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Essential oil composition of 'kewda' (*Pandanus odoratissimus*) from India

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ABSTRACT: The chemical composition of the essential oil obtained by hydrodistillation of staminate inflorescences of kewda (*Pandanus odoratissimus* L.) has been compared with the kewda oil from the local market. Both the oils were subjected to high-resolution GC and GC–MS, which resulted in the identification and quantification of 85 and 59 components, amounting to 98.7% and 98.6% of the total oils, respectively. The major components of the hydrodistilled kewda oil were 2-phenyl ethyl methyl ether (37.7%), terpinen-4-ol (18.6%), α-terpineol (8.3%) and 2-phenyl ethyl alcohol (7.5%), whereas the major constituents of kewda oil from the local market were 2-phenyl ethyl alcohol (33.2%), 2-phenyl ethyl methyl ether (16.1%), benzyl benzoate (11.0%), viridine (8.8%) and germacrene B (8.3%). Copyright © 2004 John Wiley & Sons, Ltd.

KEY WORDS: *Pandanus odoratissimus* L.; Pandanaceae; kewda; essential oil composition; 2-phenyl ethyl methyl ether; terpinen-4-ol; α-terpineol; 2-phenyl ethyl alcohol

Introduction

Pandanus odoratissimus L. syn. *P. fascicularis* Lam. (family Pandanaceae) is commonly known as 'kewda' or 'keora' in Hindi, Marathi and Gujrati; 'kiya' in Oriya and Bengali and 'mogali' in Telegu.[1] The male inflorescence of kewda is valued for the fragrant smell emitted by the tender white spathes covering the flowers. Kewda plants are found growing along seashores, banks of rivers, ponds, canals, etc. in the Ganjam district of Orissa state, India.[1–2] Kewda attar is one of the most popular perfumes, extracted and used in India since ancient times. It blends well with almost all types of fancy perfumes and is used for scenting clothes, bouquets, lotions, cosmetics, soaps, hair oils, tobacco and agarbatti. Kewda attar and water are used for flavouring various foods, sweets, syrups and soft drinks. They are popular in north India, especially on festive occasions.[3] Spadices of staminate inflorescence, which emit fragrance, are water-distilled in village type copper retorts to obtain an oil, and otto or attar by absorbing the vapours in base oil, such as sandalwood oil or liquid paraffin or dioctyl phthalate.[4]

The oil from Kewda flowers has relatively high solubility in water (0.2%), hence great care has to be taken to control the rate of distillation in order to isolate it. It is estimated that about 35 million flowers (~3500 tons) are processed annually to produce fragrance and flavour materials worth 400 million rupees.[2] The leaves are said to be valuable in leprosy, smallpox, scabies and diseases of the heart and brain. The anthers of the male flowers are given in earache, headache and diseases of the blood. The juice obtained from the inflorescences is used for rheumatic arthritis in animals. The oil and otto are considered to be stimulants and antispasmodics and are administered for headache and rheumatism. A medicinal oil is also prepared from the roots of *P. odoratissimus*.[1]

Kewda oil has been the subject of study by several investigators.[5–11] The present paper compares the essential oil composition of *P. odoratissimus* flower oil with an oil sample from the local (Lucknow) market.

Experimental

Plant Materials

Kewda flowers for this study were collected by one of the co-authors (APK) from Behrampur village in the District of Ganjam, Orissa, where Kewda plants occur widely in nature.

Isolation of Essential Oil

Flowers (70 kg) collected in the morning on hydrodistillation gave 85 l distillate, which on redistillation in a second unit resulted in 17 ml kewda oil (yield 0.024%).

Gas Chromatography (GC)

GC analysis of the oil was performed on a Perkin-Elmer GC 8500, using a fused silica capillary column (30 m × 0.32 mm i.d., film thickness 0.25 μm), coated with

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polydimethyl siloxane (BP-1). A sample of 0.02 ml oil was injected and the oven temperature was programmed from 60 °C to 220 °C at 5 °C/min, then held isothermal at 220 °C for 13 min; injector temperature, 250 °C; detector temperature, 300 °C; carrier gas, nitrogen at 10 psi; split, 1:80.

Gas Chromatography–Mass Spectrometry (GC–MS)

GC–MS data were obtained on the Perkin-Elmer GC, Auto system XL and Turbo Mass with EI source, using a PE-5 column (30 m × 0.32 mm i.d., film thickness 0.25 μm); a sample of 0.2 ml was injected; carrier gas, helium. Temperature programming: 2 min at 100 °C, rising at 5 °C/min to 220 °C, with a hold time of 20 min at 220 °C; split, 1:50.

Identification of Compounds

The compounds were identified by comparing their retention indices of peaks on the BP-1 column with literature values,[4–11] computer matching against the library spectra build up using pure substances and components of known essential oils, and finally confirmed by comparision of mass spectra of peaks with published data.[12–16] Relative amount of individual components are based on peak areas obtained without FID response factor correction. The retention indices were obtained from gas chromatograms by linear interpolation between bracketing *n*-alkanes. The homologous series of *n*-alkanes (C_8–C_{22}, Poly Science Inc., Niles, USA) were used as standard.

Results and Discussion

The volatile oil of fresh *P. odoratissimus* flowers, marked as PO-N, and a kewda oil sample from the local market (Lucknow), marked as PO-M, on GC and GC–MS analysis resulted in the identification of 85 and 59 constituents, representing 98.7% and 98.6% of the total oils, respectively. The relative concentrations of the volatile components identified are presented in Table 1 according to their elution order on a BP-1 column. On comparing our results of the natural oil with market oil, it was observed that, of 85 and 59 constituents identified in the natural and market oils, respectively, 50 were common to both the oils. However, apart from these similarities, remarkable differences were recorded in the chemical and percentage composition of the market oil. The peculiar sweet fragrant smell of kewda flowers is considered mainly due to the presence of a major constituent, 2-phenyl ethyl methyl ether,[1] but even this constituent was present in less than half in amount in the market

Table 1. Essential oil composition of kewda (*Pandanus odoratissimus*) from India

KI	Compound	Relative % in	
		PO-N	PO-M
838	(*Z*)-3-Hexenol	0.1	—
853	(*E*)-3-Hexenol	tr	—
930	α-Thujene	0.5	0.1
938	α-Pinene	—	tr
963	Sabinene	0.4	—
970	β-Pinene	0.3	—
981	Myrcene	0.5	0.1
994	α-Phellandrene	tr	—
1001	δ-3-Carene	0.3	—
1006	α-Terpinene	0.2	tr
1009	*p*-Cymene	0.4	—
1018	Phenyl acetaldehyde	0.6	0.3
1026	1,8-Cineole	0.1	—
1037	Benzyl alcohol	0.2	—
1049	γ-Terpinene	0.5	—
1062	2-Phenyl ethyl methyl ether	37.7	16.1
1064	*trans*-Sabinene hydrate	0.6	—
1072	*trans*-Linalool oxide (f)	0.2	—
1077	Linalool	0.1	—
1084	2-Phenyl ethyl alcohol	7.5	33.2
1103	α-Fenchyl alcohol	0.5	—
1121	Camphor	0.5	—
1127	*cis*-*p*-Menth-2-en-1-ol	tr	0.3
1144	(*E*)-β-Terpineol	0.1	tr
1149	Benzyl acetate	0.4	tr
1156	2-Phenyl ethyl formate	0.1	0.5
1164	Terpinen-4-ol	18.6	—
1173	α-Terpineol	8.3	—
1179	*cis*-Sabinol	0.1	—
1188	Verbenone	0.4	—
1194	Viridine [benzene (2,2-di-methoxy ethyl)]	0.2	8.7
1196	*trans*-Carveol	0.1	—
1206	Dodecane	0.1	—
1212	Citronellol + nerol	0.4	2.7
1225	2-Phenyl ethyl acetate	0.4	—
1234	Piperitone	0.4	0.4
1241	Geraniol	1.2	tr
1256	Geranial	0.4	0.1
1262	Citronellyl formate	0.1	—
1272	Neryl formate	0.2	0.1
1290	Geranyl formate	0.1	—
1301	Sabinyl acetate	tr	—
1319	Linalyl propionate	0.9	—
1326	Citronellyl acetate	0.1	—
1334	Neryl acetate	tr	—
1344	Eugenol	0.6	0.1
1350	Capric acid	0.6	—
1357	Geranyl acetate	0.8	tr
1364	Methyl eugenol	0.1	—
1375	2-Phenyl ethyl isobutyrate	0.4	4.6
1380	*iso*-Eugenol	0.1	—
1386	Vanillin	0.4	tr
1395	*n*-Tetradecane	tr	tr
1426	β-Caryophyllene	1.8	0.1
1440	β-Gurjunene	1.8	0.1
1451	Geranyl propionate	0.4	—
1459	*allo*-Aromadendrene	0.1	tr
1472	α-Amorphene	0.1	0.1
1477	γ-Muurolene	2.0	0.5
1482	Eugenyl acetate	0.1	tr
1487	α-Muurolene	0.1	tr
1494	Leden	1.2	0.1
1501	*n*-Pentadecane	0.1	0.5
1506	Citronellyl butyrate	0.2	—
1513	γ-Cadinene	0.3	1.1
1518	*Z*-Nerolidol	—	0.4

Table 1. (*Continued*)

KI	Compound	Relative % in	
		PO-N	PO-M
1537	Geranyl butyrate	—	0.1
1544	Germacrene-B	0.3	8.3
1554	2-Phenyl ethyl tiglate	0.3	0.5
1566	Caryophyllene oxide	0.2	tr
1578	Globulol	0.1	0.2
1596	Viridiflorol	0.1	0.4
1602	*n*-Hexadecane	0.1	tr
1609	Humulene epoxide II	tr	—
1617	T-Cadinol	0.1	0.3
1627	T-Muurolol	0.1	0.3
1642	*epi*-α-Cadinol	0.2	0.1
1658	α-Cadinol	0.3	0.6
1679	(*Z*)-(*E*)-Farnesol	tr	0.1
1698	*n*-Heptadecane	0.1	0.3
1725	Geranyl hexanoate	0.1	tr
1749	Benzyl benzoate	0.1	11.0
1762	Tetradecanoic acid	—	1.8
1772	*n*-Butyl-*n*-dodecanoate	—	0.2
1778	Ethyl-*n*-tetradecanoate	—	0.3
1795	*n*-Octadecane	—	1.2
1806	Neryl-*n*-heptanoate	tr	0.8
1815	Hexadecanal	tr	0.2
1820	2-Phenyl ethyl-*n*-octanoate	—	0.1
1824	Geranyl-*n*-heptanoate	0.4	0.3
1848	2-Phenyl ethyl benzoate	0.5	0.3
1951	Geranyl benzoate	—	0.1
2006	*n*-Eicosane	tr	0.4
2087	Methyl linoleate	0.1	—

tr < 0.05%.

oil sample. On the other hand, 2-phenyl ethyl alcohol, a cheap synthetic constituent, was recorded more than four times in the market sample.

Similarly, tepinen-4-ol and α-terpineol, which add a lot to the peculiar fragrance of kewda flower oil, were present in natural oil (PO-N) to an extent of 18.6% and 8.3%, respectively, while these constituents were totally absent in the market oil (PO-M). Apart from the above differences, the market oil was recorded to contain significant amounts of benzyl benzoate (11.0%), viridine (8.8%) and germacrene B (8.3%). The other differences were in the percentage composition of minor constituents, β-caryophyllene, β-gurjunene, leden and geraniol, which were 12–18 times more in the natural oil, while geranyl acetate, eugenol, myrcene, α-thujene, vanillin, geranial and γ-muurolene were 5–8 times more in the natural oil.

On the other hand 2-phenyl ethyl isobutyrate, citronellol + nerol and neryl *n*-heptanoate were 8–11 times more in the market sample, while γ-cadinene, *n*-pentadecane and 2-phenyl ethyl formate were 4–6 times more in the market sample.

Similarly, appreciable amounts (0.3–0.6%) of terpenoids, *trans*-sabinene hydrate, α-fenchyl alcohol, camphor, γ-terpinene, verbenone, geranyl propionate, *p*-cymene, sabinene, β-pinene and δ-3-carene occurred only in the natural kewda flower oil, while tetradecanoic acid (1.8%) and *n*-octadecane (1.2%) occurred in the market oil only. From the above remarkable differences, it is evident that the market oil is either synthetic or reconstituted.

Analysis of the various Indian reports[6–11] revealed that 2-phenyl ethyl methyl ether was the main constituent (65.6–75.4%),[6–11] followed by terpinen-4-ol (11.7–20.9%)[7–11] in the natural Kewda oil. In contrast to the above, Nigam *et al*.[6] in 1992, reported 2-phenyl ethyl alcohol (16.2%) as the second major constituent. On comparing the results of our natural Kewda oil (PO-N) with those reported above by Indian workers, it is evident that our oil contains a significantly low amount (37.7%) of 2-phenyl ethyl methyl ether, but higher amounts of α-terpineol (8.3%) and 2-phenyl ethyl alcohol (7.5%). The other minor constituents present in appreciable amount in our natural oil (PO-N) were geraniol (1.2%), β-caryophyllene (1.8%), β-gurjunene (1.8%), γ-muurolene (2.0%) and leden (1.2%). This drastic variation in the percentage composition of the various major and minor constituents in PO-N may be considered due to different chemotypes of *P. odoratissimus*.

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