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Original Research Article

Exploring Natural Essence: Aromatic Compounds and Antioxidant Potency in Concretes from Nong Khuang Forest Plants, Nasinuan Subdistrict, Maha Sarakham Province, Thailand

Nutkamon Tantaisong[1], Rungnapa Khrueawan[1], Chadaporn Senakun[2], Luchai Butkhup[1], Issaraporn Somboonwatthanakul[1], Vijitra Luang-In[1], Ekapol Limpongsa[3], Sirirat Deeseenthum[1]*

[1]*Natural Antioxidant Innovation Research Unit, Department of Biotechnology, Faculty of Technology, Mahasarakham University, Maha Sarakham 44150, Thailand*
[2]Walai Rukhavej Botanical Research Institute, Mahasarakham University, *Maha Sarakham 44150, Thailand*
[3]College of Pharmacy, Rangsit University, Pathum Thani 12000, Thailand

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ABSTRACT

The Nasinuan Community Forest is publicly accessible and conserved to ensure sustainable utilization, guided by the royal initiative spearheaded by Her Royal Highness Princess Maha Chakri Sirindhorn. Previous studies have highlighted the remarkable presence of microbial and plant biodiversity in this forest, suggesting that the contained plant species may possess distinctive attributes. This study investigated the volatile organic compositions (VOCs) and antioxidant activity of concretes derived from plants within this forest.

Nineteen varieties were extracted using hexane. Headspace technique of gas chromatography-mass spectrometry identified various antioxidants and compounds, including 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6 in *Ellipanthus tomentosus* subsp. *tomentosus* and acetic acid in several species. Octodrine, a weight loss dietary supplement, was detected in *Acacia auriculiformis* and *Dipterocarpus obtusifolius*. Promising antioxidant capacity was observed in *Pentacme siamensis, Xylia xylocarpa* var. *kerrii*, *Breynia glauca,* and *Peltophorum dasyrachis* var. *dasyrhachis*, displaying moderate inhibition activity by ºOH (hydroxyl radical scavenging) assay. Furthermore, *Shorea obtusa* and *Dipterocarpus obtusifolius* exhibited high inhibition activity of over 80% by DPPH (2,2-diphenyl-1-picrylhydrazyl) assay. *B. glauca* and *Amorphophallus brevispathus* exhibited the highest inhibitory activity levels >85% by ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) assay. Notably, *Naringi crenulata* measured the highest activity levels by the ferric-reducing antioxidant power (FRAP) assay. This study presents the first documentation of the antioxidant abilities of concretes derived from the bark of *Sindora siamensis* var. *maritima* and *Shorea obtusa.* However, further research and development are required to explore the pharmaceutical and cosmetic applications of these potent plant-derived concretes with high antioxidant capacities.

Keywords: essential oil, DPPH, Hydroxyl radical assay, ABTS, medicinal plants .

Introduction

Plants have long been used as a source of medicine, food and drink. Plants contain bioactive compounds which have various pharmacological and physiological effects[1]. Volatile bioactive compounds in plants are of great interest due to their potential therapeutic, sensory, flavor, and fragrance properties.[2] Plant extracts contain various volatile compounds that possess antioxidant activity.[3] Antioxidant compounds prevent free radicals from oxidative reactions that damage cells and promote the development of cancer, diabetes, and cardiovascular disease.[4]

*Corresponding author. E mail: sirirat.d@msu.ac.th
Tel: +66-845168363

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Nonpolar volatile organic compounds can be eluted from plants using hexane. Hexane crude extracts or "concreates" contain a mixture of nonpolar compounds such as lipids, terpenes, esters, alkanes, and fatty alcohols, that are typically volatile and can evaporate at room temperature.[5] Monoterpenes and sesquiterpenes are responsible for the characteristic smells of many plants. Other volatiles including aldehydes, ketones, alcohols, esters, and hydrocarbons have a range of biological activities and potential medicinal uses in the cosmetics, pharmaceuticals, and agroindustries and also for pest control in agriculture.[6,7,8] The Nasinuan Community Forest is publicly accessible and maintained for sustainable uses under the royal initiative of Her Royal Highness Princess Maha Chakri Sirinhorn. Previous studies showed demonstrated the rich microbial and plant biodiversity.[9,10,11] However, detailed characterization of the diverse plant species in terms of their unique properties, including volatile compound profiles and antioxidant activities, remains unexplored. To address this knowledge gap, a comprehensive biodiversity screening project was conducted to analyze the volatile compounds and evaluate the antioxidant activity of concretes obtained from 19 selected plants. The antioxidant activity of these plant extracts was assessed through various *in vitro* assays, including •OH, DPPH, ABTS, and FRAP assays. Static headspace gas chromatography-mass spectrometry (GC-MS) was employed to identify and quantify individual compounds. Our study seeks to contribute to the existing knowledge by shedding light on the volatile

compound profiles and antioxidant activities of these forest plants, to develop novel applications for these natural resources.

Methodology

Plant identification and extraction

Parts of 19 varieties including Family Apocynaceae (*Holarrhena pubescens* Wall. ex G.Don, *Urceola polymorpha* (Pierre ex Spire) D.J. Middleton & Livsh.); Family Araceae (*Amorphophallus brevispathus* Gagnep.); Family Bignoniaceae (*Dolichandrone serrulata* (Wall. ex DC.) Seem.); Family Connaraceae (*Ellipanthus tomentosus* subsp. *tomentosus*); Familly Cucurbitaceae (*Coccinia grandis* (L.) Voigt); Family Dipterocarpaceae (*Dipterocarpus obtusifolius* Teijsm. ex Miq., *Shorea obtusa* Wall. ex Blume, *Pentacme siamensis* (Miq.) Kurz.); Family Dioscoreaceae (*Dioscorea* sp.); Family Fabaceae (*Acacia auriculiformis* A. Cunn. ex Benth., *Dialium cochinchinense* Pierre, *Peltophorum dasyrachis* var. *dasyrhachis*, *Phyllodium pulchellum* (L.) Desv., *Senna siamea* (Lam.) H.S. Irwin & Barneby, *Sindora siamensis* var. *maritima*, *Xylia xylocarpa* var. *kerrii* (Craib ex Hutch.) I.C.Nielsen); Family Phyllanthaceae (*Breynia glauca* Craib); and Family Rutaceae (*Naringi crenulata* (Roxb.) Nicolson) in Nong Khuang Forest (Latitude 16.336084 N Longitude 103.200458 E.), Na Si Nuan Subdistrict, Kantharawichai District, Maha Sarakham Province were collected during May-July, 2022. Voucher specimens were deposited at the Department of Biotechnology, Faculty of Technology, Mahasarakham University, Thailand. Plant taxonomic classification was conducted by Asst. Prof. Dr. Chadaporn Senakun, Walai Rukhavej Botanical Research Institute, Mahasarakham University. Each fresh sample was washed with tap water, dried and blended into small pieces with a blender. Then, 250 g of sample powder was soaked in hexane 500 mL for 24 h before filtering twice with Whatman No. 1 filter paper. The filtrate was evaporated by a vacuum evaporator, dried in a laboratory chemical fume hood, then weighed and kept at 4°C for further analysis.

Analysis of volatile organic compound profiles of the concretes

The volatile organic compounds (VOCs) were analyzed by a headspace GC-MS instrument. (Shimadzu QP2010) using an Rtx-5MS capillary column (size 30 m × 0.25 mm i.d.; 0.25 μm film thickness, Roster, USA). Static headspace equilibration[12] was performed with modifications. Small pieces of the plants (0.5 g) were heated in a vial at 140°C for 5 min and shaken at 500 rpm. Headspace gas was injected with a 0.25 mL syringe, at 500 μL/min, 80 °C into the GC-MS instrument following the operation conditions[13] with a small modification. The injection temperature was set at 250 °C, and pressure was maintained at 51.3 kPa with a flow rate of 1 mL/min. The program of oven temperature was initiated at 40 °C for 5 min, increased at 7 °C/min to 100 °C and maintained for 5 min, increased at 1 °C/min to 130 °C, increased at 10 °C/min to 200 °C and maintained for 45 min. The chromatograms were compared to the National Institute of Standard and Technology (NIST) Mass Spectral Search Program, NIST Standard Reference Database Number 69[14] (https://webbook.nist.gov/chemistry/), with a quality match of > 80%.

Antioxidant activity

Hydroxyl radical scavenging assay (•OH)

All extracts were measured for antioxidant activity based on the original method.[15,16] Briefly, KH_2PO_4/KOH buffer (100 mM, pH 7.4) 200 μL and deoxyribose (16.8 mM) 200 μL were added in a 15 mL test tube. Then, the sample (50 mg/L) or standard 200 μL, $FeCl_3$ (500 μM) 200 μL, EDTA (1.2 mM) 100 μL, ascorbic acid (1 mM) 100 μL and H_2O_2 (10 mM) 100 μL were added and well mixed. After incubating at 37 ºC for 1 h, added 1% thiobarbituric acid (TBA) and 1.4% trichloroacetic acid (TCA) 1 mL each were added in the tube and heated at 90 ºC for 20 min. The mixture was cooled and absorbances were recorded at 532 nm using a microplate reader (Metertech, Taipei, Taiwan) against the buffer as a blank and Trolox as the standard. Radical-scavenging activity was reported as percentage inhibition of free radicals (Equation 1).

Percentage inhibition of free radical = $\frac{A-B}{A} * 100$ ……..….(1)

where A = absorbance of blank; B = absorbance of sample

Diphenyl – 1 – picrylhydrazyl (DPPH) assay

The antioxidant capacities of the 19 hexane extracts were analyzed as previously reported[17] with modifications. Each 50 mg/L extract (100 μL) was mixed with 100 μL of 0.2 mM DPPH (Sigma-Aldrich, St. Louis, MO, USA) mixed and left in a dark room for 30 min. A M965$^+$ microplate reader (Metertech, Taipei, Taiwan) was used to measure the absorption at 517 nm. Methanol and ascorbic acid were used as the blank and standard antioxidants, respectively. Antioxidant capacity was reported as percentage inhibition using Equation (1).

2,2'-Azino-bis (3-ethylbenzthiazoline-6-sulfonic acid) (ABTS)

For ABTS radical scavenging activity, we followed the method described.[18] In brief, 0.50 mL of aqueous sample (50 mg/L) or ascorbic acid used as a standard was supplemented with 1 mL of ABTS reagent (7 mM ABTS solution and 2.45 mM $K_2S_2O_8$ (1:1 v/v) mixed and incubated in a dark room for 12-16 h). The mixture was incubated at room temperature for 15 min in the dark. Absorbance was measured at 734 nm with Trolox used as a standard. Percentage inhibition results were calculated using Equation (1).

Ferric reducing antioxidant power (FRAP)

Plant concretes (20 μL of 50 mg/L stock solution) were mixed with 180 μL of FRAP reagent (0.02 M $FeCl_3$, 0.01 M 2,4,6-Tri (2-pyridyl) s-triazine, and 0.3 M acetate buffer at pH 3.6 in ratio (v/v) 1:1:10). After 30 min incubation, the absorbance was measured at 593 nm against deionized water as the blank and ferrous II sulfate as the antioxidant standard.[17] All experiments were conducted in triplicate using chemicals purchased from Sigma-Aldrich, St. Louis, MO, USA.

Data analysis

Data on the antioxidant activity of concretes were excluded from one-way analysis of variance (ANOVA), and Duncan's Multiple Range Test was used to determine whether there were any significant differences between the mean values ($P < 0.05$).

Results and Discussions

Plant varieties

Plant varieties were collected from Nong Khuang Forest (Figure 1) including *H. pubescens*, *U. polymorpha*, *A. brevispathus*, *D. serrulata*, *E. tomentosus* subsp. *tomentosus*, *C. grandis*, *D. obtusifolius*, *S. obtusa* , *P. siamensis*, *Di.* sp., *A. auriculiformis* , *D. cochinchinense*, *P. dasyrachis* var. *dasyrhachis*, *P. pulchellum* , *S. siamea*, *S. siamensis* var. *maritima*, *X. xylocarpa* var. *kerrii*, *B. glauca* and *N. crenulata*. Concrete yields of the plants was shown in Table 1.

Antioxidant activities

Antioxidant activities of the plant concretes were shown the Table 1 evaluated by four different assays, Results showed that antioxidant activities varied among the plant species. Different methods inhibited different radicals, and FRAP measures the ability of an antioxidant to reduce Fe^{3+}. The greater activity, the more Fe^{3+} is reduced, and the stronger the color. The FRAP assay is widely used to measure the total antioxidant activity of food and plant extracts. DPPH measures the ability of an antioxidant to scavenge DPPH radicals and is commonly used to evaluate the radical scavenging capacity of various compounds. ABTS measures the ability of an antioxidant to scavenge ABTS radical cation and is usually used for measuring the antioxidant activity of biological samples, food extracts, and natural compounds. The hydroxy radical is a highly reactive free radical that can damage DNA, protein, and lipid, leading to oxidative stress. Thus, this assay measures the ability of an antioxidant to scavenge •OH. These four methods provide complementary information about the antioxidant capacity of compounds and can be used in combination to obtain a more complete picture of antioxidant activity. This research classified the antioxidant capacity using percentage inhibition divided into three levels as strong (> 80%), moderate (>50 – 79%), and low (< 50%) activity. The concretes of *P. dasyrrachis* (50.22%), *B. glauca* (51.38%), *P. siamensis* (53.82%), *X. xylocarpa* var. *kerrii* (55.35%), and *S. siamensis* var. *maritima* (65.75%) showed moderate percentage inhibition activity

during 50 to 65.75% in OH assay whereas *S. obtusa* (84.13%) and *D. obtusifolius* (80.33%) showed high percentage inhibition activity at >80% by DPPH. Previous research indicated that the ethanolic or methanolic extract of *S. siamensis* var. *maritima* and *S. obtusa* bark showed significant free radical scavenging and reducing power.[19,20,21] However, this has never been reported before due to the antioxidant ability in the concrete of both plants. *B. glauca* showed percentage inhibition activity at 51.38% (OH assay) 69.56% (DPPH) and 92.81% (ABTS). Antioxidant capacity-related reports indicated that hexane, ethanol, and methanol extracts of *B. glauca* leaves showed activity at concentrations of more than 50 µg/mL because they contained kaempferol-3-o-rutinoside.[22] *A. brevispathus* also showed the high percentage inhibition at 89.80% by ABTS. This plant is usually used as raw material in traditional food in Northeast Thailand but no data exists about its antioxidant activity and further scientific research is required.[23] *N. crenulata* showed the highest activity (16.07 mg Fe^{2+}/g DW) by the FARP assay. A previous paper reported that leaf and bark ethanolic extracts protected the liver against oxidative stress caused by CCl_4 induced hepatotoxicity in rats.[24] Results suggested that the plant concretes showed potential as a source of natural antioxidants.

Volatile organic compounds (VOCs) analysis by headspace GC-MS

Volatile organic compounds in plant concretes and their utilizations were shown in Table 2. A weak organic acid with a pungent smell and a sour taste as acetic acid or ethanoic acid was found in *S. obtusa* (70.86%), *D. obtusifolius* (66.68%), *U. polymorpha* (62.05%), *P. dasyrachis* (59.32%), *X. xylocarpa* var. *kerrii* (55.81%), *A. brevispathus* (45.52%), and *A. auriculiformis* (8.9%). The acetic acid chromatograms were eluted at 15 min (Figure 2). Plants can synthesize acetic acid from different carbon sources through a glycolytic pathway, where glucose is broken down into pyruvate and is subsequently converted into acetyl-CoA which is a key intermediate in many metabolic processes for the synthesis of essential molecules like fatty acids, that are vital for membrane integrity and energy storage.[25] Efficient utilization of acetic acid and its derivative such as Indole-3-acetic acid (IAA) contributes to maintaining cellular homeostasis and optimal plant performance[25,26]. Acetic acid is also a key component in mechanisms that some plants use to cope with nutrient deficiencies, metal tolerance, and plant-microbe interactions operating at the root-soil interphase.[27] Octodrine (Dimethylhexylamine, DMHA) found in *A. auriculiformis* (82.56%) and *D. obtusifolius* (17.04%, Figure3A), is a central nervous stimulant that was originally developed as a nasal decongestant in the 1950s. It has recently been reintroduced on the market as a pre-workout and fat-burner product, but its use remains unregulated and there is limited research on its effectiveness and safety. While some bodybuilding websites and forums claim that octodrine can aid in weight loss, no scientific evidence supports this claim. The uncontrolled use of octodrine can have serious health implications, including hypertension, dyspnea, and hyperthermia. Therefore, it is important to thoroughly study and monitor this new phenomenon.[28] Compounds identified as antioxidants in *H. pubescens* and *E. tomentosus* subsp. *tomentosus* were Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl- (Figure3B) and 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6 (Figure3C), respectively.[29,30] In terms of their antioxidant capacity, *H. pubescens* exhibited DPPH and ABTS scavenging of 55.48 and 62.99%, while *E. tomentosus* subsp. *tomentosus* demonstrated ABTS scavenging activity of 72.38% (Table 1).

Conclusion

This study revealed varying in vitro antioxidant abilities of plant concretes obtained from the Nasinuan Community Forest. The •OH, DPPH, ABTS, and FRAP assays were utilized to assess the antioxidant activities of these concretes. Importantly, this research provides the first report on the antioxidant abilities of *S. siamensis* var. *maritima* and *S. obtusa* bark concretes. Significant VOCs, such as acetic acid, Octodrine, Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-, and 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy were also identified which might play a vital role in promoting health. These findings highlight the potential of these plant-based concretes with strong antioxidant activity for medicinal and cosmetic applications, necessitating further research and development in these areas. Overall, this study contributes to expanding current understanding of the antioxidant capacities of plant concretes and emphasizes the significance of utilizing these natural resources in the development of innovative healthcare and cosmetic products.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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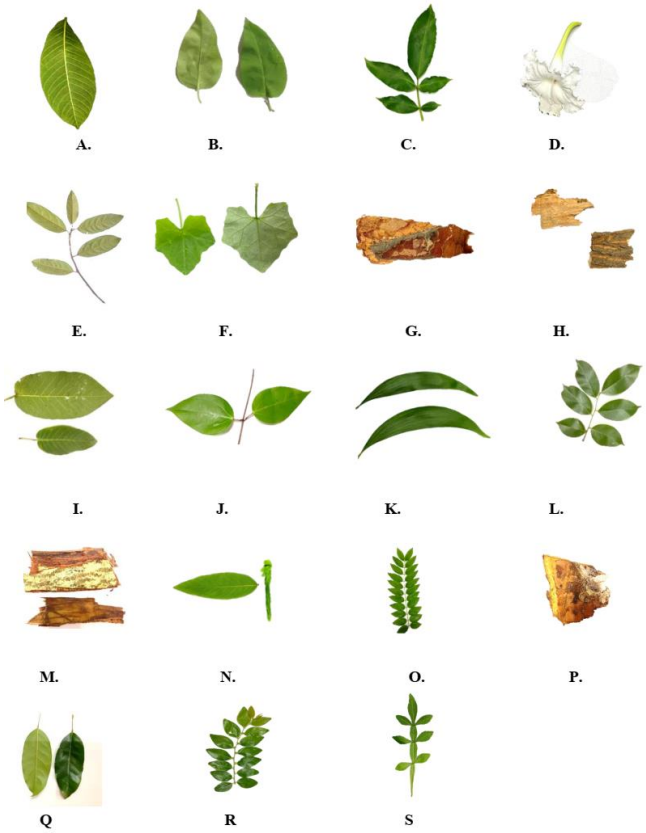

Figure 1: Plant parts used for extraction **A:** *Holarrhena pubescens* Wall. ex G.Don ; **B:** *Urceola polymorpha* (Pierre ex Spire) D.J. Middleton & Livsh. **C:** *Amorphophallus brevispathus* Gagnep. **D:** *Dolichandrone serrulata* (Wall. ex DC.) Seem.; **E:** *Ellipanthus tomentosus* subsp. *tomentosus;* **F:** *Coccinia grandis* (L.) Voigt; **G:** *Dipterocarpus obtusifolius* Teijsm. ex Miq.; **H:** *Shorea obtusa* Wall. ex Blume; **I:** *Pentacme siamensis* (Miq.) Kurz.; **J:** *Dioscorea* sp.; **K:** *Acacia auriculiformis* A. Cunn. ex Benth.; **L:** *Dialium cochinchinense* Pierre; **M:** *Peltophorum dasyrachis* var. *dasyrhachis;* **N:** *Phyllodium pulchellum* (L.) Desv.; **O:** *Senna siamea* (Lam.) H.S. Irwin & Barneby; **P:** *Sindora siamensis* var. *maritima*; **Q:** *Xylia xylocarpa* var. *kerrii* (Craib ex Hutch.) I. C.Nielsen; **R:** *Breynia glauca* Craib; **S:** *Naringi crenulata* (Roxb.) Nicolson.

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Table 1 Concrete yield of 19 plant varieties and *in vitro* antioxidant ability of plant concretes against hydroxyl radical scavenging assay (•OH), 2,2-diphenyllpicrylhdydrazyl (DPPH), 2,2'-azino-bis (3-ethylbenzthiazoline-6-sulfonic acid) (ABTS), and ferric reducing antioxidant power (FRAP) assay

Family	Species	Voucher specimen	Parts of plant	Concrete (g)	% Yield	Antioxidant activity			
						% inhibition (Mean ± S.D., n=3)			
						OH° Radical	DPPH Radical	ABTS Radical	FRAP ($mgFe^{2+}/gDW$)
Apocynaceae	*H. pubescens*	DS 22-01	Leaf	0.63	0.25	$29.97^{e} \pm 11.47$	$55.48^{d} \pm 7.21$	$62.99^{d} \pm 7.26$	$0.6^{g} \pm 0.41$
	U. polymorpha	DS 22-02	Leaf	0.62	0.25	$46.48^{c} \pm 2.31$	$17.35^{h} \pm 0.80$	$69.58^{d} \pm 1.39$	$0.73^{g} \pm 0.50$
Araceae	*A. brevispathus*	DS 22-03	Leaf	0.81	0.32	$37.61^{cd} \pm 3.31$	$62.03^{c} \pm 4.76$	$89.80^{b} \pm 0.61$	$0.79^{g} \pm 0.38$
Bignoniaceae	*D. serrulata*	DS 22-04	Flower	0.44	0.18	$40.37^{c} \pm 2.76$	$40.22^{e} \pm 0.80$	$82.52^{b} \pm 1.75$	$3.72^{d} \pm 0.17$
Connaraceae	*E. tomentosus* subsp. *tomentosus*	DS 22-05	Leaf	0.69	0.28	$33.64^{d} \pm 3.70$	$13.81^{h} \pm 0.35$	$72.38^{c} \pm 5.92$	$4.94^{c} \pm 0.99$
Cucurbitaceae	*C. grandis*	DS 22-06	Leaf	0.56	0.22	$41.59^{c} \pm 3.48$	$54.45^{d} \pm 1.46$	$51.52^{e} \pm 2.67$	$0.82^{f} \pm 0.77$
Dipterocarpaceae	*D. obtusifolius*	DS 22-07	Bark	0.45	0.18	$39.14^{d} \pm 5.37$	$80.33^{a} \pm 2.09$	$60.49^{d} \pm 4.20$	$1.36^{f} \pm 0.22$
	S. obtusa	DS 22-08	Bark	0.50	0.20	$26.91^{e} \pm 1.40$	$84.13^{a} \pm 0.34$	$70.57^{c} \pm 0.56$	$2.71^{e} \pm 0.22$
	P. siamensis	DS 22-09	leaf	0.89	0.36	$53.82^{b} \pm 3.22$	$57.76^{d} \pm 0.46$	$71.38^{c} \pm 9.03$	$1.28^{f} \pm 1.01$
Dioscoreaceae	*Di.* sp.	DS 22-10	leaf	0.84	0.34	$30.89^{d} \pm 1.40$	$51.75^{d} \pm 9.71$	$70.74^{c} \pm 2.37$	$1.20^{f} \pm 0.47$
Fabaceae	*A. auriculiformis*	DS 22-11	Leaf	0.98	0.39	$28.75^{e} \pm 2.95$	$17.84^{h} \pm 1.174$	$77.74^{c} \pm 1.17$	$1.28^{f} \pm 0.52$
	D. cochinchinense	DS 22-12	Leaf	0.78	0.31	$33.94^{d} \pm 1.84$	$31.58^{f} \pm 6.16$	$67.89^{d} \pm 5.86$	$3.48^{d} \pm 0.20$
	P. dasyrachis var. *dasyrhachis*	DS 22-13	Bark	0.74	0.30	$50.22^{b} \pm 2.82$	$76.98^{b} \pm 1.85$	$80.42^{b} \pm 2.99$	$1.06^{f} \pm 0.42$
	P. pulchellum	DS 22-14	Leaf	0.69	0.28	$38.96^{d} \pm 5.24$	$72.99^{b} \pm 2.18$	$71.27^{c} \pm 3.34$	$1.86^{f} \pm 0.62$
	S. siamea	DS 22-15	Leaf	0.72	0.29	$40.06^{c} \pm 2.81$	$15.75^{h} \pm 0.41$	$64.51^{d} \pm 0.60$	$1.39^{f} \pm 0.15$
	S. siamensis var. *maritima*	DS 22-16	Bark	0.59	0.24	$65.75^{a} \pm 2.31$	$47.95^{e} \pm 1.88$	$67.83^{d} \pm 3.55$	$3.03^{d} \pm 0.52$
	X. xylocarpa var. *kerrii*	DS 22-17	Leaf	0.78	0.31	$55.35^{b} \pm 3.70$	$24.74^{g} \pm 1.56$	$77.22^{c} \pm 1.41$	$5.47^{b} \pm 0.86$
Phyllanthaceae	*B. glauca*	DS 22-18	Leaf	0.88	0.35	$51.38^{b} \pm 1.84$	$69.56^{c} \pm 4.00$	$92.81^{a} \pm 0.13$	$3.23^{c} \pm 0.11$
Rutaceae	*N. crenulata*	DS 22-19	Leaf	0.94	0.38	$22.94^{f} \pm 1.84$	$37.79^{f} \pm 0.75$	$82.46^{b} \pm 3.85$	$16.07^{a} \pm 1.55$

a,b,c,… Mean values in each column with different superscripts are significantly different ($P < 0.05$). DW: Dry weigh

Table 2: Major volatile organic compound profiles of 19 plant concretes analyzed by headspace GC-MS

Species	Major volatile compound (relative peak area%)	Formula	Molecular weight (MW)	Reported properties	References
H. pubescens	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl- (3.53)	$C_{15}H_{24}$	204.35	Antioxidant	29
	2-Phenylacetamide, N-(1-phenyl-2-propyl)- (3.28)	$C_{17}H_{19}NO$	253.34	Transforming through a chemical reaction	31
U. polymorpha	Acetic acid (62.38)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32
	2-Methylbutanal (6.98)	$C_5H_{10}O$	86.13	Pesticide, flavor	33
	Topotecan (6.39)	$C_{23}H_{23}N_3O_5$	421.45	Chemotherapeutic agent	34
A. brevispathus	Acetic acid (45.52)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32
	1-Hydroxy-2-propanone (7.58)	$C_3H_6O_2$	74.07	Antibacterial activity.	35
	3-Methylbutanal (4.03)	$C_5H_{10}O$	86.13	Nutty flavor	36
D. serrulata	1'-Hydroxy-4,3'-dimethyl-bicyclohexyl-3,3'-dien (10.19)	$C_{14}H_{20}O_2$	220.31	Volatile compound found in *Dolichandrone Falcata* Seem. flower	37
	Ethanol (5.46)	C_2H_6O	46.06	Aroma of wine	38
E. tomentosus sub. *tomentosus*	Acetaldehyde (21.22)	C_2H_4O	44.05	Pungent fruity odor, flammable, colorless, solvent	39
	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6 (12.39)	$C_6H_8O_4$	144.12	Antioxidant	30
C. grandis	1,2,3-Butanetriol (92.37)	$C_4H_{10}O_3$	106.12	Fragrance	40,41
	3-Hexen-1-ol (3.87)	$C_6H_{12}O$	100.16	Green aroma	41
	n-Hexadecanoic acid (3.76)	$C_{16}H_{32}O_{32}$	256.42	Anticancer, pesticide, antibiotic	42, 43
D. obtusifolius	Acetic acid (66.68)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32
	Octodrine (17.04)	$C_8H_{19}N$	129.24	Nasal congestion medicine, dietary supplements for weight loss	28
S. obtusa	Acetic acid (70.86)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32
	Acetone (7.22)	C_3H_6O	58.08	Breakdown of body fat, makeup remover	44
P. siamensis	Acetaldehyde (30.76)	C_2H_4O	44.05	Pungent fruity odor, flammable and colorless, solvent	39
	2,3-Pentanedione (30.64)	$C_5H_8O_2$	100.12	Butter flavorings (caramel, butterscotch, strawberry)	45
	2,3-Butanedione (8.63)	$C_4H_6O_2$	86.09	Enhances flavor in fermented goods	46
Di. sp.	2-Methylbutanal (27.11)	$C_5H_{10}O$	86.13	Pesticides, solvent in paints and oils, flavor	33
	2-Methylpropanal (25.42)	C_4H_8O	72.11	Flavor and fragrance	47
	Acetaldehyde (15.23)	C_2H_4O	44.05	Pungent fruity odor, flammable, colorless, solvent	39
A. auriculiformis	Octodrine (82.56)	$C_8H_{19}N$	129.24	Nasal congestion medicine, dietary supplements for weight loss	28
	Acetic acid (8.9)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32

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D. cochinchinense	3-Hexen-1-ol, acetate, (E)-(29.61)	$C_8H_{14}O_2$	29.61	Flavor esters	48
	Butanoic acid, 3-hexenyl ester, (Z)- (10.82)	$C_{10}H_{18}O_2$	10.82	volatile compound produced during drying process	49
P. dasyrachis var. *dasyrhachis*	Acetic acid (59.32)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32
	Acetone (4.09)	C_3H_6O	58.07	Breakdown of body fat, makeup remover	44
P. pulchellum	2-Methylpropanal (49.61)	C_4H_8O	72.10	Low odor thresholds	47
	2-Methylbutanal (25.42)	$C_5H_{10}O$	86.13	Pesticides, chemical solvents, paints and oils, flavor.	33
	Acetaldehyde (6.86)	C_2H_4O	44.05	Pungent fruity odor, flammable, colorless, solvents	39
S. siamea	Acetic acid (17.87)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32
	4-Hydroxy-3-methylacetophenone (12.37)	$C_9H_{10}O_2$	150.17	Antitubercular activities	50
S. siamensis var. *maritima*	Acetaldehyde (51.21)	C_2H_4O	44.05	Pungent fruity odor, flammable, colorless, solvents	39
	2-Methylbutanal (22.53)	$C_5H_{10}O$	86.13	pesticides, solvents in paints and oils, flavor	33
	2-Methylpropanal (13.74)	C_4H_8O	72.10	Low odor thresholds	47
X. xylocarpa var. *kerri*	Acetic acid (55.81)	$C_2H_4O_2$	60.05	Applications in the chemical and food industries	32
	2-Methylpropanal (14.18)	C_4H_8O	72.10	Low odor thresholds	47
	2-Methylbutanal (13.34)	$C_5H_{10}O$	86.13	Pesticides, solvents in paints and oils, flavor	33
B. glauca	1-Methylpyrrole (16.46)	C_5H_7N	81.12	Anti-inflammatory	51
	Acetone (12.59)	C_3H_6O	58.08	Breakdown of body fat, makeup remover	44
	2,4-Nonadienal,(E,E)- (12.09)	$C_9H_{14}O$	138.20	Flavor, fragrance	52
N. crenulata	Acetone (24.28)	C_3H_6O	58.08	Breakdown of body fat, makeup remover	44
	Acetaldehyde (22.8)	CH_3CHO	44.05	Pungent fruity odor, flammable, colorless, solvent	39
	Caryophyllene (20.34)	$C_{15}H_{24}$	204.35	Neurological and metabolic pain therapy	53

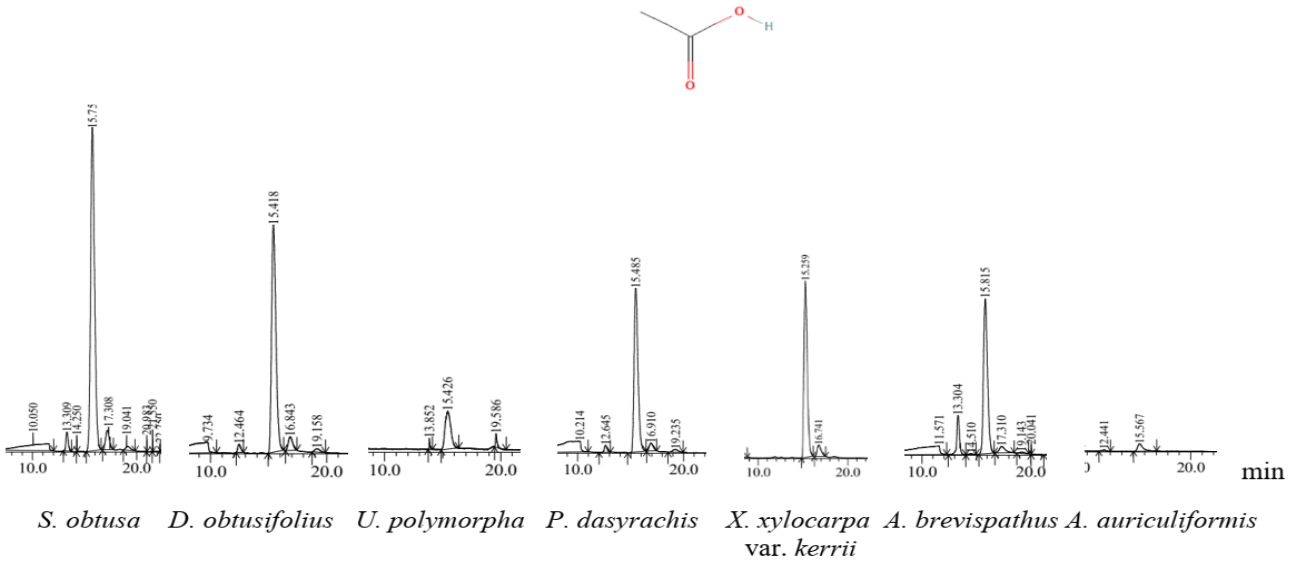

Figure 2: Acetic acid chromatograms showing concretes of *S. obtusa*, *D. obtusifolius*, *U. polymorpha*, *P. dasyrachis*, *X. xylocarpa* var. *kerrii*, *A. brevispathus* and *A. auriculiformis* using headspace GC-MS technique at retention time ~15 min. Chemical structures from PubChem[54].

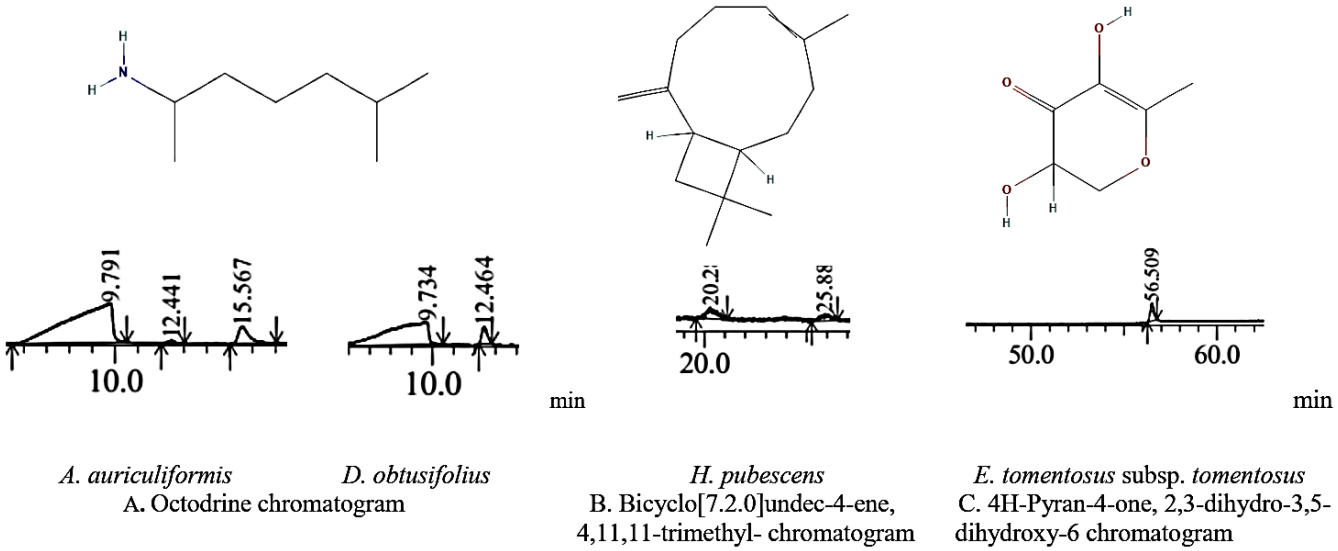

Figure 3: Chromatogram of some VOCs in plant concretes using headspace GC-MS technique. Chemical structure from PubChem[54]. **A.** Octodrine Chromatogram at retention time (RT) ~ 9.7 min from *A. auriculiformis* with peak area 82.56% and *D. obtusifolius* with peak area 17.04%. **B**. Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl- chromatogram at RT ~ 20 min from *H. pubescens* with peak area 3.53% **C.** 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6 chromatogram at RT ~ 56 min from *E. tomentosus* subsp. *tomentosus* with peak area 12.39%

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