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Research Article

The volatile components of *Eriogonum ovalifolium* var. *depressum* from southeastern Oregon

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Cushion buckwheat, essential oil composition, long-chain alkanes, fatty acids, enantioselective.

Abstract

Eriogonum ovalifolium var. *depressum* is an herbaceous member of the Polygonaceae growing in western North America. The purpose of this study is to examine the volatile components of this plant collected in southeastern Oregon. The essential oils from three individual plants were obtained by hydrodistillation in relatively poor yields of 0.383-0.632%. The essential oils were analyzed by gas chromatography and chiral gas chromatography. The essential oils were dominated by *n*-alkanes (11.7-25.4%), fatty aldehydes (11.0-29.1%), and fatty acids (2.8-20.7%). Chiral GC-MS showed (–)-camphene, (–)-β-pinene, (+)-α-phellandrene, (+)-limonene, and (+)-β-phellandrene to be the predominant monoterpene enantiomers. Because the yields were so low, *E. ovalifolium* is unlikely to serve as a practical source of essential oil.

1. Introduction

There are around 250 species of *Eriogonum* (Polygonaceae), which are found naturally in North and Central America [1]. Of these, *Eriogonum ovalifolium* Nutt. (cushion buckwheat) is restricted to western North America (British Columbia and Saskatchewan, south through Washington, Idaho, Montana, Oregon, Wyoming, California, Nevada, Utah, western Colorado, and into northern Arizona and northwestern New Mexico [2]. According to *Flora of North America*, there are 11 varieties of *Eriogonum ovalifolium* [3]. *Eriogonum ovalifolium* var. *depressum* Blankinship ranges in the Rocky Mountains of Alberta, Idaho, western Montana, and Wyoming, and in desert regions of eastern Oregon [4]. The plant is characterized by greenish, elliptic or oblong to spatulate, tomentose leaves (0.4-10 cm); the scapes are generally suberect to decumbent, usually thinly floccose (Fig. 1) [3]. As part of our interest in researching the essential oils of aromatic and medicinal plants of the intermountain western United States, we present the essential oil obtained from aerial parts of *E. ovalifolium* var. *depressum* collected from southeastern Oregon. To the best of our knowledge, there have been no previous reports on the volatile components of *E. ovalifolium*.

2. Materials and methods

2.1. Plant material

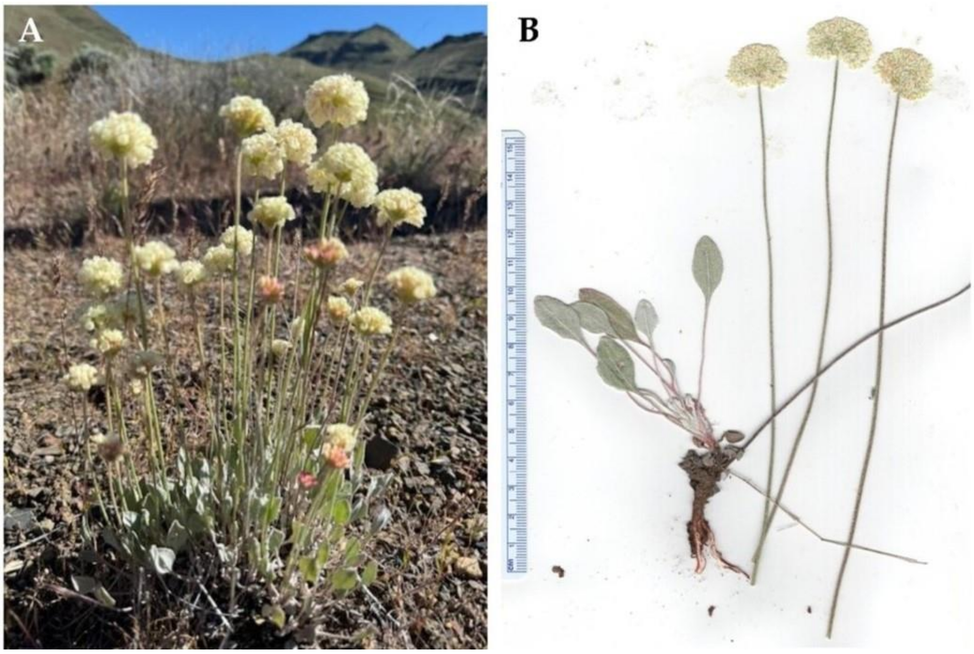

Figure 1. *Eriogonum ovalifolium* var. *depressum*. **A:** Photograph by K. Swor at the time of collection. **B:** Scan of the pressed plant material.

Table 1. Plant collection and hydrodistillation yields of *Eriogonum ovalifolium* var. *depressum* from southeastern Oregon

Plant samples	Locations	Mass aerial parts (g)	Mass essential oil (mg)	Yield (%)
#1	43°36′24″ N, 117°14′58″ W, elevation 847 m asl	53.12	220.8	0.416
#2	43°36′45″ N, 117°15′07″ W, elevation 835 m asl	43.36	274.0	0.632
#3	43°36′45″ N, 117°15′07″ W, elevation 835 m asl	44.81	171.8	0.383

Aerial parts of *E. ovalifolium* var. *depressum* were collected on 8 May 2024 from three individual plants growing in Lake Owyhee State Park (Table 1). The plant was identified in the field by W.N. Setzer using a field guide [5] and verified by comparison with samples from the C.V. Starr Virtual Herbarium [6]. A voucher specimen (WNS-Eod-0119) was deposited in the University of Alabama in Huntsville Herbarium. The fresh plant material was stored frozen at (–20 °C) until distilled.

2.2. Essential oils extraction

The fresh-frozen plant material was hydrodistilled for four hours using a Likens-Nickerson apparatus with continuous extraction of the distillate with dichloromethane to give colorless essential oils (Table 1).

2.3. Gas chromatographic analysis

The *E. ovalifolium* var. *depressum* essential oils were analyzed using GC-MS, GC-FID, and enantioselective GC-MS as previously reported [7]. Retention indices were calculated using the method of van den Dool and Kratz [8]. Essential oil components were identified by comparison of mass spectral fragmentation patterns and retention indices found in the Adams [9], FFNSC3 [10], NIST20 [11], and Satyal [12] databases.

3. Results and discussion

3.1. Essential oil composition

The colorless essential oils of *E. ovalifolium* var. *depressum* were obtained in relatively low yields (0.383-0.632%). Gas chromatographic analysis (GC-MS, GC-FID) allowed for the identification of a total of 82 components, which accounted for 98.3-100.0% of the total compositions (Table 2). The fatty-acid derivatives, *n*-alkanes (11.7-25.4%), fatty aldehydes

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Table 2. Essential oil composition of three *Eriogonum ovalifolium* var. *depressum* samples from southeastern Oregon

Compounds	RI_{calc}	RI_{db}	Composition (%)		
			#1	#2	#3
(3*Z*)-Hexenal	800	797	0.4	0.3	0.3
Hexanal	801	801	2.8	1.0	1.1
iso-Valeric acid	830	830	1.1	0.3	0.5
Furfural	837	837	0.4	2.0	1.4
2-Methylbutanoic acid	839	840	1.7	1.3	1.1
(2*E*)-Hexenal	853	850	12.9	5.2	4.9
Heptanal	906	905	1.0	0.5	0.3
α-Pinene	932	932	2.1	6.4	1.7
Camphene	949	950	0.5	0.5	0.3
Thuja-2,4(10)-diene	953	953	-	0.2	-
Sabinene	972	972	1.0	0.2	0.2
β-Pinene	977	978	0.8	1.8	0.6
Myrcene	989	989	0.3	0.2	0.1
Octanal	1007	1006	0.6	0.3	0.2
α-Phellandrene	1008	1006	2.3	0.6	0.5
δ-3-Carene	1009	1008	0.3	0.2	0.2
p-Cymene	1026	1025	0.9	1.1	0.3
Limonene	1029	1030	2.7	1.3	1.0
β-Phellandrene	1031	1031	1.2	0.6	0.3
1,8-Cineole	1032	1032	4.1	2.8	2.1
Phenylacetaldehyde	1045	1045	-	-	0.1
γ-Terpinene	1058	1057	0.3	0.4	0.2
Dihydromyrcenol	1072	1070	-	0.9	-
Terpinolene	1085	1086	0.7	0.3	0.2
Nonanal	1107	1107	4.1	3.0	1.3
α-Campholenal	1129	1127	-	0.4	-
trans-Pinocarveol	1142	1141	-	1.2	-
trans-Verbenol	1147	1146	-	0.4	-
Camphor	1149	1145	0.3	0.3	0.3
Pinocarvone	1165	1164	-	0.5	-
p-Mentha-1,5-dien-8-ol	1174	1171	-	0.9	-
α-Terpineol	1197	1195	-	0.5	-
Myrtenal	1198	1196	-	0.6	-
Dodecane	1200	1200	0.7	1.0	0.2
Decanal	1208	1206	1.2	0.4	0.3
Verbenone	1210	1208	-	1.8	-
Octyl acetate	1211	1211	0.8	0.6	-
Bornyl acetate	1284	1282	0.6	1.7	1.0
Tridecane	1300	1300	0.5	0.4	0.2
Undecanal	1309	1309	0.7	0.7	0.3
4-Vinylguaiacol	1312	1310	-	3.1	1.6
trans-β-Elemene	1387	1390	-	0.8	0.1
Tetradecane	1400	1400	0.4	0.5	0.4
Decyl acetate	1408	1408	-	1.3	0.1
Dodecanal	1410	1410	0.8	1.0	0.3
(*E*)-β-Caryophyllene	1417	1417	1.9	1.3	0.7
γ-Elemene	1427	1427	0.7	-	0.7
Germacrene D	1479	1480	-	0.5	0.2
Pentadecane	1500	1500	-	0.3	0.1

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Table 2. *(Continued)*

Compounds	RI_{calc}	RI_{db}	Composition (%)		
			#1	#2	#3
β-Bisabolene	1505	1508	-	0.5	-
Tridecanal	1511	1510	1.7	2.6	0.7
δ-Cadinene	1516	1518	-	0.6	-
Germacrene B	1557	1557	1.4	-	1.2
Caryophyllene oxide	1581	1587	-	0.6	-
Hexadecane	1600	1600	-	-	0.3
Tetradecanal	1612	1613	1.8	1.2	0.5
1,10-di-*epi*-Cubenol	1614	1614	-	0.5	-
τ-Cadinol	1641	1640	-	1.0	-
τ-Muurolol	1644	1644	-	0.4	-
Methyl dihydrojasmonate	1650	1653	-	0.4	0.4
α-Cadinol	1655	1655	0.6	1.5	-
ar-Turmerone	1664	1664	1.7	0.9	2.5
α-Turmerone	1668	1668	5.3	2.5	6.9
α-Bisabolol	1684	1688	-	3.4	0.5
β-Turmerone (= Curlone B)	1701	1699	3.2	1.8	4.9
Pentadecanal	1714	1715	1.1	1.4	0.8
cis-Ligustilide	1731	1730	2.6	3.1	7.9
Oplopanone	1734	1735	1.5	-	-
(6*S*,7*R*)-Bisabolone	1743	1742	-	-	0.5
trans-α-Atlantone	1773	1771	-	-	0.4
2-Methyl-5-(1,2,2-trimethylcyclopentyl)phenol	1779	1776	1.6	-	2.8
Palmitic acid	1957	1859	-	11.5	10.0
Linoleic acid	2132	2128	-	3.3	9.1
iso-Pimarinal [a]	2221	---	1.4	-	-
Dehydroabietal	2270	2266	0.8	-	-
Methyl isopimarate	2297	2297	1.4	-	-
Tricosane	2300	2300	1.6	1.1	0.9
Methyl dehydroabietate	2336	2359	1.5	-	-
Tetracosane	2400	2400	0.6	0.3	0.4
Pentacosane	2500	2500	7.9	3.6	6.9
Hexacosane	2600	2600	1.2	0.7	1.3
Heptacosane	2700	2700	10.3	3.8	14.8
Compound classes					
Monoterpene hydrocarbons			13.2	13.9	5.6
Oxygenated monoterpenoids			5.0	11.9	3.3
Sesquiterpene hydrocarbons			3.9	3.6	2.8
Oxygenated sesquiterpenoids			12.3	12.5	15.9
Diterpenoids			5.1	0.0	0.0
Benzenoid aromatics			1.6	3.1	4.5
Fatty aldehydes			29.1	17.6	11.0
Fatty acids			2.8	16.4	20.7
n-Alkanes			23.2	11.7	25.4
Others			3.8	7.4	9.8
Total identified			*100.0*	*98.3*	*99.0*

RI_{calc} = Retention index determined with respect to a homologous series of *n*-alkanes on a ZB-5ms column. RI_{db} = Reference retention index obtained from the databases [9–12]. tr = trace (< 0.05%). [a] Reference RI on a 5% phenyl (polydimethylsiloxane) column not available.

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Table 3. Enantiomeric distribution of chiral monoterpenes in *Eriogonum ovalifolium* var. *depressum* essential oil from southeastern Oregon

Enantiomers	RI_{calc}	RI_{db}	Composition (%)		
			#1	#2	#3
(–)-α-Pinene	977	976	47.0	76.2	46.6
(+)-α-Pinene	981	982	53.0	23.8	53.4
(–)-Camphene	999	998	100.0	100.0	100.0
(+)-Camphene	n.d.	1005	0.0	0.0	0.0
(+)-β-Pinene	1026	1027	0.0	14.6	0.0
(–)-β-Pinene	1031	1031	100.0	85.4	100.0
(–)-α-Phellandrene	n.d.	1050	0.0	0.0	0.0
(+)-α-Phellandrene	1052	1053	100.0	100.0	100.0
(–)-Limonene	1075	1073	21.6	20.0	22.0
(+)-Limonene	1081	1081	78.4	80.0	78.0
(–)-β-Phellandrene	n.d.	1083	0.0	0.0	0.0
(+)-β-Phellandrene	1089	1089	100.0	100.0	100.0

RI_{db} = Retention index from our in-house database based on commercially available compounds available from Sigma-Aldrich and augmented with our own data. RI_{calc} = Calculated retention index based on a series of *n*-alkanes on a Restek B-Dex 325 capillary column. n.d. = not detected.

(11.0-29.1%), and fatty acids (2.8-20.7%), were the dominant chemical class. Oxygenated sesquiterpenoids (12.3-15.9%) were also relatively abundant. The most abundant fatty acid derivatives were heptacosane (3.8-14.8%), pentacosane (3.6-7.9%), palmitic acid (0.0-11.5%), and (2*E*)-hexenal (4.9-12.9%). α-Turmerone (2.5-6.9%), β-turmerone (1.8-4.9%), and *cis*-ligustilide (2.6-7.9%) also had high percentages.

Since this is the first report on the essential oil composition of *E. ovalifolium*, there are no previous reports for comparison. Nevertheless, the essential oil composition of *Eriogonum heracleoides* Nutt. var. *heracleoides* has been described [13]. Fatty acid derivatives, fatty aldehydes in particular (33.5-60.0%), dominated the essential oils of *E. heracleoides*, including hexanal (2.3-3.8%), (2*E*)-hexenal (4.9-14.2%), nonanal (4.7-6.4%), dodecanal (2.8-7.4%), tridecanal (4.1-6.4%), and tetradecanal (2.5-4.7%). *n*-Alkanes (5.7-14.6%) and fatty acids (7.6-11.4%) were also abundant in *E. heraclеioides* essential oil. Although the Polygonaceae is not regarded as an essential oil-producing family, investigations of the volatile compositions of members of the family have shown fatty aldehydes to be particularly abundant [13].

3.2. Enantiomeric distribution of chiral monoterpenoids

Although monoterpene hydrocarbons made up a small proportion of the *E. ovalifolium* essential oil compositions (5.6-13.9%), enantioselective GC-MS was carried out, allowing the evaluation of the enantiomeric distributions of six monoterpenes (Table 3). α-Pinene was virtually racemic in the essential oils, but (–)-camphene (100%), (–)-β-pinene (85.4-100%), (+)-α-phellandrene (100%), (+)-limonene (78.0-80.0%), and (+)-β-phellandrene (100%) were the predominant enantiomers. This is the first report describing the enantiomeric distributions of monoterpene components of any *Eriogonum* species.

4. Conclusions

This is the first report of the essential oil from *E. ovalifolium*. The essential oil was dominated by fatty acid derivatives, particularly *n*-alkanes and fatty aldehydes as well as fatty acids. These constituents seem to be common in the Polygonaceae and additional research on volatile components in members of the genus and the family should confirm this. However, essential oil yields were low, so *E. ovalifolium* cannot be considered a viable source of essential oil.

Authors' contributions

Conceptualization, W.N.S.; Methodology, A.P., P.S., W.N.S.; Software, P.S.; Validation, W.N.S., Formal analysis, A.P., W.N.S.; Investigation, K.S. A.P., P.S., W.N.S.; Resources, P.S., W.N.S.; Data curation,

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W.N.S.; Writing – original draft preparation, W.N.S.; Writing – review & editing, K.S., A.P., P.S., W.N.S.; Project administration, W.N.S.

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Availability of data and materials

All data will be made available on request according to the journal policy.

Conflicts of interest

The authors declare no conflict of interest.

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