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The chemical composition of essential oil from the fruit of coriander (Coriandrum sativum L.)

Skład chemiczny olejku eterycznego z owoców kolendry siewnej (Coriandrum sativum L.)

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is native to the Mediterranean Sea region. It is grown in Europe and in other parts of the world [12,13,17]. Coriander is an important plant in medicine, food production as well as in the cosmetics and perfume industry [7]. It provides two types of herbal raw material: fruit and leaves [2,15]. The main biologically active substance of the fruit (seeds) and leaves is essential oil the composition of which has been studied by many researchers in different parts of the world [1,2,5,9]. The components of coriander oil, both from the fruit and leaves, inhibit the growth of microorganisms [3]. Moreover, the coriander fruit has a spasmolytic, carminative, and antibacterial effect [17]. Coriander oil, in particular linalool contained in it, is responsible for proper intestinal peristalsis. Coriander seeds are a component of herbal mixtures and fixed combinations used in digestion difficulties, abdominal distension, and excessive intestinal fermentation. Coriander oil can be used externally for mouth and throat rinsing [8].

In Poland the fruit is used more frequently. Coriander seeds are added to dishes as an aromatic spice and, at the same time, they are a digestive agent that accelerates the digestion process. The literature reports that in some countries of the world fresh coriander leaves are used more widely as a spice [11]. The extracts from the above-ground part of coriander (herb) show antioxidant and antibacterial properties [16].

Immature fruits and leaves have a very unpleasant smell called a “stink bug smell”, which comes from trans-tridecen contained in the oil [17]. Hence, it is important to collect raw material at the appropriate plant growth stage in order to avoid this unsavoury smell. The problem in growing coriander is its high propensity to shed mature seeds, which is affected by air temperature and rainfall. These factors can also modify the content and chemical composition of oil. Therefore, the aim of the present study was to evaluate the essential oil content in coriander seed and the chemical composition of coriander oil depending on weather conditions.

ATERIAL AND METHODS

A field study was carried out in 2006-2007 in the Experimental Station of the Department of Vegetable Crops and Medicinal Plants, University of Life Sciences in Lublin, (51°14'N 22°34'E). The experiment was set up on grey-brown podzolic soil formed from loess deposits on chalky marl, containing 1.6% of organic substance. The crop stand was prepared in accordance with agricultural practice recommendations. Coriander seeds were obtained from the company PNOS Ożarów Mazowiecki. They were sown in rows with 30 cm spacing in the middle of April. Hand weeding and soil loosening were done during the growing period. Fruits were harvested before full maturation, when 1/3 of umbels were ripe and light brown coloured (2nd half of July). The plants were cut at half height and dried in a shaded and well-aired place. After threshing, seeds were additionally dried in natural conditions (a dry, shaded, and well- aired place).

Essential oil was obtained from air-dry coriander seeds through steam distillation in a Deryng apparatus, according to Polish Pharmacopoeia VI [10]. Twenty grams of coriander fruits and 400 ml of water were used for distillation. The distillation time was 3 hours. The oil content is given in percent (% v/w) of dry weight.

The analysis of oil chemical composition was conducted using gas chromatography method combined with mass detector, with the use of Varian 4000 GC/MS/MS chromatograph. We applied the VF-5 ms column, 30 m long, with the diameter of 0.25 mm and stationary phase thickness of 0.25 mm. The batcher temperature reached 220^{0}C. We applied 50^{0}C temperature gradient for 1 min, and then increased to 250^{0}C with a speed of 4^{0}C/min and 250^{0}C for 10 min. The carrier gas was helium. Steady flow of 0.5ml/min was applied. One µl of the solution (1 µl sample in 1000 µl of hexane), batcher 250^{0}C, split 1:100 was added. A Varian 4000 MS/MS detector with the registered range 40–1000 m/z, and the scan speed 0.8 sec. /scan was used. Kovats' retention indices were determined on the basis of alkane C6-C40.

RESULTS AND DISCUSSION

Average air temperatures from April to July in 2006 and 2007 were close to the long-term averages (Table 1). But precipitation totals from May to July 2006 were lower than in 2007. Rainfall totals in June and July 2006 were also lower than the long-term averages. Worth noting is the period of drought in the 2nd decade of June and in the 1st decade of July 2006. In spite of such large differences in rainfall between 2006 and 2007, the oil content in coriander seeds was at a similar level and it was 2.33% (2006) and 1.87% (2007) (Fig. 1). The average oil content in coriander seeds was 2.1 % (v/w).

Table 1. Air temperature and total precipitation in 2006 - 2007 years against a background of many-year averages

	Month	2006				2007				1951-2005
		Decade			Mean	Decade			Mean	
		I	II	III		I	II	III		
Temperature (°C)	IV	6.2	7.7	12.3	8.7	6.2	9.5	10.7	8.8	7.4
	V	13.5	14.6	12.8	13.6	9.9	15.1	19.6	14.8	13.0
	VI	11.6	17.9	21.1	16.8	18.2	20.0	16.2	18.1	16.2
	VII	21.2	20.8	23.5	21.8	17.1	21.0	19.3	19.1	17.8
					Σ				Σ	
Precipitation (mm)	IV	19.4	10.5	0.4	30.3	8.8	5.6	3.0	17.4	40.2
	V	9.0	18.4	32.1	59.5	13.5	29.9	37.1	80.5	57.7
	VI	28.4	0.0	9.5	37.9	52.4	25.4	10.0	87.8	65.7
	VII	0.0	6.8	0.0	6.8	48.8	35.0	3.2	87.0	83.5

In a study carried out in Canada, the oil content varied depending on fruit size. Large seeds contained less oil (0.83-0.91%) than small seeds (1.17-1.30%) [1]. These views have been confirmed by some other researchers who showed that small-seeded coriander varieties grown in Turkey provided raw material (fruit) with a higher oil content than large-seeded ones [5.] European coriander seeds were characterized by higher oil content (1.34-1.62% v/w) than Argentinean coriander seeds (0.29-0.33) [4]. The oil content in the fruit of coriander grown in India ranged from 0.18 to 0.39 % [13].

GC/MS analysis of the coriander oil showed the presence of 40 compounds, out of which 9 were not identified (Table 2). The number of compounds identified in coriander oil in various research studies varies significantly and ranges from 16 to 53 compounds [2, 4, 13].

Table 2. Percentage composition of essentialoil from the fruit of coriander (*Coriandrum sativum* L.)

No	Compound	IR	Percentage	
			2006	2007
1	α-Pinene	935	4.41	3.62
2	Camphene	952	1.73	1.20
3	Sabinene	973	0.71	0.66
4	*β*-Pinene	979	1.04	0.69
5	Myrcene	988	1.48	0.89
6	p-Cymene	1026	0.74	0.84
7	Limonene	1029	1.33	1.35
8	*γ*-Terpinene	1059	1.82	2.50
9	hydrate-cis-Sabinene	1072	0.11	0.16
10	Terpinolene	1086	0.31	0.33
11	Linalool	1102	69.88	72.50
12	Nonanal	1106	0.07	0.12
13	Camphor	1153	6.11	5.54
14	Pinocarvone	1168	0.08	0.06
15	Borneol	1178	0.11	0.16
16	Terpinen-4-ol	1185	0.14	0.19
17	α-Terpineol	1200	0.55	0.60
18	Decanal	1208	0.61	0.54

19	Verbenone	1215	tr.	tr.
20	Citronellol	1230	0.11	0.13
21	Geraniol	1253	3.06	3.65
22	2(E)-Decenal	1267	1.05	0.93
23	n.i.	1290	0.06	tr.
24	Octylfuran-2-n	1295	tr.	tr.
25	n.i.	1312	0.10	0.08
26	Myrtenyl acetate	1328	0.10	0.08
27	n.i.	1369	0.06	tr.
28	Geranyl acetate	1378	1.73	1.54
29	n.i.	1453	0.20	0.13
30	(E)2-Dodecanal	1472	0.83	0.59
31	α-Muurolene	1505	0.08	tr.
32	trans-Calamenene	1529	0.25	0.13
33	E-Nerolidol	1563	0.05	0.10
34	n.i.	1611	0.17	0.19
35	n.i	1677	0.27	0.15
36	Cadalene	1684	0.26	0.05
37	n.i.	1738	0.12	tr.
38	n.i.	1760	0.10	tr.
39	n.i.	1903	0.07	tr.
40	6-Octadecenoic acid. methyl ester	2101	0.06	tr.
Total			99.96	99.70

n.i. – not identified; tr – trace (<0.05)

The present study showed that weather conditions in south-eastern Poland had no effect on the content of the main oil components (Table 2). The dominant compounds in the coriander seed oil were as follows: linalool (69.88-72.50% v/w), camphor (5.54-6.11 % v/w), α-pinene (3.62-4.41 % v/w), geraniol (3.06-3.65% v/w), and γ-terpinene (1.82-2.50 % v/w).

The literature reports that linalool is the main compound in the oil from the fruit of coriander grown in different parts of the world [1,4,13]. The linalool content may depend on the plant growth stage. The oil from immature seeds contained the lowest amount of linalool (10.96%), and there was over six times more linalool in the oil from not fully mature seeds (76.33%), whereas the content of this compound in the oil obtained from mature seeds was 87.54% [7]. Other authors have shown that the linalool content is greatly affected by the size of seeds from which the oil is extracted. The oil from small seeds contained more linalool (63.5-71.0%) than that from large seeds (42.1-52.7%) [5].

In the papers of many authors, the linalool content in coriander seed oil ranges between 50 and 80%. The linalool content in the oil obtained in India was 56.71-75.14%. Other dominant compounds were geranyl acetate (8.95-24.51%) and α-pinene (2.36-23.23%) [13]. The coriander seed oil from New Zealand had on average 65.8% of linalool, as well as 6.8% of α-pinene, 6.1% of γ-terpinene, and 5.1% of camphor [14]. The coriander seed oil extracted in Pakistan contained slightly more linalool (78.1%), while the main compounds were also geranyl acetate (3.8%), γ-terpinene (3.4%), and α-pinene (2.5%) [12]. The Argentinean coriander seed oil was characterized by the linalool content at a level of 77.7-82.9%. The content of γ-terpinene ranged from 2.7 to 5.6%, while for camphor it

was 2.4-3.0% [4]. The researchers in Bangladesh obtained interesting results, as the coriander seed oil contained the lowest amount of linalool (37.7%). It should be added that the main constituents were also geranyl acetate (17.6%) and γ-terpinene [2].

The studies of the chemical composition of coriander oil from the fruit and leaves showed large differences in its composition. The coriander seed oil significantly differed in the chemical compounds contained in it compared to the leaf oil [3,6,9]. Such diversity in the oil components determines the multi-directional action of this active substance.

CONCLUSIONS

Weather conditions prevailing in south-eastern Poland are appropriate for growing coriander. In spite of different moisture conditions in the years 2006 and 2007, the seed essential oil content was at a similar level. Weather conditions did not cause differences in the content of the oil components. The main component of the coriander seed oil was linalool, similarly as in the research studies of other authors. The dominant compounds were also camphor, α-pinene, geraniol, and γ-terpinene. In the available literature, the authors also indicate these constituents as the main compounds of coriander oil.

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SUMMARY

Coriander is an oil plant used as a spice as well as for medicinal and cosmetic purposes. It has a spasmolytic, antibacterial, and carminative effect. The fruit of coriander, collected from plants grown at the Department of Vegetable Crops and Medicinal Plants, University of Life Sciences in Lublin, was used as the raw material for this research. The oil was obtained by steam distillation and subsequently its composition was analysed using the GC/MS method. Varying weather conditions prevailing during the study period did not affect the oil content and composition. The essential oil content ranged from 1.87 to 2.33% (v/w). The presence of 40 components of the coriander oil was determined, out of which 9 were unidentified. The main components of the coriander seed oil were as follows: linalool, camphor, α-pinene, geraniol, and γ-terpinene.

Keywords: Coriandrum sativum L., coriander, essential oil, linalool, camphor, GC/MS

STRESZCZENIE

Kolendra siewna jest rośliną olejkową, uprawianą w celach przyprawowych, leczniczych i kosmetycznych. Działa spazmolitycznie, przeciwbakteryjni i wiatropędnie. Surowcem do badań był owoc kolendry siewnej, zebrany z roślin uprawianych w Katedrze Warzywnictwa i Roślin Leczniczych Uniwersytetu Przyrodniczego we Lublinie. Olejek otrzymano poprzez destylację z parą wodną, a następnie analizowano jego skład metodą GC/MS. Zróżnicowane warunki pogodowe panujące podczas przeprowadzonych badań nie miały wpływu na zawartość olejku oraz jego skład. Zawartość olejku eterycznego wahała się od 1.87 do 2.33% (v/w). Oznaczono udział 40 składników olejku kolendrowego, z czego 9 niezidentyfikowano. Głównymi składnikami olejku z owocu kolendry były: linalol, kamfora, α-pinen, geraniol oraz γ-terpinen.

Słowa kluczowe: Coriandrum sativum L., kolendra, olejek eteryczny, linalol, kamfora, GC/MS