

The Diurnal and Nocturnal Floral Scent of *Dracaena fragrans* (L.) Ker Gawl. in Thailand

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ABSTRACT

Dracaena fragrans (L.) Ker Gawl., with its green leaves and attractive shape, is a popular ornamental plant in Thailand, used for both interior decorating and outdoor landscaping. Its fragrant flowers only bloom at night. This study investigated the volatile chemicals from the flowers of *D. fragrans* during the day and night. Volatile compounds were extracted by Head Space Solid Phase Micro-extraction (HS-SPME) technique and determined by Gas Chromatography-Mass Spectrometry (GC-MS). Thirty compounds were identified; sesquiterpenes were the most prevalent (α -farnesene, 23.1-50.8%). The composition of the volatile compounds from the flowers differed between day and night.

Keywords: *Dracaena fragrans*, Volatile compounds, GC-MS, HS-SPME

INTRODUCTION

Dracaena fragrans (L.) Ker Gawl. (Asparagaceae) is a shrub with a vertical stem that can grow to than 15 m in height. Its leaves are green and lorate-oblongate. Inflorescences are erect and located at the terminal branch. Its flowers are white with a red to purple line through the center; they bloom in the nighttime (Bos, 1984; Hyde et al., 2018).

D. fragrans is one of the world economic plants (Wiersema and Leon, 2013). It is used as an ornamental plant in wedding ceremonies and in folk medicine to ward off witchcraft (Kakudidi, 2004). It has many ethnomedicinal usages, including boiling the roots in water and using to fight illness (Moshi et al., 2012), collecting rainwater from its leaves to treat ear pain, using the

decoction of its bark to treat malnutrition (Lacroix et al., 2011), and squeezing or chewing its leaves and roots to induce labor (Kamatenesi-Mugisha and Oryem-Origa, 2007). It has also been reported to have antimalarial activity (Lacroix et al., 2011) and to be an acetylcholinesterase inhibitor (Calderon et al., 2010). In addition, *D. fragrans* can reduce on pollutants such as bisphenol a, formaldehyde, toluene and xylene (Wolverton 1997; Saiyood et al., 2010).

In Thailand, *D. fragrans* (known as *wassana* in Thai, or lucky plant) is popular as an ornamental plant, both indoors and outdoors, easily growing in both. The flowers bloom infrequently, so Thais believe it brings the owner good luck when it does. The fragrant flowers usually bloom at night. The previous work has been already reported only 2 time of sampling (buds and flowers were collected at 2 pm and 6 pm, Modak Dhar et al., 2013). No study has reported on variations in the volatile compounds of this plant from day to night. The demand for active ingredients for cosmetic and perfumery use is rapidly grown. The natural substances are preferred and can enhance the economic valued. But, in nature, plant volatile compounds are produced at a low level and depended on many factors such as light, temperature, environmental and other factors. The volatile compounds are rhythmically emitted with diurnal and nocturnal maximum. So, if the *D. fragrans* can produce volatile compounds not only in the night time but also in the day time, it will be a benefit for collecting and preparing the new usage source of volatile compounds for the cosmetic and fragrance industries.

This study characterized the diurnal and nocturnal volatile compounds from the flower of *D. fragrans* using Gas Chromatography-Mass Spectrometry (GC-MS) coupled with Head Space Solid Phase Micro-extraction (HS-SPME). The scent of this flower may be used for cosmetics and medicinal applications.

MATERIALS AND METHODS

Materials

Flowers of *D. fragrans* were collected from the Medicinal Plant Garden, Faculty of Pharmacy, Chiang Mai University, Chiang Mai, Thailand. Fresh flowers were gently picked from the plants every two hours over a 24-hour period (at 02:00, 04:00,..., 24:00). The samples were placed in 20-ml, screw-capped, glass vials (National Scientific, Rockwood, TN) and analyzed immediately. *n*-Alkane solution (C₈-C₂₀) was purchased from Sigma-Aldrich Co.

HS-SPME

Volatile compounds of the flower samples were extracted using the method described by Julsrigival et al. (2013). Briefly, an AOC 5000 Combi PAL SPME holder (CTC Analytic AG., Switzerland) was equipped with a 65-μm polydimethylsiloxane/divinylbenzene (PDMS/DVB) fiber assembly (Supelco, Bellfonte, PA). The fiber was pre-conditioned according to the manufacturer's

specification (250 °C for 30 min). The vials were pre-equilibrated and heated at 80 °C for 30 min with agitation at 500 rpm. Then the fiber was introduced into the GC-MS with 2 min desorption time.

GC-MS

The volatile compounds of the flower samples were analyzed by GC-MS using a Shimadzu GCMS-QP 2010Plus system (Shimadzu, Kyoto, Japan). Volatile compounds were separated by DB-5 MS capillary column (30 m × 0.25 mm, 0.25 µm film thickness; Agilent Technologies, Palo Alto, CA). The oven temperature was programmed as follows: initial temperature 60 °C, increased to 200 °C at a rate of 5 °C min⁻¹, then held for 10 min; the injector and ion source temperatures were set at 180 °C and 200 °C, respectively. The carrier gas (helium) was controlled at a flow rate of 1.0 mL min⁻¹. The electron impact mode was operated with an ionization voltage of 70 eV. The mass range was 40-400 amu. Volatile compounds were identified by comparing the obtained mass spectra of relevant chromatographic peaks with spectra of the WILEY 7 library and Kovats retention indices with other published mass spectra (Adam, 2007; NIST Chemistry WebBook). The retention indices were calculated for all volatile constituents using a homologous series of *n*-alkane under the same conditions of analysis.

RESULTS

Thirty volatile compounds of *D. fragrans* flowers were identified (Table 1). The main components were α -farnesene (23.1-50.8%), 3-hydroxy-4-phenyl-2-butanone (2.2-18.2%), and benzyl alcohol (3.3-15.6%). The components were classified into eight categories: aldehydes, alcohols, esters, ketones, monoterpenes, sesquiterpenes, phenylpropenes, and other compounds. The main volatile compounds were from the sesquiterpene (26.2-59.0%), alcohol (12.7-29.4%), and phenylpropene group (7.5-24.4%), respectively (Figure 1).

Table 1. Volatile composition of *D. fragrans*.

Compound	RT	KI	Chemical group	Relative content (%)											
				Time of day											
				02.00	04.00	06.00	08.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
Benzaldehyde	5.428	973	aldehyde	0.49	0.44	0.51	0.33	0.29	0.14	0.31	0.16	-	0.13	0.38	0.33
Octen-3-ol	5.667	985	alcohol	0.68	0.36	1.74	1.78	1.61	0.60	0.25	0.28	0.27	0.18	-	0.36
2-Pentyl furan	5.850	993	furan	0.46	0.30	0.77	0.92	0.85	-	-	-	-	-	0.25	0.30
Benzyl alcohol	7.010	1046	alcohol	7.08	11.27	5.21	3.34	7.11	15.55	12.80	9.83	15.14	15.38	11.83	10.93
β -Ocimene	7.117	1051	monoterpene	1.60	-	0.68	0.62	2.28	-	-	-	-	-	1.90	1.75
Benzene acetaldehyde	7.215	1055	aldehyde	0.62	-	0.97	0.89	1.20	-	-	-	-	-	2.29	2.03
Linalool oxide	8.223	1094	monoterpene	1.91	2.42	4.48	4.81	3.67	-	-	-	-	0.12	0.53	1.02
Linalool	8.508	1105	monoterpene	2.45	2.94	2.20	2.14	3.31	-	-	-	0.12	0.36	1.21	1.51
Phenylethyl alcohol	8.963	1124	alcohol	8.36	10.66	4.38	4.72	3.72	3.04	3.68	4.18	8.78	11.91	10.60	10.94
2,6-Nonadienal, (<i>E,Z</i>)-	9.923	1162	aldehyde	1.32	1.38	1.54	1.57	0.97	-	-	-	-	0.19	0.72	1.11
3,6-Nonadien-1-ol, (<i>E,Z</i>)-	10.011	1165	alcohol	0.77	0.87	0.35	0.35	-	-	-	-	-	0.16	0.48	0.65
2-Nonenal, (<i>E</i>)-	10.087	1168	aldehyde	0.93	0.84	1.57	1.65	0.98	-	-	-	-	-	0.44	0.71
Benzyl acetate	10.197	1172	ester	-	-	2.22	-	1.61	0.71	1.57	0.84	-	-	0.95	-
2,6-Nonadien-1-ol, (<i>E,Z</i>)-	10.226	1173	alcohol	1.11	1.63	-	1.27	-	-	-	-	-	-	-	1.10
2-Nonenol, (<i>E</i>)-	10.291	1175	alcohol	0.46	0.67	0.59	0.51	-	-	-	-	-	-	0.25	0.42
Phenethyl acetate	12.632	1264	ester	0.79	1.28	0.40	0.37	0.95	0.25	0.89	0.68	-	-	0.83	0.76
Indole	13.768	1304	indole	-	-	0.77	-	3.79	6.26	7.23	4.51	5.67	3.63	0.34	-
Cinnamyl alcohol	14.111	1318	alcohol	1.19	0.57	0.68	0.73	2.87	5.22	4.06	3.74	2.96	1.73	1.46	0.76
2,4-Decadienal, (<i>E,E</i>)-	14.315	1327	aldehyde	0.50	0.34	0.26	0.64	0.94	-	-	-	-	-	0.25	-
3-Hydroxy-4-phenyl-2-butanone	15.124	1358	ketone	17.22	10.47	2.17	2.54	15.35	15.67	12.10	11.75	16.93	18.19	17.24	13.01
Eugenol	15.222	1362	phenylpropene	0.58	0.36	2.71	2.30	7.08	12.40	15.23	10.43	10.58	4.28	-	0.40
Methyl eugenol	16.436	1408	phenylpropene	8.55	6.76	6.30	5.99	3.42	4.03	8.92	5.89	3.49	10.06	8.34	7.90
Cinnamyl acetate	17.617	1457	ester	-	-	-	-	2.63	2.39	4.40	1.59	-	-	-	-
β -Farnesene	17.634	1457	sesquiterpene	0.58	0.53	0.80	0.65	-	-	-	0.91	0.38	0.32	0.51	0.53
1-Dodecanol	18.240	1481	alcohol	-	-	-	-	-	0.20	0.18	0.40	-	-	-	-
α -Bergamotene, (<i>E</i>)-	18.575	1494	sesquiterpene	4.25	7.02	6.67	7.55	3.44	4.07	3.03	4.23	4.32	4.10	5.24	5.21
α -Farnesene	18.954	1510	sesquiterpene	33.08	34.30	48.48	50.76	29.79	26.41	23.13	32.63	27.64	24.90	28.21	33.36
Elemicin	20.026	1556	phenylpropene	0.35	0.41	0.37	0.43	-	0.10	0.25	0.27	-	0.21	0.41	0.40
Tetradecanal	21.499	1619	aldehyde	4.36	4.19	2.50	2.37	1.68	1.77	1.39	6.49	2.99	3.46	4.95	4.14
Benzyl benzoate	25.035	1780	ester	-	-	-	-	-	1.09	0.58	1.19	0.64	0.57	0.41	0.36

Note: RT, retention time (min); KI, Kovat retention indices calculated against *n*-alkane standards (C₈-C₂₀).

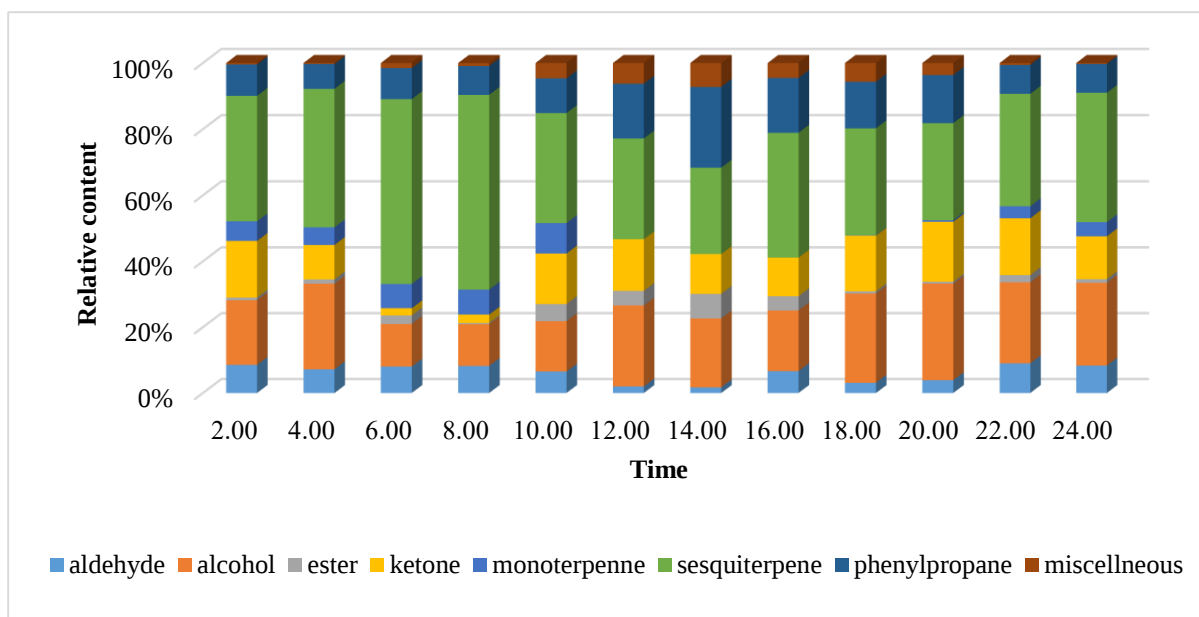


Figure 1. Chemical groups of *D. fragrans*.

DISCUSSION

The chemical composition of the volatile compounds of the flowers of *D. fragrans* varied with time of day. Usually, the flowers of *D. fragrans* bloom during the night – from evening until early morning, with its fragrance released then. The following chemicals were found in the samples collected from all time periods, i.e., both diurnally and nocturnally: benzyl alcohol, phenylethyl alcohol, cinnamyl alcohol, 3-Hydroxy-4-phenyl-2-butanone, methyl eugenol, α -bergamotene, (*E*)-, α -farnesene, and tetradecanal, with α -farnesene the predominant compound in all sampled time periods (23.1-50.8%). The following components were present mostly only during the blooming time (varied by compound, but ranging from 18:00 to 10:00): 2-pentyl furan; β -ocimene; benzene acetaldehyde; linalool oxide; linalool; 2,6-Nonadienal, (*E,Z*)-; 3,6-Nonadien-1-ol, (*E,Z*)-; 2-Nonenal, (*E*)-; 2,6-Nonadien-1-ol, (*E,Z*)-; 2-Nonenol, (*E*)-; and 2,4-decadienal, (*E,E*)-. Of these, the following compounds were not only present during the nighttime, but also increased over the course of the night, such as 2-pentyl furan; linalool oxide; linalool; 2,6-Nonadienal, (*E,Z*)-; 2-Nonenal, (*E*); and 2-Nonenol, (*E*)- (Figure 2). Linalool oxide and linalool were maximum produced at 8.00 and 10.00 (4.8% and 3.1%). Volatile compounds were rhythmically produced. Cinnamyl acetate and 1-dodecanol were detected only in the midday samples (10:00-16:00 and 12:00-16:00, respectively).

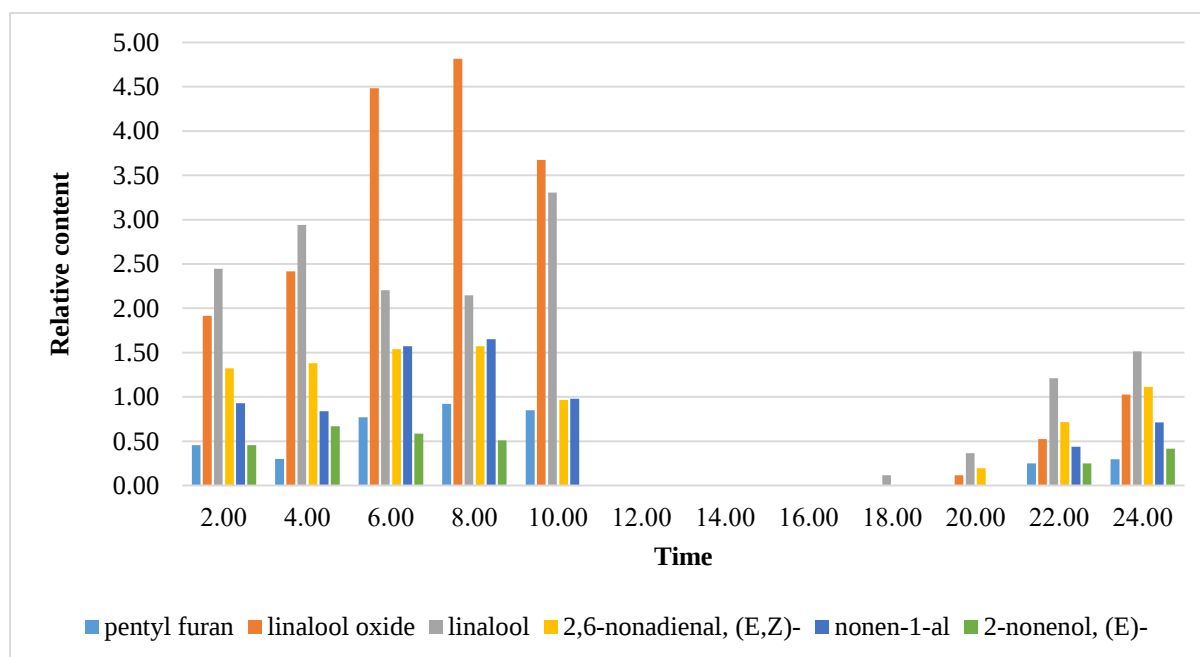


Figure 2. Selected chemical compounds of bloomed *D. fragrans*.

In contrast with the α -farnesene of our study, Modak Dhar et al. (2013) reported that the major compounds of the essential oils analyzed from *Dracaena* flowers were butanoate and linalool produced at 18:00. The flowers were collected in Kolkata, India and the essential oils were extracted by immersing in the petroleum ether for 2 hour; differences in geography and extraction methods might account for this. Others have also reported α -farnesene as the main compound in some flowers, such as *Actinidia deliciosa* (Nieuwenhuizen et al., 2009), *Lonicera japonica* (Schlotzhauer et al., 1996) and *Murraya exotica* (Raina et al., 2006).

Linalool, one of the compounds we found, has been reported to have many biological activities, including anti-inflammation, inducing relaxation, sedation and treating anxiety (Peana et al., 2002; Linck et al., 2009; Linck et al., 2010; Guzmán-Gutiérrez et al., 2015). Linalool is an important ingredient found in cosmetic products including body lotion, face cream, eau de toilette, fragrance cream and other toiletries (Letizia et al., 2003). α -Farnesene was found in many fruit peels and flowers (Jaoui et al., 2017). The activities of α -farnesene have been reported, including, plant defense (Zeng et al., 2017) and antioxidant activity (Celik et al., 2014).

The scents are used for communicating between plants and the other pollinators (Knudsen et al., 2006). Some night emitting compounds are attractive for pollinators such as moths (Morinaga et al., 2009; Dotterl et al., 2012), beetles (Maia et al., 2018).

This study found that time of day affected the composition of the volatile compounds found in the flowers of *D. fragrans*. α -Farnesene was the most

abundant compound emitted in all day time. However, some fragrances were produced in the early morning including linalool oxide and linalool.

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