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The essential oil composition of *Lysichiton americanus* Hultén & H. St. John (Araceae)

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Abstract
The aerial parts of *Lysichiton americanus* were collected from plants growing in a bog near the Oregon (USA) coast. The essential oils were obtained by hydrodistillation (1.75-4.14% yield) and analyzed by gas chromatography. The major component classes were *n*-alkanes (11.4-42.1%), oxygenated sesquiterpenoids (12.8-17.2%), diterpenoids (7.6-16.9%), and oxygenated monoterpenoids (2.0-23.6%). Lactonitrile was also abundant (up to 11.9%). This is the first report on the essential oil composition of *L. americanus*.

Keywords Western skunk cabbage, volatiles, gas chromatography, mass spectrometry, lactonitrile

1. Introduction

Lysichiton americanus Hultén & H. St. John, Araceae (western skunk cabbage), is a plant found in swamps and wet woods, along streams and in other wet areas of the Pacific Northwest, it has large leaves (40-150 cm long, 10-70 cm wide), a bright yellow spathe and malodorous spadix (Fig. 1). The natural range is from Kodiak Island and Cook Inlet, Alaska south through western British Columbia, Washington, Oregon, and into northern California as far south as the San Francisco Bay area. There are also isolated populations in northeastern Washington, northern Idaho, and northwestern Montana (Fig. 2) [1, 2]. The plant has been introduced as an ornamental to western and northern European gardens but has the potential to be invasive [3].

Fig 1: Photograph of *Lysichiton americanus* Hultén & H. St. John at the time of collection (photograph by K. Swor)

Fig 2: Native range of *Lysichiton americanus* Hultén & H. St. John, based on Thompson, 1995 [2]

Lysichiton americanus is a food source for elk (*Cervus canadensis* Erxleben), black bears (*Ursus americanus* Pallas), grizzly bears (*Ursus arctos horribilis* Linnaeus), and Canada geese (*Branta canadensis* Linnaeus) [2]. The Native Americans of northwestern North America used *L. americanus* as food, especially during famine conditions, as medicines, as well as a material for food preparation [2,4]. As far as we are aware, there have been no phytochemical investigations of *L. americanus*. The aim of this work is to investigate the essential oil from the aerial parts of *L. americanus*.

2. Materials and Methods

2.1 Plant Material and Essential Oil

Aerial parts of *L. americanus* were collected from three individual plants growing in a bog near Wecoma Beach, Oregon (44°59′49″ N, 123°59′49″ W, 5 m asl) on 16 April 2023. The plant was identified by W.N. Setzer using a field guide [1]. A voucher specimen was not obtained; the plant is unmistakable. The fresh plant material was stored frozen (–20 °C) until distilled. The fresh/frozen plant material was chopped and hydrodistilled using a Likens-Nickerson apparatus [5–7] for four hours with continuous extraction of the distillate with dichloromethane: Plant #1, 60.47 g aerial parts, 1.0566 g pale yellow essential oil (1.747% yield); plant #2, 27.60 g aerial parts, 0.6051 g pale yellow essential oil (2.192% yield); plant #3, 96.82 g aerial parts, 4.0051 g colorless EO (4.137% yield).

2.2 Gas Chromatographic Analysis

The essential oils of *L. americanus* were analyzed by GC-MS and GC-FID as previously described [8]. GC-MS: Shimadzu GC-MS-QP2010 Ultra (Shimadzu Scientific Instruments), ZB-5ms GC column (60 m × 0.25 mm × 0.25 μm film thickness, Phenomenex); injector and detector temperatures = 260 °C, He carrier gas (column head pressure = 208.2 kPa, flow rate = 2.00 mL/min; GC oven temperature program (50-260 °C at 2 °C/min); injected 1.0 μL of a 5% (w/v) essential oil solution in CH_2Cl_2, splitting mode = 24.5:1. Retention index (RI) values were calculated using a homologous series of *n*-alkanes [9]. The essential oil components were identified by comparing RI values and MS fragmentation patterns with those from the Adams [10], FFNSC 3 [11], NIST20 [12], and Satyal [13] databases. GC-FID: Shimadzu GC 2010 with FID detector (Shimadzu Scientific Instruments), ZB-5 GC column (60 m × 0.25 mm × 0.25 μm film thickness, Phenomenex); same operating conditions as above for GC-MS. The percent compositions were determined from raw peak areas without standardization.

3. Results and Discussion

Hydrodistillation of the aerial parts of *L. americanus* gave colorless to pale-yellow essential oils in yields of 1.75% to 4.14%. Gas chromatographic analysis (GC-MS and GC-FID) led to the identification of 46 chemical components, which accounted for 96.5-100.0% of the compositions (Table 1).

Table 1: Chemical components (percent of total) of the essential oil of three samples of *Lysichiton americanus* aerial parts

RI_{calc}	RI_{db}	Compound	#1	#2	#3
790	na	Lactonitrile (acetaldehyde cyanohydrin)	-	11.9	6.7
796	804	(3*E*)-2-Methyl-3-penten-1-ol	1.1	1.7	-
800	800	Octane	-	0.6	2.7
803	802	Hexanal	0.6	0.7	2.3
851	850	(2*E*)-Hexenal	8.6	1.9	4.6
895	901	(3*E*)-4-Ethyl-3-heptene	1.2	1.2	0.7
904	901	Heptanal	0.2	0.4	0.6
934	933	α-Pinene	0.2	0.2	-
989	989	Myrcene	0.8	0.4	0.7
1005	1004	Octanal	0.6	0.9	1.1
1025	1025	*p*-Cymene	0.4	0.3	0.5
1030	1030	Limonene	0.3	0.3	0.3
1031	1031	β-Phellandrene	1.2	1.0	1.6
1046	1046	(*E*)-β-Ocimene	0.4	-	0.5
1058	1057	γ-Terpinene	0.8	0.5	1.6
1071	1069	1-Octanol	0.3	0.6	1.6
1072	1070	Dihydromyrcenol	1.2	2.0	-
1100	1101	Linalool	0.9	4.1	23.6
1106	1107	Nonanal	2.3	8.4	14.0

1284	1282	Bornyl acetate	-	1.2	-
1291	1290	Indole	-	-	2.5
1309	1309	4-Vinyl guaicol	3.6	1.8	-
1355	1357	Terpendiol B (2,6-Dimethyl-3,7-octadiene-2,6-diol)	-	1.3	-
1644	1643	τ-Cadinol	0.3	0.5	-
1645	1644	τ-Muurolol	0.5	0.8	-
1648	1651	α-Muurolol (= δ-Cadinol)	-	0.3	-
1657	1655	α-Cadinol	1.8	2.8	0.8
1664	1660	*ar*-Turmerone	4.4	2.9	2.2
1669	1668	α-Turmerone	-	-	1.6
1701	1699	Curlone B (= β-Turmerone)	4.3	2.4	5.4
1870	1875	Oplopanonyl acetate	4.2	7.6	2.8
1898	1896	Rimuene	0.5	0.8	-
1899	1900	Nonadecane	-	1.4	2.5
1934	1933	Beyerene	5.5	10.4	3.1
2020	2018	(*E*,*E*)-Geranyl linalool	-	-	2.1
2052	2053	Manool	-	0.9	-
2072	2072	10-Heneicosene	-	1.2	-
2099	2100	Heneicosane	1.6	4.5	6.4
2107	2106	Phytol	5.7	4.8	2.4
2273	2274	(9*Z*)-Tricosene	-	0.7	-
2300	2300	Tricosane	3.3	5.1	2.3
2400	2400	Tetracosane	38.8	-	-
2472	2472	1-Heneicosyl formate	0.7	1.1	-
2492	2488	1-Docosanol	-	1.6	-
2500	2500	Pentacosane	1.7	3.2	1.5
2700	2700	Heptacosane	-	2.2	1.2
		Monoterpene hydrocarbons	4.1	2.6	5.2
		Oxygenated monoterpenoids	2.0	8.6	23.6
		Sesquiterpene hydrocarbons	0.0	0.0	0.0
		Oxygenated sesquiterpenoids	15.6	17.2	12.8
		Diterpenoids	11.7	16.9	7.6
		Benzenoid aromatics	3.6	1.8	0.0
		Alkanes	42.1	11.4	11.6
		Others	19.0	38.0	39.3
		Total identified	98.1	96.5	100.0

RI_{calc}: Retention Index calculated with respect to a homologous series of *n*-alkanes on a ZB-5ms column. RI_{db}: Reference Retention Index from the databases [10–13]. na: Although there was a good MS match (95% similarity), a reference RI was not available in the databases.

The essential oils showed pronounced inter-plant variation in composition. Nevertheless, the major components in the essential oils were tetracosane (0.0-38.8%), linalool (0.9-23.6%), nonanal (2.3-14.0%), beyerene (3.1-10.4%), lactonitrile (0.0-11.9%), (2*E*)-hexenal (1.9-8.6%), oplopanonyl acetate (2.8-7.6%), phytol (2.4-5.7%), heneicosane (1.6-6.4%), curlone B (2.4-5.4%), and tricosane (2.3-5.1%). The relatively high concentrations of *n*-alkanes and fatty-acid derived components are not surprising; the leaves of *L. americanus* are known to be waxy [14]. However, the high concentration of the cyanohydrin lactonitrile (11.9% and 6.7% in samples #2 and #2, respectively) was surprising. Although rare, lactonitrile has been detected previously in essential oils [15–18]. Note that lactonitrile is highly toxic by eye contact, ingestion, or skin absorption, and may cause cyanide poisoning [19, 20]. The total terpenoid concentrations in the essential oils were less than 50% in all three samples. To our knowledge, this is the first examination of the essential oil of *L. americanus*, so there are no comparisons to be made. Furthermore, there is only one other member of the genus, *Lysichiton camtschatcensis* (L.) Schott, which is found in Japan and far eastern Russia [21]. However, there have apparently been no phytochemical investigations of *L. camtschatcensis* either.

4. Conclusions
This is the first report on the essential oil composition of *Lysichiton americanus*, the western skunk cabbage. In this work, the flowering part (spadix) of *L. americanus* was not investigated. It would be interesting to see an analysis of the floral volatiles of the plant to discern the components responsible for the foul odor.

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7. Conflicts of Interest
The authors declare no conflicts of interest.

8. References
1. Turner M, Gustafson P. Wildflowers of the Pacific Northwest. Timber Press, Inc., Portland, Oregon, USA; c2006.
2. Thompson SA. Systematics and Biology of the Araceae and Acoraceae of Temperate North America, Ph.D. Thesis, University of Illinois, Urbana-Champaign; c1995.
3. Rotteveel T. *Lysichiton americanus* (American skunk cabbage). CABI Compendium. Available from: https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.31580. Accessed on June 13, 2024.

4. Moerman DE. Native American Ethnobotany. Timber Press, Inc., Portland, Oregon, USA; c1998.
5. Likens ST, Nickerson GB. Detection of certain hop oil constituents in brewing products. Proceedings Annu Meet - Am Soc Brew Chem. 1964;22(1):5-13. doi:https://doi.org/10.1080/00960845.1964.12006730
6. Au-Yeung CY, MacLeod AJ. A comparison of the efficiency of the Likens and Nickerson extractor for aqueous, lipid/aqueous, and lipid samples. J Agric Food Chem. 1981;29(3):502-505. doi:10.1021/jf00105a016
7. Bouseta A, Collin S. Optimized Likens-Nickerson methodology for quantifying honey flavors. J Agric Food Chem. 1995;43(7):1890-1897. doi:10.1021/jf00055a025
8. Swor K, Poudel A, Satyal P, Setzer WN. Chemical composition of the foliar essential oil of *Juniperus occidentalis* var. *occidentalis* from southeastern Oregon. Am J Essent Oils Nat Prod. 2024;12(1):1-8. doi:10.22271/23219114.2024.v12.i1a.258
9. Van den Dool H, Kratz PD. A generalization of the retention index system including linear temperature programmed gas-liquid partition chromatography. J Chromatogr A. 1963;11:463-471. doi:10.1016/S0021-9673(01)80947-X
10. Adams RP. Identification of Essential Oil Components by Gas Chromatography/Mass Spectrometry, 4th ed. Allured Publishing, Carol Stream, Illinois, USA; c2007.
11. Mondello L. FFNSC 3. Shimadzu Scientific Instruments, Columbia, Maryland, USA; c2016.
12. NIST20. National Institute of Standards and Technology, Gaithersburg, Maryland, USA; c2020.
13. Satyal P. Development of GC-MS Database of Essential Oil Components by the Analysis of Natural Essential Oils and Synthetic Compounds and Discovery of Biologically Active Novel Chemotypes in Essential Oils, Ph.D. dissertation, University of Alabama in Huntsville; c2015.
14. eFloras.org. *Lysichiton americanus* Hulten & H. St. John. Flora of North America, Vol. 22. Available from: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=222000246. Accessed on June 13, 2024.
15. Radulović N, Dekić M, Zlatković B, Dekić S, Dekić V, Palić R. A detailed analysis of volatile constituents of *Aquilegia pancicii* Degen, a Serbian steno-endemic species. Chem Pap. 2007;61(5):405-409. doi:10.2478/s11696-007-0055-y
16. Radulović NS, Dordevic AS, Zlatković BK, Palić RM. GC-MS analyses of flower ether extracts of *Prunus domestica* L. and *Prunus padus* L. (Rosaceae). Chem Pap. 2009;63(4):377-384. doi:10.2478/s11696-009-0031-9
17. Dekic MS, Radulovic NS, Randelovic VN, Stojanovic-Radic ZZ, Veljkovic BP. Essential oils and diethyl ether extracts of Serbian *Xeranthemum cylindraceum* and *X. annum*: Chemical composition, antimicrobial activity, and chemotaxonomic implications. Chem Biodivers. 2015;12(9):1378-1397. doi:10.1002/cbdv.201400316
18. Raičević V, Mladenović M, Aćimović M, Radulović N. New esters from the essential oil of dry flowers of elder (*Sambucus nigra* L.). J Sci Food Agric. 2024;104(3):1308-1321. doi:10.1002/jsfa.13012
19. National Library of Medicine NLM. Lactonitrile. PubChem. Available from: https://pubchem.ncbi.nlm.nih.gov/compound/Lactonitrile. Accessed on June 14, 2024.
20. Cubbison C. Provisional Peer-Reviewed Toxicity Values for Lactonitrile. National Center for Environmental Assessment, United States Environmental Protection Agency Cincinnati, Ohio, USA; c2017.
21. World Flora Online WFO. *Lysichiton camtschatcensis* (L.) Schott. The World Flora Online. Available from: https://www.worldfloraonline.org/taxon/wfo-0000231604. Published 2024. Accessed on June 14, 2024.