliferae</i>	28.95
<i>Satureja hortensis</i> L.	<i>Labiatae</i>	24.67
<i>Hyssopus officinalis</i> L.	<i>Labiatae</i>	12.74
<i>Lavandula angustifolia</i> L.	<i>Labiatae</i>	18.07
<i>Melissa officinalis</i> L.	<i>Labiatae</i>	22.41

Table 2. Fatty acids composition of several aromatic plant seed oils (%).

Samples	<i>Salvia officinalis</i>	<i>Foeniculum vulgare</i>	<i>Cuminum cyminum</i>	<i>Petroselinum crispum</i>	<i>Coriandrum sativum</i>	<i>Pimpinella anisum</i>	<i>Satureja hortensis</i>	<i>Hyssopus officinalis</i>	<i>Lavandula angustifolia</i>	<i>Melissa officinalis</i>	Average
Myristic	0.1±0.0	0.1±0.0	0	0	0	0	0	0.1	0	0.6±0.16	0.09±0.016
Palmitic	7.4±0.82	3.7±0.42	3.2±0.58	2.7±0.75	3.6±0.45	3.8±0.38	4.8±0.05	5.3±0.12	4.7±0.08	5.4±0.15	4.46±0.38
Unknown	0	0.2±0.03	0.2±0.03	0.2±0.03	0.2±0.03	0.1±0.03	0	0.1±0.03	0	0	0.1±0.0
Palmitoleic	0.1±0.11	0.1±0.11	0.2±0.08	2.5±0.69	0.2±0.08	0.3±0.04	0.1±0.11	0.2±0.08	0.1±0.11	0.1±0.11	0.39±0.152
Margaric	0	0	0	0	0	0	0	0.1±0.03	0	0.1±0.03	0.02±0.006
Heptadecenoic	0.0±	0.1±0.019	0.1±0.019	0.0±	0.1±0.019	0.1±0.019	0.0±	0.0±	0.0±	0.0±	0.04±0.0076
Stearic	2.4±0.24	1.4±0.09	0.8±0.29	1.0±0.23	0.7±0.33	1.8±0.04	1.6±0.03	1.9±0.07	1.4±0.09	2.2±0.17	1.52±0.158
Oleic	20.4±7.72	70.7±9.05	54.2±3.55	68.9±8.45	79.2±11.88	59.3±5.25	7.1±12.15	16.4±9.05	9.8±11.25	6.0±12.51	39.2±9.086
Cis-vaccenic	1.0±0.21	0.3±0.44	4.5±0.96	0.2±0.47	0.8±0.27	4.6±0.99	0.9±0.24	0.9±0.24	0.6±0.34	0.8±0.27	1.46±0.443
Linoleic	66.1±13.65	9.1±5.35	26.4±0.41	6.4±6.25	12.4±4.25	20.7±1.49	23.7±0.48	17.6±2.52	15.0±3.38	29.1±1.31	22.65±4.909
Linolenic	0.9±8.28	0.2±8.52	0.2±8.52	0.2±8.52	0.3±8.49	0.3±8.49	60.4±11.55	50.7±8.31	64.8±13.01	53.9±9.38	23.19±9.307
Arachidic	0.1±0.027	0.2±0.006	0.7±0.17	0.1±0.027	0.1±0.027	0.1±0.027	0.1±0.027	0.1±0.027	0.1±0.027	0.1±0.027	0.17±0.0392
Gadoleic	0.5±0.11	0.0±	0.1±0.02	0.0±	0.1±0.02	0.1±0.02	0.1±0.02	0.4±0.08	0.2±0.01	0.1±0.02	0.16±0.03
Eicosadienoic	0.1±0.15	0	0	0	0	0	0.1±0.15	0.1±0.15	0.1±0.15	0.1±0.15	0.05±0.075
Behenic	0.0±0.02	0.1±0.02	0	0	0	0	0	0.1±0.02	0.1±0.02	0.0±	0.03±0.006
Erucic	0.1±0.15	0.0±	0.0±	0.2±0.05	0.2±0.05	0.0±	0.0±	0.0±	0.0±	0.0±	0.05±0.025
Lignoceric	0.0±	0.1±0.15	0.0±	0.0±	0.0±	0.1±0.15	0.1±0.15	0.0±	0.1±0.15	0.1±0.15	0.05±0.075
Nervonic	0.0±	0.0±	0.3±0.09	0	0	0	0	0	0	0	0.003±0.009
Total	99.2±1.59	86.0±5.99	90.9±4.36	82.5±7.16	98.1±1.96	90.4±4.52	99.0±1.65	94.0±3.32	97.1±2.29	98.6±1.79	93.58±3.463

family seed oils were generally found to be lower than 1.0%, except in a few samples like *Satureja hortensis* (60.4%), *H. officinalis* (50.7%), *L. angustifolia* (64.8%) and *M. officinalis* (53.9%). Stearic acid was generally established in a low level. But stearic acid contents of *S. officinalis*, *P. anisum*, *H. officinalis* and *M. officinalis* samples were found in partly high concentrations. On the other hand, this fatty acid was reported as lower in some *Vicia* spp. from different countries: *Vicia faba* (1.4%), *V. sativa* (1.3%), *Colutea melonacalyx* (1.38%) and *Onobrychis altissima* (1.79%) seed oils showed low stearic acid amounts (Bağcı *et al.*, 2004). In the others, it was generally lower than 1% of the oil. Erucic acid undesirable effects on the metabolisms of animals and humans (Fail and Stamp, 1993; James, 1994). Matthäus *et al.* (2003) determined that the oils of *Anethum graveolens*, *C. sativum* and *Ocimum basilicum* contained 3.64, 2.91 and 7.33% palmitic, 0.87, 0.51 and 2.60% stearic, 7.79, 0.0 and 7.43% oleic, 5.51, 14.23 and 24.89% linoleic and 0.34, 0.20 and 54.58% linolenic acids, respectively. Analysis of the fatty acid composition of *Salvia hispanica* L. demonstrated that linolenic acid was predominant and varied from 63.4 to 60.7% of the total (Ayerza, 1995). Angers *et al.* (1996) reported that content, fatty acid composition of seven basil (*Ocimum* sp.) chemotypes were determined. The oil content ranged from 18 to 26%. The major acylated fatty acids were linolenic (43.8-64.8%), linoleic (17.8-31.3%),

oleic (8.5-13.3%) and palmitic acid (6.1-11.0%) (Angers *et al.* 1996). The high proportion of unsaturated fatty acids averaged 89%, with the major fatty acids being linolenic acid (43.8-64.8%) and linoleic acid (18.3-31.3%), along with lesser amounts of oleic acid (8.5-13.3%) (Angers *et al.* 1996). Sage leaves in control plants were characterised by a high proportion of polyunsaturated fatty acids (59.78%) versus 20.55% of monounsaturated and 19.67% of saturated fatty acids (Taarit *et al.* 2010). Analysis exhibited that low molecular acids from the saturated fatty acid were absent or present at trace levels in the *Labiatae* (except *S. hortensis*) and *Umbelliferae* seed oils. This is also a very constant lipid constituent in most of the *Labiatae* and *Umbelliferae* genera seed oils.

With this study some *Labiatae* and *Compositae* seed oils were determined as potential sources of natural tocopherols and tocotrienols. Tocopherol contents show differences depending on seed oil samples (Table 3).  $\alpha$ -tocotrienol contents of *C. cyminum*, *P. crispum* and *S. hortensis* were found higher than others. In addition,  $\gamma$ -tocopherol contents of *S. officinalis* (40.2%), *S. hortensis* (35.7%) and *M. officinalis* (52.0%) were established of the high levels. Also,  $\gamma$ -tocotrienol contents of *P. crispum* (18.6%) and *C. sativum* (14.2%) were found higher than those of other samples. The highest  $\delta$ -tocotrienol was found in

**Table 3. Tocopherol contents of several aromatic plant seed oils (mg/100 g).**

Sample	$\alpha$ -tocopherol	$\alpha$ -tocotrienol	$\beta$ -tocopherol	$\gamma$ -tocopherol	$\beta$ -tocotrienol	p8	$\gamma$ -tocotrienol	$\delta$ -tocopherol	$\delta$ -tocotrienol	Total
<i>Salvia officinalis</i>	1.4±0.12	1.5±2.15	0.3±0.01	40.2±8.63	0.0	0.2±0.003	0.7±1.05	0.7±0.11	0.0	45.0±4.17
<i>Foeniculum vulgare</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cuminum cyminum</i>	0.0	44.3±12.11	0.0	0.2±4.70	2.8±0.83	0.0	0.9±0.99	0.0	21.4±5.79	69.6±12.37
<i>Petroselinum crispum</i>	1.6±0.18	9.2±0.42	0.0	0.2±4.70	0.0	0.6±0.13	18.6±4.91	0.2±0.06	0.4±1.21	30.8±0.56
<i>Coriandrum sativum</i>	0.0	2.5±1.81	0.0	0.5±4.60	0.0	0.0	14.2±3.45	0.9±0.18	0.4±1.21	18.6±4.63
<i>Pimpinella anisum</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Satureja hortensis</i>	0.0	14.0±2.02	2.3±0.65	35.7±7.13	0.0±	0.7±0.16	0.4±1.15	0.9±0.18	14.2±3.39	68.2±11.91
<i>Hyssopus officinalis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lavandula angustifolia</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Melissa officinalis</i>	6.5±1.82	0.0±	0.5±0.05	52.0±12.56	0.0±	0.4±0.06	0.0±	0.7±0.11	0.0±	60.2±9.24
Average	0.95±0.212	7.15±1.851	0.31±0.071	12.88±4.232	0.28±0.083	0.19±0.0353	3.48±1.155	0.34±0.064	3.64±1.16	29.24±4.288

*C. cyminum* (21.4%) and *S. hortensis* (14.2%). All other tocopherols and tocotrienols have been determined in negligible amounts. Zlatanov and Antova (2004) reported that  $\alpha$ -tocopherol contents of *Labiatae* seed oils changed between 5.1% (*Leunurus cardiaca* L.) to 99.9% (*Salvia aethopis* L.). Ayerza (1995) determined 32.3-38.6% yield of oil, 52.0-63.4% linolenic, 19.8-20.8% linoleic, 7.3-8.2% oleic, 3.1-3.7% stearic and 6.2-7.1% palmitic acids in *S. hispanica* Seed oils from five locations in Argentina. Future works should be carried out to determine the exact environmental influences on the formation of aromatic plant seed oil quantity and quality. Matthaues *et al.* (2003) reported that *A. graveolens*, *C. sativum* and *O. basilicum* contained 96, 46 and 52 mg/kg  $\alpha$ -tocopherol and 29, 31 and 828 mg/kg  $\gamma$ -tocopherol, respectively. Matthaues *et al.* (2003) reported that the seed oil content varied between 0.2 g/100 g for *Mongifera indica* and 75.7 g/100 g for *Calophyllum inophyllum*, whereas only nine seeds contained more than 40% oil. The tocopherol content ranged from 26 (*Sapindus mukorossi*) to 9,361 mg/kg (*Litchi chinensis*) (Matthaues *et al.*, 2003). The results emphasise important differences in the relative ratios of oleic to linolenic acids in both family seed oils, and compare similarly the most literature values. The effects of temperature, light, soil type, and nutrition can affect seed oil quantity and quality (Ayerza, 1995).

#### 4. Conclusions

- The present study indicates that oil-bearing material used in this research are good natural sources of tocopherol and tocotrienol.
- Knowledge of their oil content, fatty acid and tocopherol profiles are of great interest.
- Oleic and linoleic acids had the highest amount in seed oils.

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