Jurnal Teknologi

Full Paper

GC-MS Analyses of Essential Oils of Three Varieties of *Mangifera indica*

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Article history
Received
23 March 2015
Received in revised form
27 July 2015
Accepted
20 August 2015

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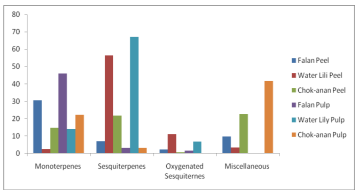
Graphical abstract



Abstract

Mangifera indica or commonly known as mango, is one of the 30 species of *Mangifera* genus from the family of Anacardiaceae. The fruit of *M. indica* is consumed for its antioxidant and health promoting activities in addition to its exotic flavor and texture. The present study was aimed to comparatively analyze the volatile constituents in the peel and pulp of *M. indica* cultivar Falan, Water Lily and Chok-anan. The mango peel and pulp were subjected to hydrodistillation using Clavenger type apparatus and the essential oils obtained were analyzed using GC-MS. There were 32 compounds identified in the essential oils of peel and pulp of three *M. indica* L. cultivars. Falan mango has the highest monoterpenes hydrocarbon composition in the essential oils of peel and pulp with 30.67% and 45.65%, respectively, whereas the essential oils of Water Lily mango are mainly dominated by the presence of sesquiterpenes hydrocarbon in both peel and pulp with 50.75% and 67.11%, respectively. The essential oils of Chok-anan mango are mainly consist of miscellaneous compounds in the peel and pulp with 22.56% and 44.1%, respectively. 4-Carene, β-caryophyllene, α-terpinolene, cyclohexadecane and *n*-hexadecanoic acid were the major volatile constituents in the essential oils of the three mango varieties.

Keywords: *Mangifera indica,* essential oil, Anacardiaceae

Abstrak

Mangifera indica atau lebih dikenali sebagai mangga merupakan salah satu daripada 30 spesis *Mangifera* daripada keluarga Anacardiaceae. Buah *M. Indica* dimakan kerana ia bersifat antioksidan dan menggalakkan kesihatan yang baik di samping rasa dan teksturnya yang eksotik. Kajian ini bertujuan untuk mengananalisis perbandingan kandungan bahan kimia mudah meruap di dalam minyak pati kulit dan isi *M. indica* dari jenis Falan, Water Lily dan Chok-anan. Isi dan kulit tiga jenis manga disuling secara hidro menggunakan alat radas jenis Clavenger dan minyak pati yang diperoleh dianalisa menggunakan GC-MS. Terdapat 32 sebatian dikenalpasti di dalam minyak pati isi dan kulit dari ketiga-tiga variasi mangga tersebut. Mangga Falan mengandungi jumlah hidrokarbon monoterpena terbesar di dalam minyak pati kulit dan isi masing-masing 30.67% dan 45.65%, manakala minyak pati mangga Water lily didominasi oleh sebatian hidrokarbon seskuiterpena di dalam kedua-dua minyak pati kulit dan isi dengan komposisi masing-masing 50.75% dan 67.11%. Minyak pati mangga Chok-anan mengandungi pelbagai sebatian di dalam kulit dan isi dengan masing-masing sebanyak 22.56% dan 44.1%. 4-Karena, β-kariofilena, α-terpinolena, sikloheksadekana dan asid *n*-heksadekanoik merupakan bahan kimia mudah meruap utama di dalam minyak pati tiga jenis mangga tersebut.

Kata kunci: *Mangifera indica,* minyak pati, Anacardiaceae

1.0 INTRODUCTION

Mangifera is one of the 73 genera belongs to the Anacardiaceae family. This genus is distributed in tropical and subtropical regions. The genus *Mangifera* originates in Tropical Asia, where it was usually found in Borneo, Java, Sumatera and Malay Peninsula. The tree which is native to India spread to the tropical region of the world. The name of mango was claimed to be adapted either from Kodagu *mange*, the Malayalam *manga*, or the Tamil *mangai* and it had been loaned into Portuguese in the early 16th century before been passed into English with the use of –o at the end of the name [1]. Mango tree is a large spreading evergreen tree that can grow up to 45 m in height with heavy doom shaped crown [1]. The shape of mango fruit varies from round to ovate to oblong and long with variable lateral compression. Generally, before ripens the fruit has dark green colour skin and turns to lighter green, yellow or orange as it ripens

In recent years, there has been an increasing interest in studies of mango because the phenolic compounds in it have many valuable health benefits. The bioactive compounds are not only been found in the fruits but almost in all parts of the plant such as leaves, barks, seed kernel and peels which were believed to have antioxidants and health promoting properties [4]. The oil extract from the seed kernel of mango was found to be rich in oleic acid and stearic acid with high unsaponifiable content [2]. Mango kernel oil has been used in the cosmetics industry as an ingredient in soaps, shampoos and lotions because it is a good source of phenolic compounds [3].

Essential oil can be extracted from flowers, leaves, stems, roots, seeds, wood and bark. The diverse chemical constituents in the essential oils contribute to the source of aromatic and flavouring chemicals in food, industrial, and pharmaceutical products. Over the last few decades, more than 300 volatile compounds have been discovered from several varieties of mangoes [4]. In these various mango cultivars, there is considerable variation in volatile composition and aroma quality [5]. Only few reports were found in the literature on the comparative analyses on different varieties of local mango. Moreover, the peel of mango has been wasted in the industries without extracting the essential oils in processing mangoes despite the fact that mango's peel contains larger amount of essential oils than the pulp [5]. Thus, this study aims to provide comparative analyses on the chemical constituents of essential oil of peel and pulp from three varieties of mango; *M. indica* cultivar Chok-anan, *M. indica* cultivar Water Lily and *M. indica* cultivar Falan.

2.0 EXPERIMENTAL

2.1 Plant materials

Fresh Falan, Chok-anan and Water Lily mangoes were bought from local market at Shah Alam, Selangor. The peel and pulp were separated before being subjected to hydrodistillation.

2.2 Essential Oil Extraction

The 300 g (peel) and 2 kg (pulp) were placed into round bottom flask (5 L) containing distilled water (2 L) and subjected into hydrodistillation process using Clavenger type apparatus for 5 to 6 hours. The collected oil was extracted using hexane and dried over anhydrous sodium sulphate to remove moisture. The oil-hexane mixture was subjected to rotary evaporator (40-45°C) to remove hexane from oil and its percentage yield (%) was calculated. The essential oils were kept in glass vial and refrigerated at 4°C before further analysis.

2.3 GC-MS Analyses

The essential oils were analyzed using GC-MS model Agilent 19091S-433 series: 70eV with capillary column (30 m × 250 μm × 0.25 nm) at intermediate polarity (HP5MS). The carrier gas is helium; the pressure is 8.71 psi, the flow is 1.0 m^3/min, and the average velocity is 37 cm/s. The temperature of the column was initially set at 60°C (2 min hold) followed by 60-120°C (2 min hold) with temperature programming of 3°C/min and 120–270°C (2 min hold) with temperature programming of 2°C/min. The injection temperature was set at 250°C. This method was adapted from Mohd Jaafar *et al*. [6]

The total ion chromatogram obtained was autointegrated by ChemStation and the constituents were identified by comparison with published mass spectra database.

3.0 RESULTS AND DISCUSSION

The percentage yield of essential oils of peel of *M. indica* cultivar Chok-anan, Falan and Water Lily were 0.0120%, 0.0221% and 0.0142%, respectively. The percentage yield of essential oils of pulp of *M. indica* cultivar Chok-anan, Falan and Water Lily were 0.0015 %, 0.0016% and 0.0013%, respectively. The peel gave higher percentage yield as compared to pulp consistent with report by Tamura *et al*. [5].

There were 32 compounds identified in the essential oils of peel and pulp of three different *M. indica* cultivars. 4-Carene was the major compound in the essential oils of Falan mango peel and Chok-anan mango pulp which were 29.09% and 21.64%, respectively. 4-Carene has sweet and pungent odour. α-Terpinolene was the major monoterpene hydrocarbon in the essential oils of Falan mango pulp and Chok-anan mango peel which were 44.57% and 14.32%, respectively. α-Terpinolene was also reported as major constituent in the essential oil of Brazillian mangoes [7]. α-Terpinolene has sweet, fresh, piney citrus with woody lemon peel nuance aroma.

Table 1 Chemical Composition of Essential Oils of Three *M. indica* Cultivars

Chemical compounds	Retention Times	Precentage					
		Peel			Pulp		
		Falan	Water Lily	Chok-anan	Falan	Water Llily	Chok-anan
Monoterpenes hydrocarbon							
α - Pinene	5.49	1.58	-	-	1.38	-	0.42
(+)-Carene	7.87	-	-	0.34	-	13.22	-
3,7-dimethyl-1,3,7-octatriene	9.17	-	-	-	-	0.94	-
Terpinolene	11.10	-	-	14.32	44.57	-	-
4 - Carene	11.20	29.09	-	-	-	-	21.64
2,6-dimethyl-2,4,6- octatriene	12.43	-	2.60	-	-	-	-
β-Guaiene	27.46	-	-	-	-	-	0.21
Total		**30.67**	**2.60**	**14.66**	**45.95**	**14.16**	**22.27**
Sesquiterpenes hydrocarbon							
α - Cubebene	22.86	-	2.15	-	-	-	-
Caryophyllene	25.24	1.94	18.91	-	-	32.53	0.86
1,5,9,9-tetramethyl-1,4,7-cycloundecatriene	26.74	-	-	-	1.08	15.87	-
β - Caryophyllene	26.96	0.96	8.57	-	-	-	-
(-)-Germacerene	28.21	-	4.64	1.61	-	9.09	-
β-Selinene	28.35		-	-	-	-	2.37
β-Cadinene	29.33	-	5.71	-	-	-	-
Globulol	33.54	-	0.99	-	-	-	-
Cyclohexadecane	49.54	4.20	15.49	20.20	1.99	9.62	-
Total		**7.1**	**56.46**	**21.81**	**3.07**	**67.11**	**3.23**
Oxygenated sesquiterpenes hydrocarbon							
Caryophyllene oxide	33.63	0.45	-	-	-	-	-
α - Cadinol	37.41	1.73	6.17	0.62	1.08	4.48	-
τ – Muurolol	36.73	-	4.88	-	0.50	-	-
(+)- Junenol	35.23	-	-	-	-	2.37	-
Total		**2.18**	**11.05**	**0.62**	**1.58**	**6.85**	-
Miscellaneous Compound							
β-Damascenone	23.26	-	-	-	-	-	0.62
1,2,3,4,4a,5,6,8a-octahydro-4a,8-dimethyl-1-(1-methylethyl)-naphthalene	29.18	9.49	-	-	-	-	-
Tetradecane	40.70	-	-	0.70	-	-	-
n-Hexadecanoic acid	55.30	-	-	10.22	-	-	39.65
9-Octadecen-1-ol	58.04	0.27	1.08	-	-	-	-
9,12,15-Octadecatrienoic acid	62.38	-	-	-	-	-	1.52
Cyclotetracosane	83.04	-	-	2.20	-	-	-
Heptacosane	83.24	-	0.91	5.33	-	-	-
Octacosane	86.56	-	0.52	-	-	-	-
Eicosane	86.12	-	0.92	2.51	-	-	-
Nonacosane	90.00	-	-	1.60	-	-	-
Total		**9.76**	**3.43**	**22.56**	**-**	**-**	**41.79**

Cyclohexadecane dominated the essential oil of Chok-anan mango peel (20.20%) and present in four other essential oils except in the pulp of Chok-anan mango. Water Lily mango has the highest percentage of β-caryophyllene both in essential oils of its peel (18.91%) and pulp (32.53%). β-Caryophyllene was also reported in the essential oils of peel and pulp of Green Thai mango, Khieo Sawoei cultivar [5] and Brazilian mangoes [7]. β-Caryophyllene was known to have sweet floral, dry woody and clove leaf oil-like aroma. *n*-Hexadecanoic acid present only in the essential oils of peel (10.22%)and pulp (39.65%) of Chok-anan mango. *n*-Hexadecanoic acid was considered as marker phytoconstituents of mango species [8].

It is interesting to note the exclusive presence of certain volatile constituents to one variety. Caryophyllene oxide and 1,2,3,4,4a,5, 6,8a-octahydro-4a,8-dimethyl-1-(1-methylethyl)-naphthalene, the stereoisomer of γ-muurolene and *cis*-γ-cadinene were only present in the peel of Falan mango and accounted for 9.94% of its essential oil composition. 2,6-Dimethyl-2,4,6-octatriene, α-cubenene, β-

cadinene and globulol were only found in Water Lily peel and making up 11.45% of its essential oil composition. 3,7-Dimethyl-1,3,7-octatriene and (+)-junenol were only present in Water Lily mango pulp which contribute 3.31% to its final essential oil composition. β-Guaiene, β-selinene and β-damascenone were only found in Chok-anan pulp with a total of 3.14% composition. The unique presence of these compounds to these varieties could be responsible to the distinctive aroma and flavour for each type of variety. The chemical structures of major chemical constituents in the essential oils of *M. indica* are illustrated in Figure 1. The chemical composition of each essential oil is tabulated in Table 1.

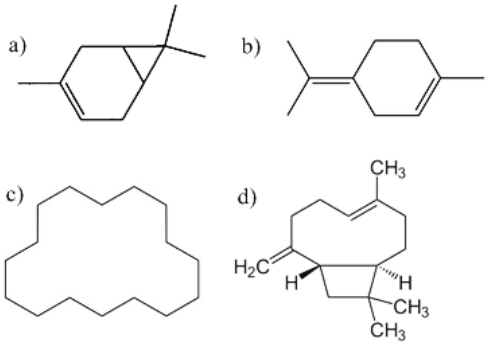


Figure 1 The major chemical constituents of essential oil of peel and flesh of *M. indica* cultivar Chok-anan, Falan and Water Lily (a) 4-carene (b) α-Terpinolene c) Cyclohexadecane (d) β-Caryophyllene

Monoterpenes hydrocarbon is the major type of compounds in the essential oils of peel and pulp of Falan mango with 30.67% and 45.65%, respectively. Meanwhile the essential oils of Water lily mango are mainly dominated by the presence of sesquiterpenes hydrocarbon in both peel and pulp with 50.75% and 67.11%, respectively. The essential oils of Chok-anan mango are rich in miscellaneous compounds in the peel and pulp with 22.56% and 44.10%, respectively. The chemical composition of the essential oils of three varieties of *M. indica* is illustrated in Figure 2.

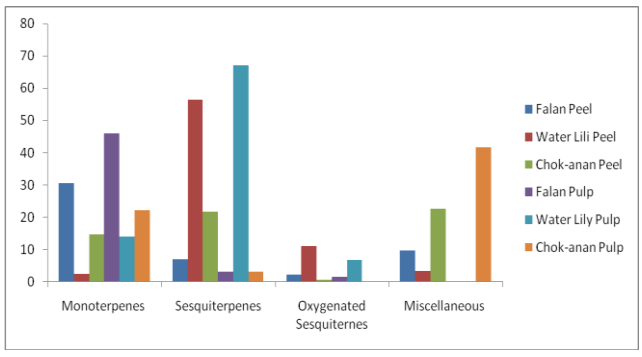


Figure 2 Chemical Compositions of the Essential Oils of Peel and Pulp of *M. indica* cultivar Chok-anan, Falan and Water Lily

4.0 CONCLUSION

The essential oil of peel and pulp of three different *M. indica* cultivars have been successfully extracted using hydrodistillation method. Thirty two compounds have been identified in the essential oils of peel and pulp of *M. indica* cultivar Chok-anan, Water Lily and Falan. The essential oils of peel and pulp of Falan mango is dominated by monoterpenes hydrocarbon (30.67% and 45.95%, respectively) while Water Lily peel and pulp are mainly consist of sesquiterpenes hydrocarbon (50.75% and 67.11%, respectively). Chok-anan peel and pulp are rich in miscellaneous compounds (22.56% and 41.79%, respectively). The aromas of these mangoes could be attributed to the presence of their major volatile constituents. The sweet and pungent Chok-anan mango is due to 4-Carene (21.64%), the sweet floral, dry woody aroma of Water Lily mango is due to β-caryophyllene (32.53%) and sweet, fresh and piney citrus aroma of Falan mango is due to α-terpinolene (44.57%).

Acknowledgement

The authors would like to thank Ministry of Education (MOE) for financial support under Fundamental Research Grant Scheme (FRGS) with 600-RMI/FRGS 5/3/(5/2013) and Universiti Teknologi MARA for the use of research facilities.

References

[1] Bally, I. S. E. 2006. *Mangifera indica* (mango). In Traditional Trees of Pacific Island, *Permanent Agriculture* Resources Bachang (*Mangifera foetida*). 442-467.

[2] Nzikou, J. M., Kimbonguila, A., Matos, L., Loumouamou, B., Tobi, N. P. G. P., Ndangui, C. B., Abena, A. A., Silou, Th., Scher, J. and Desobry, S. 2010. Extraction and Characteristics of Seed Kernel Oil from Mango (*Mangifera indica*). *Research Journal of Environmental and Earth Science*. 2: 31-35.

[3] Kittiphoom, S. and Sutasinee, S. 2013. Mango Seed Kernel Oil and Its Physicochemical Properties. *International Food Research Journal*. 20: 1145-1149.

[4] Wang, H. W., Liu, Y. Q., Wei, S. L., Yan, Z. Y. and Lu, K. 2010. Comparison of Microwave- Assisted and Conventional Hydro-distillation in the Extraction of Essential Oil from Mango (*Mangifera indica* L.) Flower. *Molecule*. 15: 7715-772.

[5] Tamura, H., Boonbumrung, S., Yoshizawa, T., and Varanyanond, W. 2011. The Volatile Constituents in The Peel and Pulp of A Green Thai Mango, Khieo Sawoei Cultivar (*Mangifera indica* L.). *Food Science Technology Research*. 7: 72-77.

[6] Mohd Jaafar, F., Osman, C. P., Ismail, N. H., and Awang, K. 2007. Analysis of the Essential Oils of Leaves, Stems, Flowers, and Rhizomes of *Etlingera elatior* (Jack) R. M. Smith *Malaysian Journal of Analytical Sciences*. 11: 269-273.

[7] Andrade, E. H. A., Maia, J. G.S. and Zoghbi M. G. B. 2000. Aroma Volatile Constituents of Brazilian Varieties of Mango Fruit. *Journal of Food Composition and Analysis*. 13: 27-33

[8] Dzamic, A.M. and Marin, P.D. 2010. Chemical Composition of *Mangifera indica* Essential Oil From Nigeria. *Journal of Essential Oil Research*. 22: 123-125.