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Short Communication

Volatile compound profile of *Bursera graveolens* (Burseraceae) resin from Ecuador

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Abstract

Bursera graveolens (palo santo) is an aromatic tree, belonging to the Burseraceae family. This plant species, which is widely distributed throughout Central and South America, has both historical and current spiritual and economic importance. The current study investigated the solvent extraction profiles of palo santo resin (n = 6) from the Central Pacific coast of Ecuador. Naturally exuded resin was collected, solvent (ethanol) extracts were conducted to isolate the volatile fraction, and resin volatile compound profiles were analyzed by GC/MS, with 36 identified volatile compounds. Profiles were largely composed (average relative area %) of limonene (51.9%), menthofuran (6.2%), β-bisabolene (5.9%), α-bisabolol (5.1%), mentholactone (5.0%), β-bourbonene (4.1%), valerianol (3.4%), 10-epi-γ-eudesmol (3.0%), and 7-α-hydroxymintlactone (2.7%). The current findings add to the body of knowledge on economically important tree species that have both historical, spiritual and medicinal importance.

1. Introduction

Bursera graveolens (Kunth) Triana & Planch is an aromatic tree, belonging to the Burseraceae family [1]. This tree, which grows 4-10 meters in height, is typically found in seasonally dry forests in Central America and the northern countries of South America [1]. Although the IUCN has classified *B. graveolens* as a species of 'least concern', its dry forest habitats are important areas for conservation [2].

Historically, *B. graveolens* (commonly known as palo santo), has been used to treat rheumatism, digestive issues, respiratory problems, and support skin care [3, 4]. It is also regarded by Indigenous peoples for its spiritual and cleansing properties [5]. Bark decoctions are used to treat neonates for both medicinal and spiritual purposes [6, 7]. Modern research has suggested that palo santo essential oil can be used in agricultural pest control [8, 9]. Palo santo essential oil and solvent extracts also demonstrate medicinal properties, including topical antifungal [9, 10] and antispasmodic applications [11].

The modern applications of palo santo essential oil are generally associated with its chemical profile. Previous research has demonstrated that palo santo essential oil and other non-resin solvent extracts are

largely composed of limonene (9- 44 %) and, to a lesser degree, several other mono- and sesquiterpenoids [8, 9, 12]. Published scientific literature is largely based on the extraction of palo santo woody materials, leaves, and/or fruits, all of which contain aromatic compounds [8, 9, 11-16]. While research on extractions from resin has been conducted on other *Bursera* species [17], this does not appear to be the case for *B. graveolens*.

The current study investigates the volatile compound profile of *B. graveolens* resin solvent extracts (n = 6) from the Central Pacific coast of Ecuador. The current findings add to the body of knowledge on important tree species that have both historical, spiritual and medicinal importance.

2. Materials and methods

Bursera graveolens resin was collected on 11 December 2024 from the Finca Botánica Aromatica in Chongon, Ecuador (-2.277237°, -80.065141°). A representative voucher sample was collected from said site and is held in the Young Living Aromatic Herbarium (YLAH): *B. graveolens* (Kunth) Triana & Planch., Wilson 2024-01 (YLAH).

Volatile compound samples (n = 6) were produced by manually collecting naturally exuded resin from *B. graveolens* trees (n = 33). For samples A-C, resin was collected from 10 trees (30 trees in total). For samples D-F, resin was collected from an individual tree (3 trees in total). Samples were produced as follows: (1) resin was collected from trees and added to a 20 mL clear screw cap vial (Gerstel Inc., Linthicum Heights, MD, USA), (2) ethanol (Quimical Scientific Diagnostic, Quito, Ecuador) was added to the vial in a 2:5 (w/w) ratio (resin-to-ethanol), (3) vials were manually mixed for 10 min (adequate time for resin to go into solution), and (4) the samples were filtered with a 0.22 µm PVDF Luer lock filter (Restek Corporation, Bellefonte, PA, USA). The samples were stored in sealed amber glass bottles at room temperature until analysis.

To determine the volatile compound profiles, samples 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, 100:1 split ratio, initial oven temp. of 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, scan range was 35–650 amu, scan rate was 2.4 scans per s, source temp. 230 °C, and quadrupole temp. 150 °C. The compounds were identified using the Adams volatile oil library [18] and a Chemstation library search in conjunction with retention indices (KI). For compounds that were not present in the Adams volatile oil library ((*E*)-Isopulegone, Limonene-1,2-diol, Menthalactone, 7-α-Hydroxymintlactone), identifications were made using the NIST (2020) reference library and retention indices (KI) were manually calculated using C7-C30 alkane standards (Sigma-Aldrich, St. Louis, MO, USA).

3. Results

Naturally exuded resin is of various colors and textures. The colors ranged from orange to green (Fig. 1). Textures were either liquid and non-viscous or thick and viscous.

Figure 1. Photos of naturally exuded *Bursera graveolens* resin. Resin varied in color and texture.

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Table 1. Volatile profiles of *Bursera graveolens* resin samples (n = 6).

Compounds	KI	*Bursera graveolens* volatile profiles (area %)					
		A	B	C	D	E	F
α-Pinene	932	0.1	0.1	0.1	0.1	0.1	0.2
Myrcene	988	nd	nd	nd	0.1	nd	nd
p-Cymene	1020	nd	nd	0.5	nd	nd	0.5
Limonene	1024	67.5	39.3	55.5	44.5	47.0	57.6
1,8-Cineole	1026	nd	nd	nd	nd	nd	0.5
(*E*)-p-Mentha-2,8-dien-1-ol	1119	0.1	0.2	0.2	0.1	nd	0.1
(*Z*)-p-Mentha-2,8-dien-1-ol	1133	0.1	0.2	0.2	0.1	nd	0.1
Menthofuran	1159	6.0	7.7	1.9	14.8	4.3	2.4
(*E*)-Isopulegone	*1176	0.4	0.3	0.3	0.2	0.4	0.3
α-Terpineol	1186	0.2	0.4	0.1	nd	nd	0.2
(*E*)-Carveol	1215	0.2	0.4	0.8	0.2	0.2	0.6
(*Z*)-Carveol	1226	0.1	0.2	0.2	nd	nd	0.2
Thymol methyl ether	1232	nd	nd	0.3	nd	nd	nd
Pulegone	1233	1.2	1.0	1.4	0.3	2.3	1.0
Carvone	1239	0.2	0.2	0.5	nd	nd	0.3
Lavandulyl acetate	1288	0.1	tr	nd	nd	nd	nd
Limonene-1,2-diol	*1334	0.6	0.5	1.3	0.1	0.2	1.2
α-Ylangene	1373	nd	nd	0.1	0.1	nd	0.2
α-Copaene	1374	0.1	tr	0.1	nd	nd	0.2
β-Bourbonene	1387	1.8	5.1	5.5	3.9	3.2	4.9
β-Ylangene	1419	0.4	0.5	0.4	0.6	0.4	0.4
β-Copaene	1430	0.7	0.5	0.6	0.5	0.4	0.7
allo-Aromadendrene	1458	0.3	1.1	0.7	1.8	nd	1.2
γ-Muurolene	1478	0.2	0.2	0.4	0.1	0.2	0.7
Germacrene D	1480	0.2	0.5	0.3	6.0	nd	nd
Menthalactone	*1495	2.9	5.1	6.2	2.4	5.8	7.5
β-Bisabolene	1505	3.2	5.2	3.0	5.0	13.2	nd
γ-Cadinene	1513	nd	nd	0.3	nd	nd	0.4
δ-Cadinene	1522	0.7	0.2	0.7	0.1	0.2	1.5
(*E*)-γ-Bisabolene	1529	0.1	0.2	nd	0.3	0.1	nd
7-α-Hydroxymintlactone	*1550	1.7	2.9	4.1	0.9	1.8	4.9
Salvial-4(14)-en-1-one	1594	nd	nd	nd	nd	nd	0.3
10-epi-γ-Eudesmol	1622	2.6	5.3	2.6	3.3	2.1	1.9
γ-Eudesmol	1630	0.5	1.4	0.6	0.7	0.5	0.5
Valerianol	1656	2.8	5.3	3.3	3.7	2.2	3.1
α-Bisabolol	1685	2.9	5.7	2.8	4.6	9.7	nd
Identified Total		***97.7***	***89.7***	***95.2***	***94.3***	***94.5***	***94.0***

KI is the Kovat's Index value and was previously calculated by Robert Adams using a linear calculation on a DB-5 column [18]. The compound name and value (relative area %) are reported for each detected compound. Values less than 0.1% are denoted as trace (tr) and those not detected as nd. *KI not included in the Adam's Library [18] and was manually calculated using alkane standards on a DB-5 column.

Bursera graveolens samples (n = 6) were prepared by solvent extraction. Samples A-C were produced from a composite of resin from multiple (n = 10) trees. Samples D-F were produced from the resin of a single tree. Volatile profiles were largely composed (average relative area %) of limonene (51.9%), menthofuran (6.2%), β-bisabolene (5.9%), α-bisabolol (5.1%), mentholactone (5.0%), β-bourbonene (4.1%), valerianol (3.4%), 10-epi-γ-eudesmol (3.0%), and 7-α-hydroxymintlactone (2.7%). Volatile profiles are listed in Table 1.

Table 2. Volatile compounds, and standard deviations, present in *Bursera graveolens* resin samples (n = 6).

Compounds	Relative area (%)			A-C σ	Relative area (%)			D-F σ
	A	B	C		D	E	F	
Limonene	67.5	39.3	55.5	11.6	44.5	47.0	57.6	5.7
Menthofuran	6.0	7.7	1.9	2.4	14.8	4.3	2.4	5.4
β-Bourbonene	1.8	5.1	5.5	1.7	3.9	3.2	4.9	0.7
Menthalactone	2.9	5.1	6.2	1.4	2.4	5.8	7.5	2.2
β-Bisabolene	3.2	5.2	3.0	1.0	5.0	13.2	nd	4.1
7-α-Hydroxymintlactone	1.7	2.9	4.1	1.0	0.9	1.8	4.9	1.7
10-epi-γ-Eudesmol	2.6	5.3	2.6	1.3	3.3	2.1	1.9	0.6
Valerianol	2.8	5.3	3.3	1.1	3.7	2.2	3.1	0.6
α-Bisabolol	2.9	5.7	2.8	1.3	4.6	9.7	nd	2.5

4. Discussion

Three samples (A-C) were collected from multiple trees (n = 10) to establish average profiles for the population. The other three samples (D-F) were collected from a single tree to establish the profile of single trees within the population, and investigate tree-to-tree variability. It was assumed that the samples of A-C profiles would be more similar to each other than to samples D-F. However, of the nine abundant compounds previously mentioned, only five had smaller standard deviations (samples A-C), compared to samples from individual trees (samples D-F) (Table 2). Given the inherent variability in naturally exuded resin from tree-to-tree, collecting resin from more than 10 trees would be needed to produce a representative sample of the population. Future investigations should include a larger number of samples, and investigate both tree-to-tree variation and larger groupings of pooled resin samples from multiple trees (10+ trees).

The resin volatile profiles established herein were somewhat similar to previously established essential oil profiles from palo santo woody materials, leaves and/or fruits [8, 9, 12]. Previously established profiles demonstrated that the essential oil is largely composed of limonene (9-44%), compared to a higher content of limonene in samples from the current study (average 51.9%). Additionally, and as was the case with previously investigated palo santo essential oil samples [8, 9, 11-16], the sample profiles herein were largely composed of limonene and, to a lesser degree, several other mono- and sesquiterpenoids.

Three samples (B, D and E) contained a late-eluting compound that could potentially be ursolic aldehyde (or related compounds). Previous research has shown that ursolic acid and its derivatives are present in the leaves and resin of other *Bursera* species [19, 20]. The identification of this triterpenoid was not possible due to the lack of an accessible reference standard, therefore, it was excluded from the established profiles of the current samples (Table 1). Additionally, triterpenoid analysis is best conducted by liquid chromatography and should be the focus of future studies.

5. Conclusions

The current study is the first to investigate the volatile profile of naturally exuded resin from *Bursera graveolens*. Profiles were largely composed (average relative area %) of limonene (51.9%), menthofuran (6.2%), β-bisabolene (5.9%), α-bisabolol (5.1%), mentholactone (5.0%), β-bourbonene (4.1%), valerianol (3.4%), 10-epi-γ-eudesmol (3.0%), and 7-α-hydroxymintlactone (2.7%). By definition, resins are a complex mixture of volatile and non-volatile compounds, and future research should focus on the non-volatile profiles of *B. graveolens* resin.

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, data curation, formal analysis (GC/MS), methodology, sample procurement,

software, writing – original draft; T.M.W.; conceptualization, sample procurement, writing – original draft; J.S.W.; data curation, formal analysis (GC/MS), writing – review and editing, I.P.L.; conceptualization, sample procurement, writing – review and editing; C.P.; funding acquisition, validation, writing – review and editing, C.R.B.

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Availability of data and materials

All data resulting from this study have been included herein. A limited samples of the resin volatile fractions are available from the authors upon request.

Conflicts of interest

The authors declare no conflicts of interest. The funding entity had no role in the design of the study, nor in the collection, analysis, or interpretation of data.

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