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Short Communication

Flavoring profiles of *Artemisia ludoviciana* and *Matricaria discoidea* (Asteraceae) from Northeastern Utah

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Abstract

Artemisia ludoviciana and *Matricaria discoidea* are aromatic plants in the Asteraceae family. Both plant species, which exhibit large native geographic ranges, have broad historical usage, including as food and flavoring materials. In the current study, flavoring profiles were established from populations originating in the Intermountain Region (USA), specifically in Northeastern Utah. Ethanol extractions (maceration technique) were analyzed by GC/MS. The flavor profile of *A. ludoviciana* was primarily composed of 1,8-cineole (43.7%), camphene (18.4%), camphor (10.8%), α-pinene (6.8%), sabinene (6.7%), santolina triene (4.6%), and β-pinene (3.6%). The flavor profile of *M. discoidea* was simpler, with prominent compounds being myrcene (63.5%), (*E*)-β-farnesene (19.4%), limonene (11.4%), α-pinene (2.9%), and β-pinene (2.3%). The prominent volatile compounds present in *A. ludoviciana* are characterized by flavor profiles of camphor, earthy, eucalyptol, and spice flavors. Those abundant in *M. discoidea* are characterized as having flavor profiles of fruit, herb, citrus, and sweet flavors. The established aromatic profiles provide a foundation for the use and application of these plants in the food and flavor industry.

1. Introduction

Artemisia ludoviciana Nutt., also known as white sagebrush, is an aromatic plant in the Asteraceae family [1,2]. This perennial flowering plant is native to the Intermountain Region, east throughout the USA, south throughout Central America, and north into Canada [2-6]. *A. ludoviciana* has been used, typically as a tea or infusion, to help with a wide range of aliments including sores, respiratory issues, eczema, arthritis, horse illnesses, and has been used in many cleansing-spiritual rituals [1, 7-11]. However, throughout history, the most common use of the plant has been to treat infectious diseases and their symptoms [1, 5, 7-10]. Previous research of the leaf volatiles (flavoring compounds), determined by GC analysis, of *A. ludoviciana* have been identified as being largely composed of β-ocimene, α-pinene, camphene, hexyl butyrate, 1,8-cineole, camphor, borneol, nonanal, linalool, carvacrol, and p-α-dimethylbenzyl alcohol [8, 12].

Matricaria discoidea DC., also known as pineapple-weed, is an annual plant of the Asteraceae family [3, 4, 13]. The exact origin of the species is debated, but it is believed to be native to both North America and Asia, and has been widely naturalized throughout Europe [14]. This flowering plant thrives in heavily treaded areas, such as roadsides and footpaths, and is characterized by its yellow, cone-shaped, rayless florets, feathery leaves, and distinct pineapple aroma when crushed [14, 15]. *M. discoidea*, like its relative Roman chamomile (which is also often consumed as an infusion), is believed to have sedative properties, may help with anxiety and insomnia, has been noted for its anti-inflammatory properties, and has well-documented ethnomedicinal uses of the entire plant [16]. Quercetin galactoside, malonylapigenin glucoside, apigenin acetylglucoside, quercetin, luteolin, and apigenin glycosides are flavonoids that are relevant constituents of *M. discoidea*, and may be responsible for various purported pharmacological activities [17]. Volatile compounds (flavoring compounds) reportedly present in the essential oil of *M. discoidea*, as determined by GC analysis, include (Z)-enyne-dicycloether, (E)-β-farnesene, geranyl isovaleriate, and myrcene [18].

Given the widespread distribution and historical use of both plants in the Asteraceae family, chemical profiling of distinct regions and climates is of interest to the food and flavor. industries. The current study investigated the volatile profiles of ethanol extract of *A. ludoviciana* and *M. discoidea* from Northeastern Utah.

2. Materials and methods

2.1. Plant material collection

Artemisia ludoviciana and *Matricaria discoidea* (Fig. 1) populations grow naturally on public lands (Bureau of Land Management) in the Otter Creek area in Northeastern Utah (41°42′03.5″ N,111°22′.01.0″ W). Seeds were collected from this site during the fall of 2024, grown and cultivated in the Young Living Essential Oils greenhouse (40°25'16.8"N 111°52'24.3"W) during the winter of 2025, and transplanted to private garden plots in the Salt Lake Valley in the spring of 2025. Respecting the wishes of the landowner, the GPS coordinates for the private garden plots were withheld. Plant material (leaf, stem, and flower) for both species was harvested from the private garden plots on August 1, 2025 and allowed to shade-dry for 72 hours. A representative voucher sample of each species is held at the Young Living Aromatic Herbarium (YLAH): *Artemisia ludoviciana* Nutt., Wilson 2025-01, and *Matricaria discoidea* DC., Wilson 2025-01.

Figure 1. Botanical illustration of *Artemisia ludoviciana* (left) and *Matricaria discoidea* (right). Illustration by Zach Nielsen.

2.2. Extraction technique

Laboratory-scale extractions were performed using a custom 2-L stainless steel device (Fig. 2) as follows: 500 mL of 200-proof ethanol (MilliporeSigma, Sigma Aldrich, St. Louis, MS, USA) were combined with 100 g of plant material and macerated for 72 h. The plant material was then removed, and the liquid solution was heated and distilled for 10 min after passover. The condensed distillate was stored in a glass amber bottle until analysis.

Figure 2. Illustration of distillation unit employed. Section 1 (2-L capacity) holds ethanol and plant materials (maceration) for 72-hours, upon heating the vapor passes through section 2, and the vapor is cooled and condensed back to a liquid state in section 3. Illustration by Rick Simonson (Science Lab Studios, Inc).

2.3. Analysis methods

To determine volatile compound profiles, samples

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Table 1. Volatile compounds detected in *Artemisia ludoviciana* and *Matricaria discoidea* ethanol extractions.

Compounds	KI	Relative area %	
		A. ludoviciana	*M. discoidea*
Santolina triene	906	4.6	nd
Tricyclene	921	0.9	nd
α-Thujene	924	0.3	nd
α-Pinene	932	6.8	2.9
Camphene	946	18.4	nd
Sabinene	969	6.7	nd
β-Pinene	974	3.6	2.3
Myrcene	988	nd	63.5
p-Cymene	1020	0.8	nd
Limonene	1024	0.7	11.4
1,8-Cineole	1026	43.7	nd
Santolina epoxide	*1054	0.6	nd
Artemisia alcohol	1080	0.6	nd
Camphor	1141	10.8	nd
Artemisyl acetate	1169	0.3	nd
Bornyl acetate	1284	0.2	nd
(*E*)-β-Farnesene	1454	nd	19.4
	Total	***98.9***	***99.5***

The compound name, KI, and relative area % are reported. Values are reported as an average of three repeat injections from the same sample (σ < 1 for all compounds). KI is the Kovat's Index value and was previously calculated by Robert Adams using a linear calculation on a DB-5 column [19]. * KI manually calculated.

were analyzed, and compounds were identified and quantified by GC/MS using an Agilent 7890B GC/5977B MSD (Agilent Technologies, Santa Clara, CA, USA) and Agilent J&W DB-5, 60 m × 0.25 mm, 0.25 µm film thickness, fused silica capillary column. Operating conditions: 0.1 µL of sample (splitless injection) was injected using an autosampler, the initial oven temperature was set to 40 °C with an initial hold time of 5 min, and an oven ramp rate of 4.5 °C per min to 310 °C with a hold time of 5 min. The electron ionization energy was 70 eV, the scan range was 35–650 amu, the scan rate was 2.4 scans per second, the source temperature was set to 230 °C, and the quadrupole temperature was set to 150 °C. Compounds were identified using the Adams volatile oil library [19] and a Chemstation library (MSD Chemstation F.01.03.2357) search in conjunction with retention indices. Samples were analyzed in triplicate and the reported values (relative area %) are an average of those relative quantifications (σ < 1 for all compounds).

3. Results

Ethanol distillations (maceration technique) were conducted on both *Artemisia ludoviciana* and *Matricaria discoidea*. The volatile profile of *A. ludoviciana* comprised 15 compounds with prominent compounds (compounds > 2%) being 1,8-cineole (43.7%), camphene (18.4%), camphor (10.8%), α-pinene (6.8%), sabinene (6.7%), santolina triene (4.6%), and β-pinene (3.6%). The volatile profile of *M. discoidea* was composed of the following five compounds: myrcene (63.5%), (*E*)-β-farnesene (19.4%), limonene (11.4%), α-pinene (2.9%), and β-pinene (2.3%). The profiles are detailed in Table 1.

4. Discussion

Samples (*n* = 2) of *Artemisia ludoviciana* and *Matricaria discoidea* were produced by ethanol extraction. The exact technique (maceration technique) is often employed by distilleries for producing liquors such as gin. In this technique, aromatic herbs are soaked in an ethanol solution for a prolonged period depending on the structural and quality characteristics of the botanicals used. For this study, a 72-h maceration period was employed, which was suggested by industry experts [20]. The 72-h maceration technique was employed as a viable and representative

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approach for recovering volatile compounds (flavoring compounds) that would be of interest to the food and flavor industry.

Previous research found that the volatile profile of *A. ludoviciana* is largely composed of β-ocimene, α-pinene, camphene, hexyl butyrate, 1,8-cineole, camphor, borneol, nonanal, linalool, carvacrol, and p-α-dimethylbenzyl alcohol [8, 12]. In the current study, there was considerable overlap in the volatile profile of *A. ludoviciana*, with prominent compounds being 1,8-cineole (43.7%), camphene (18.4%), camphor (10.8%), α-pinene (6.8%), sabinene (6.7%), santolina triene (4.6%), and β-pinene (3.6%). Similarly, there is much overlap with previous research on the volatile profile of *M. discoidea*, where previous research determined that (Z)-enyne-dicycloether, (E)-β-farnesene, geranyl isovaleriate, and myrcene are prevalent compounds [18]. Two of these compounds, myrcene (63.5%) and (*E*)-β-farnesene (19.4%), were also the most prevalent compounds in the sample from the current study. Other prominent compounds included limonene (11.4%), α-pinene (2.9%), and β-pinene (2.3%). For both plant species, aromatic profiles likely differ due to variations in extraction techniques, compared to those employed in the current study, and due to the inherent variations in plant species with large native growing regions.

The Flavor and Extract Manufacturers Association of the United States (FEMA) has detailed the flavor profiles associated with many volatile compounds [21]. The descriptive quality for the top three most abundant volatile compounds in *A. ludoviciana* (camphene, 1,8-cineole, camphor) are associated with camphor, earthy, eucalyptol, and spice flavors [22-24].

The descriptive quality for the top three most abundant volatile compounds in *M. discoidea* (myrcene, limonene, and (*E*)-β-farnesene) are associated with fruit, herbs, citrus, and sweet flavors [25-27]. While consumer taste experiences are somewhat subjective, the authors believe that these are accurate descriptive flavor profiles for the ethanol extracts *A. ludoviciana* and *M. discoidea.*

In the United States, the Food and Drug Administration (FDA) is responsible for controlling the food ingredients permitted for use in the food and flavor industry, including alcoholic beverages [28]. The Code of Federal Regulations recognizes some species of *Artemisia* (*A. dracunculus*) and *Matricaria* (*M. chamomilla*), as generally recognized as safe food items [29]. Additionally, thujone-free *Artemisia* species are permitted for use in food items by the FDA [30]. While neither plant species, *A. ludoviciana* and *M. discoidea*, are specifically detailed as being permitted for use as food items within the United States, both species have widespread historical use as food items, contain aromatic profiles comprised of common natural compounds, and did not contain (in the case of *A. ludoviciana*) detectable amounts of thujone. As such, volatile extracts from both plant species could be considered as usable food ingredients within the United States if approved by the FDA.

Given the process of the maceration technique employed herein, it is likely that non-volatile compounds are also extracted from the plant materials of both species. This was further confirmed by the fact that after the 72-h period, the samples were dark green (*A. ludoviciana*) and yellow-green (*M. discoidea*). However, upon distillation, both samples were a clear, colorless solution, suggesting that non-volatile compounds were not retained during the distillation process. Future research should focus on the identification and quantification of these non-volatile compounds.

5. Conclusions

The current study established the volatile compound profiles of two plants in the Asteraceae family, *Artemisia ludoviciana* and *Matricaria discoidea*, using the maceration technique. These plant species have a large native distribution range; however, the current study focused on a small population in Northeastern Utah (USA).

The volatile profiles established herein reflect the extraction techniques employed by distilleries for flavoring beverages, such as gin. The profile for *A. ludoviciana* was primarily composed of 1,8-cineole (43.7%), camphene (18.4%), camphor (10.8%), α-pinene (6.8%), sabinene (6.7%), santolina triene (4.6%), and β-pinene (3.6%). The profile of *M. discoidea* was primarily composed of myrcene (63.5%), (*E*)-β-farnesene (19.4%), limonene (11.4%), α-pinene (2.9%), and β-pinene (2.3%). Prominent volatile compounds

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present in *A. ludoviciana* portray camphor, earthy, eucalyptol, and spice flavors. Those abundant in *M. discoidea* portray fruit, herb, citrus, and sweet flavors. These findings are of interest to the food and flavor industry, which is investigating the use of botanicals native to the Intermountain Region (USA).

Disclaimer (artificial intelligence)

Author(s) hereby state that no generative AI tools such as Large Language Models (ChatGPT, Copilot, etc.) and text-to-image generators were utilized in the preparation or editing of this manuscript.

Authors' contributions

Conceptualization, T.M.W.; sample procurement and production, K.E.C.W., I.P.L., T.M.W.; methodology, T.M.W; software, T.M.W.; validation, C.R.B.; formal analysis, T.M.W.; data curation, T.M.W.; writing—original draft preparation, K.E.C.W., I.P.L., T.M.W.; writing—review and editing, K.E.C.W., I.P.L., C.R.B.; funding acquisition, C.R.B. All authors have read and agreed to the published version of the manuscript.

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Availability of data and materials

All data have been presented within the current manuscript. Additional data will be made available on request according to the journal policy.

Conflicts of interest

The authors declare no conflicts of interest.

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