

Chemical Composition, Antimicrobial and Antioxidant Activities of Essential Oil from *Pedicularis condensata* BIEB.

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ABSTRACT

The chemical composition of the essential oil obtained from the dried aerial parts of *Pedicularis condensata* was analyzed by GC-FID and GC-MS. Thirty-eight components have been identified in the essential oil of *P. condensata*. The major compounds of the essential oil were pentacosane (21.28%), hexadecanoic acid (18.48%) and tricosane (13.70%). The antimicrobial activity of the essential oil was also investigated and it showed moderate antimicrobial and antifungal activities against twelve gram negative bacteria and five fungi. The amount of total phenolic and DPPH reducing activity quantified essential oil in *P. condensata* were found as 198.28 GGA/L and 10.90 % respectively.

Keywords:

Pedicularis condensata; Essential oil; GC-FID; GC-MS; Antimicrobial and antioxidant activity; Pentacosane.

INTRODUCTION

Pedicularis L. is a large hemi parasitic genus and, 12 taxa of *Pedicularis* are existing in Turkey [1]. Traditionally, *Pedicularis* was placed in Scrophulariaceae but, this genus has been transferred to Orobanchaceae based on molecular evidence [2,3]. Iridoic and phenylpropanoid glycosides were isolated from *P. condensata* Bieb. [4]. Lignans glycosides, flavonoids and alkaloids were also obtained from some members of the *Pedicularis* as well as Iridoic and phenylpropanoid glycosides [5]. Some species of the *Pedicularis* are used as traditional medicine by Chinese people [5]. Li et al. (2014) also determined that extracts of some species of *Pedicularis* from China have antitumor, hepatoprotective, anti-oxidative, antibacterial activity, antihaemolysis, fatigue relief of skeletal muscle and nootropic effects. The genus *Pedicularis* comprising about 500 medicinal herbs and mostly endemic to China, is one of those genera of this family [6]. Several species of this genus, e.g., *P. muscicola*, *P. oliveriana*, *P. kansuensis* and *P. rhinanthoides*, have been using in Tibetan medicine system [6,7].

The aim of this study was to investigate the major

volatiles and biological activities of the essential oil from *P. condensata* by GC-MS/GC-FID. Furthermore, It was also tested the bioactive properties of essential oil of *P. condensata*.

MATERIALS AND METHODS

Plant Sample Collection

Pedicularis condensata Bieb. was collected from Özkürtün-Kürtün, Gümüşhane: (40°40'25"K, 39°10'20"D at 1740 m above sea level) in the North-Eastern part of Turkey(A7) in August 2013. The plant was authenticated immediately and air-dried at room temperature for later analysis [8,9]. And a voucher specimen (No. M. Gultepe 513 KTUB) was deposited in the Herbarium of the Department of Biology, Faculty of Science, Karadeniz Technical University, Turkey.

Isolation of the essential oil: Crude essential oil of *P. condensata* was obtained from the air-dried crushed material (ca. 100g) by hydrodistillation in a clevenger-type apparatus with cooling bath (-15 °C) system (4 h) (yield: 0.016 % (w/w)) [10,11]. The obtained oil was

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extracted with HPLC grade *n*-hexane (0.5 mL) and dried over anhydrous sodium sulphate and stored at 4-6 °C in a sealed brown vial. 1 mL of the extract was directly injected into the GC-MS instrument.

Gas chromatography (GC) and Gas chromatography-mass spectrometry (GC-MS) analyzes: The chromatographic column used for the analysis was a HP-5MS capillary column. The capillary GC-FID analysis was performed using an Agilent-5973 Network System, equipped with a FID and a split inlet. GC-MS and GC-FID analyses were as described previously [10].

Identification of components: The identity of the components was achieved from their retention indices, determined by Kovats method using *n*-alkanes (C₆-C₄₀) as standards. The constituent of oil was identified by comparison of their mass spectra with those of mass spectral libraries (NIST and Wiley 7NL) and data [12,13].

Antimicrobial activity assessment: All test microorganisms were obtained from Gumushane University Food Engineering Laboratories. The oil was dissolved in hexane to prepare chemical stock solution of 10000 ppm. The antimicrobial activity of the essential oil was determined against to *Aeromonas hydrophila* ATCC 7965, *Bacillus cereus* ATCC 33019, *Bacillus subtilis* ATCC 6633, *Enterobacter cloacae* ATCC 13047, *Escherichia coli* ATCC 11230, *Escherichia coli* O157:H7 ATCC 33150, *Klebsiella pneumoniae* ATCC 13883, *Listeria monocytogenes* ATCC 7644, *Proteus vulgaris* ATCC 13319, *Pseudomonas aeruginosa* ATCC 17853, *Salmonella typhimurium* ATCC 14028, *Staphylococcus aureus* ATCC 25923, *Saccharomyces cerevisiae* BC 5461, *Candida albicans* ATCC 1223 by using agar-well diffusion method [14,15].

Determination of free radical scavenging activity: Free radical scavenging activity of the samples was carried out by DPPH method according to the literature [16]. The measurements were performed in five times and the results were averaged. The results were given as % inhibition;

% Inhibition = (Control Absorbance - Absorbance of the Sample / Control Absorbance) x 10

The amount of total phenolic: Folin-Ciocalteu method used by Sagdic *et al.* was applied for the analysis of total phenolic substance amount [17]. The measurements were performed in five times and the results were averaged. The total phenolic substance amount results were given as (GAE) / L sample being equivalent of mg

gallic acid. Calculations were done according to the as described previously [18].

RESULTS AND DISCUSSION

The GC-FID and GC-MS analysis of *P. condensata* essential oil is presented in Table-1. Altogether, 38 essential compounds were identified with HP-5MS column, representing 86.84 % of the total oil and the major compounds were pentacosane (21.28%), hexadecanoic acid (18.48%), tricosane (13.70), tetrahydro-2,5-dimethyl furan (7.63%) and 6,10,14-trimethyl-2-pentadecanone (7.33%). Chemical contents were characterized on the basis of a typical library search and literature data [12, 19].

The compounds were separated 6 classes, which were terpenes or terpene related, alcohols, acids, esters, hydrocarbons and others (Table 1).

In literature survey, 6,10,14-trimethyl-2-pentadecanone, and (*E*)- β -damascenone compounds were found in GC-MS analyzes of some *Pedicularis* species (*P. sibthorpii* and *P. wilhelmsiana*) [20]. But other compounds showed large differences. All chemical profile of the essential oils showed big differences as in our case, which can be explained by the environmentally, harvest time, locality and the subspecies of the plant used.

Essential oil extracts of *P. condensata* exhibited different inhibition levels against selected bacteria and fungi (in Table 2). In the antimicrobial activity study, the inhibition zone increased with increasing concentration of essential oil extract. At 1000 ppm and 500 ppm concentrations, samples exhibited remarkable inhibition activity against bacteria, and bacterial inhibition of essential oil extracts of *P. condensata* was stronger than those of fungi. However, the essential oil extracts of plant showed antibacterial activity against *B.cereus*, *E.coli* and *Sal. typhimurium* in the 1000 ppm concentration.

The essential oil exhibited weak antioxidant activity. As shown in Table 3, essential oil of *P. condensata* were reduce the radical activity DPPH to the yellow-colored diphenylpicrylhydrazine. The effect of radical activity DPPH was observed for the essential oil was %10.90. The high relative total phenolic content of essential oil of *P. condensata* were found as 198.28 GGA/L (Table 3).

In conclusion, It have been demonstrated that essential oil of *P. condensata* contains high levels of total phenolic compounds and shows reducing power and scavenging effects on free radicals. The results in the study indicate essential oil of *P. condensata* not only do not play a major role as dietary antioxidants, but also may use strong

Table 1. Identified Components in the Essential Oil of *Pedicularis condensata* BIEB.

No	Compounds	RT(min)	Area %	Exp. RI
<i>Terpene or terpene related</i>				
1	Limonene	13.086	0.75	1031
2	α -Terpinolene	16.138	0.46	1101
3	(E)- β -Damascenone	28.979	0.30	1389
4	Dehydro- β -ionone	30.219	0.16	1418
5	Geranyl acetone	31.745	0.40	1455
6	α -Ionone	33.206	0.49	1491
7	Aromadendrene	33.349	0.21	1494
8	6.10.14-Trimethyl-2-pentadecanone	46.433	7.33	1847
	Total		10.10	
<i>Alcohols</i>				
9	2-methyl-1-butanol	4.502	0.88	727
10	3-Penten-2-ol	5.135	1.53	770
11	5-methyl-3-heptanol	9.683	1.40	943
12	6-methyl-2-heptanol	10.038	0.52	952
13	2-Methyl-1,3-pentanediol	11.647	0.23	997
14	1-Hexadecanol	47.591	0.17	1882
15	trans-9-Hexadecen-1-ol	47.925	0.28	1891
	Total		5.01	
<i>Acids</i>				
16	Hexadecanoic acid	50.539	18.48	1971
17	Oleic acid	55.780	0.63	2140
	Total		19.11	
<i>Esters</i>				
18	Methyl-2-hydroxydodecanoate	40.356	0.15	1676
19	1,2-Benzenedicarboxylic acid, butyl 2-methylpropyl ester	47.287	0.84	1872
20	Hexadecanoic acid ethyl ester	51.324	0.22	1995
	Total		1.21	
<i>Hydrocarbones</i>				
21	3,4-dimethyl-1-hexene	4.533	0.83	730
22	1-Tetradecene	29.725	0.16	1406
23	4-methyl-tetradecane.	32.062	0.19	1463
24	5-Octadecene	42.198	0.10	1761
25	Nonadecane	48.233	0.27	1900
26	Heneicosane	54.584	2.33	2100
27	Docosane	57.553	0.70	2200
28	Tricosane	60.428	13.7	2301
29	Tetracosane	63.194	1.62	2400
30	Pentacosane	66.506	21.28	2502
	Total		41.18	
<i>Others</i>				
31	Furan, tetrahydro-2,5-dimethyl-	4.284	7.63	714
32	4-(Prop-2-enoyloxy)octane	10.998	0.36	979
33	Furan, 2-pentyl-	11.495	0.36	993
34	Benzothiazole	21.744	0.15	1225
35	1H-Indene, 2,3-dihydro-1,1,4,7-tetramethyl-	29.101	0.44	1392
36	3,7-Benzofurandiol, 2,3-dihydro-2,2-dimethyl	34.763	0.44	1530
37	13-Tetradecenal	38.062	0.12	1614
38	Pentadecanal	41.838	0.73	1716
	Total		10.23	
Total percentages			86.84	

Table 2. Screening Results for Antimicrobial activity of the Essential Oil of *Pedicularis condensata* BIEB.

Bacteria	1000 ppm	500 ppm	200 ppm	100 ppm
<i>A. hydrophila</i>	-	-	-	-
<i>B. cereus</i>	8.19±0.10	4.97±0.10	-	-
<i>B. subtilis</i>	-	-	-	-
<i>Ent. cloacae</i>	-	-	-	-
<i>E. coli</i>	5.05±0.10	-	-	-
<i>E.coli O157:H7</i>	-	-	-	-
<i>K. pneumoniae</i>	-	-	-	-
<i>L.monocytogenes</i>	-	-	-	-
<i>P. vulgaris</i>	-	-	-	-
<i>Pseu. aeruginosa</i>	-	-	-	-
<i>Sal. typhimurium</i>	9.10±0.10	5.28±0.10	-	-
<i>S. aureus</i>	-	-	-	-
Fungus				
<i>Sac. cerevisiae</i>	-	-	-	-
<i>C. albicans</i>	-	-	-	-
<i>A.niger</i>	-	-	-	-
<i>A.flavus</i>	-	-	-	-
<i>Penicillium</i>	-	-	-	-

Table 3. Total phenolic content and reducing activity of *P. condensata* essential oil.

Sample	Total phenolic content	Reducing activity
Essential oil of <i>P. condensata</i>	198.28 GGA/L	% 10.90

antibacterial agents. However, further investigations are required to assay the antioxidant and antimicrobial effects in vivo and to evaluate its relevance to human health.

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