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ESSENTIAL OIL COMPOSITIONS OF SOME SPECIES OF *Cyclotrichium* AND ANTIMICROBIAL ACTIVITIES

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In this study we report on the essential oil composition of six freshly collected plant species, *Cyclotrichium glabrescens* (Boiss. & Kotschy ex Rech. F.) Leblebici, *C. longiflorum* Leblebici, *C. stamineum*, *C. niveum*, *C. leucotrichum*, and *C. origanifolium*, and their biological activity. The essential oil compositions of *Cyclotrichium glabrescens* and *C. longiflorum* and their antimicrobial activities are reported for the first time in this study.

The yields of essential oils of the leaves of the species *Cyclotrichium glabrescens*, *C. longiflorum*, *C. stamineum*, *C. niveum*, *C. leucotrichum*, and *C. origanifolium*, were 0.5, 0.8, 1.2, 3.4, 1.8, and 2.3%, respectively.

The hydrodistilled essential oil of *C. glabrescens* was analyzed by GC/MS, and 29 volatile compounds were identified which represented 75.6% of the total oil (Table 1). The main compounds of the essential oil of the species were found to be thymol (26.3%), carvacrol (16.6%), isopulegol acetate (11.1%), and spathulenol (6.1%).

Thirty-one components were determined in the essential oil of *C. longiflorum* which represented 90.2% of total oil. The main compounds of the species were isopinacamphone (59.8%) together with spathulenol (6.8%), myrtenyl acetate (6.7%), and menthone (3.6%).

The main compounds of *Cyclotrichium glabrescens*, *C. longiflorum*, *C. stamineum*, *C. niveum*, *C. leucotrichum*, and *C. origanifolium* were found to be isopinacamphone (47.4%) and terpinene-4-ol (7.0%), spathulenol (6.0%), *trans*-caryophyllene (4.8%), and menthone (4.3%) (Table 1). However, according to Baser et al., the main compounds of the species obtained from the Herbarium of the Royal Botanic Garden, Edinburgh were reported to be pinacamphone (33.78%), isopinacamphone (13.67%) and terpinen-4-ol (7.22%), but the location of the species was not reported by the authors [1].

The essential oil composition of the fourth species collected from Sivas, Gurun, *C. niveum*, was reported previously [2] and the main components of the species were reported pulegone (32.49–56.56%) and isomenthone (33.75–35.36%). The main compounds were determined as pulegone in this study; however, the percentage of pulegone in the essential oil was 81.2%, and isomenthone was found as a trace. This is difference could depend on the climate conditions of the collection years.

The essential oil composition of the fifth species, *C. leucotrichum*, consists of 36 compounds representing 82.3% of the total oil. In this species, the main compounds were distributed in equal percentages in contrast to other species where the compounds are present in different percentages: *p*-mentha-3,8-diene and *t*-cadinol (15.8%), pulegone (15.6%), borneol formate (7.6%), terpinen-4-ol (5.9%), spathulenol (3.1%), and *trans*-caryophyllene (2.4%). However, according to Baser et al., the main compounds of the species obtained from the Herbarium of the Royal Botanic Garden, Edinburgh were reported again to be present in different percentages: caryophyllene (14.4%), *p*-menth-3-en-8-ol (11.1%), and camphor (11.92%).

The last reported species in this study was *C. origanifolium*, collected from Osmaniye (Southern part of Anatolia) [3] and Mugla, Isparta, and Antalya (Western Part of Anatolia) [4]. In this study we report on the species collected from Kayseri (Eastern part of Turkey). However, the results are similar to the other species collected from the mentioned localities. The main compounds were determined as isopinacamphone (26.4%), menthone (25.2%), β-pinene (15.5%), pulegone (14.1%), and 1,8-cineole (8.9%).

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TABLE 1. Essential Oil Composition of Species of *Cyclotrichium*

Compound	RT	*C. glabrescens*	*C. longiflorum*	*S. stamineum*	*C. niveum*	*C. leucotrichum*	*C. origanifolium*
α-Pinene	934	Tr.	0.4	Tr.	Tr.	Tr.	1.0
β-Myrcene	941	Tr.	Tr.	Tr.	0.1	Tr.	Tr.
β-Pinene	988	1.2	Tr.	1.1	0.2	Tr.	15.5
α-Phellandrene	1002	-	Tr.	Tr.	Tr.	Tr.	Tr.
α-Terpinene	1014	Tr.	Tr.	0.5	Tr.	Tr.	Tr.
p-Cymene	1022	1.0	Tr.	0.3	Tr.	1.5	Tr.
Limonene	1027	-	0.3	0.4	1.4	1.9	0.1
β-Phellandrene	1030	Tr.	Tr.	0.3	Tr.	Tr.	Tr.
1,8-Cineole	1032	Tr.	0.5	0.5	0.9	2.7	8.9
γ-Terpinene	1058	Tr.	Tr.	1.7	Tr.	1.6	Tr.
p-Mentha-3,8-diene	1072	Tr.	-	-	Tr.	15.8	Tr.
α-Terpinolone	1091	0.2	Tr.	Tr.	Tr.	2.5	Tr.
Linalool	1098	Tr.	1.0	1.5	0.1	Tr.	0.3
Pinacamphone	1160	-	-	-	-	0.9	0.8
Menthone	1163	0.8	3.6	4.3	Tr.	Tr.	25.2
Isopinacamphone	1174	Tr.	59.8	47.4	0.3	1.7	26.4
Terpinen-4-ol	1177	1.2	1.1	7.0	0.7	5.9	Tr.
Borneol formate	1208	-	-	-	0.3	7.6	Tr.
Pulegone	1238	1.2	Tr.	Tr.	81.2	15.6	14.1
Thymol	1291	26.3	Tr.	0.3	Tr.	Tr.	Tr.
Menthol acetate	1295	7.5	-	-	-	-	-
Carvacrol	1298	16.6	Tr.	Tr.	Tr.	Tr.	Tr.
Isopulegol acetate	1322	11.6	Tr.	Tr.	Tr.	Tr.	Tr.
Myrtenyl acetate	1333	Tr.	6.7	3.9	0.1	Tr.	0.8
Piperitenone	1335	-	-	-	1.2	Tr.	0.3
α-Copaene	1378	Tr.	0.5	0.3	Tr.	Tr.	Tr.
α-Bourbonene	1386	Tr.	Tr.	0.5	Tr.	0.5	Tr.
β-Elemene	1392	Tr.	0.4	0.4	Tr.	Tr.	Tr.
trans-Caryophyllene	1420	0.7	0.8	4.8	Tr.	2.4	Tr.
Aromadendrene	1444	1.2	1.7	3.9	Tr.	Tr.	Tr.
γ-Muurolene	1478	-	0.8	1.0	Tr.	Tr.	Tr.
Germacrane D	1484	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
Ledene	1518	Tr.	1.6	4.4	Tr.	Tr.	Tr.
δ-Cadinene	1525	Tr.	2.8	3.0	Tr.	0.5	Tr.
Spathulenol	1581	6.1	6.8	6.0	1.1	3.1	0.7
Cubenol	1625	-	-	-	Tr.	2.3	Tr.
t-Cadinol	1642	-	1.4	1.3	0.1	15.8	Tr.
Total		75.6	90.2	94.8	87.7	82.3	94.1

Tr.: trace (less than 0.1%).

The essential oil of fresh leaves of the species *C. origanifolium*, *C. stamineum*, *C. glabrescens*, and *C. longiflorum* are pure compounds; pulegone, β-pinene, and *trans*-caryophyllene were tested against standard bacterial strains (Table 2). Against the gram negative bacteria *E. coli*, the essential oil of the species was found to be slightly active. MIC values were determined as 0.94 mg/mL for *C. glabrescens* and > 2.8 mg/mL for the essential oil of the other species. The essential oil of *C. origanifolium*, *C. stamineum*, and *C. glabrescens* was found to be moderately active against *C. albicans* (Table 2) while all the tested oils were found to be slightly active against *K. pneumoniae* at > 2.8 mg/mL. None of the tested essential oils showed activity against *P. aeruginosa* (Table 2). β-Pinene did not show activity as reported previously by one of the authors [5]. The purified compound pulegone showed activity against *E. coli* (0.94 µg/mL), *B. subtilis* (1.88 µg/mL), *K. pneumoniae* (>2.88 µg/mL), *P. aeruginosa* (>2.88 µg/mL), and the yeast *C. albicans* (<0.94 µg/mL). The activity of menthone, one of the main compound of the species, was reported by Quimzil et al. and it showed moderate activity against the tested microorganisms (Table 2). In conclusion, species of *Cyclotrichium* showed moderate activity against the tested microorganisms.

TABLE 2. Antibacterial and Antifungal Activity of Essential Oil of Species of *Cyclotrichum* and Some Main Compounds

Tested material	*E. coli*	*B. subtilis*	*K. pneumoniae*	*P. aeruginosa*	*C. albicans*
C. origanifolium	>2.8	0.94	>2.8	NA	<0.47
C. stamineum	>2.8	1.88	>2.8	NA	1.88
C. glabrescens	0.94	1.88	NT	NA	0.94
C. longiflorum	>2.8	NT	>2.8	NA	NT
Pulegone	<0.94	1.88	>2.88	>2.88	<0.94
β-Pinene	NA	NA	NA	NA	NA
Menthone[b]	5.5	NT	5.5	11.1	11.1
Gentamicin*	0.97	0.97	0.48	0.97	NT
Fluconazole*	NT	NT	NT	NT	15.6

[a]MIC values are given as mg/L, NA: non-active; NT: not tested.

*Gentamicin and flucanozole are used as positive controls and results are given as μg/mL.

[b]Values were taken from literature [6].

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