COMPARISON OF CHEMICAL PROFILES OF SELECTED GAHARU OILS FROM PENINSULAR MALAYSIA

Nor Azah M.A, Chang Y.S., Mailina J., Abu Said A , Abd. Majid J. Saidatul Husni S., Nor Hasnida H. and Nik Yasmin Y.

Forest Biotechnology Division, Forest Research Institute Malaysia, 52109 Kepong, Selangor Darul Ehsan, Malaysia

Abstract

Gaharu (agarwood) is a fragrant wood that is usually derived from the diseased timber of the genus *Aquilaria* (Thymelaeceae) and often occurs as dark coloured patches or streaks in the tree. Due to its strong, unique scent and medicinal properties, gaharu oil is greatly valued as perfumery ingredient and incense. Gaharu may be classified into various grades; Grade A, B, C and D and they are often graded according to the physical properties, gaharu formation and its unique scent. The lower grades such as Grade C are often distilled to obtain gaharu oils. As part of an on-going research on the chemical profiling of some Malaysian gaharu oils and evaluation of their potential beneficial properties; gaharu oils obtained from different sources were analysed and compared by GC and GC-MS. Identification of the chemical components was based on comparison of calculated retention indices and mass spectral data with literature values. Examination of the oils showed some variations and differences in terms of GC profiles, concentration and chemical components. Majority of the essential oil profiles were complex and made up of sesquiterpenoids and their oxygenated derivatives. However, common occurrences of chemical compounds such as 3-phenyl-butanone, α-guaiene, β-agarofuran, α-agarofuran, agarospirol and jinkoh-eremol were detected.

Keywords: Gaharu, essential oil, chemical analysis

Introduction

Agarwood or *gaharu* is the resin impregnated, fragrant and highly valuable heartwood found in species of *Aquilaria*. It has been a highly prized commodity for more than 2000 years. When the wood is burnt, the fragrance released is considered as a scent from heaven. It is known by names in various languages such as aloeswood, eagle wood, agarwood, gaharu, oud, kalambac, chen xiang, jinkoh and gridsanah, to mention but a few. It is used in religious and spiritual ceremonies and recently used in the perfumery, incense and pharmaceutical industry. In traditional Malay medicine, the high quality gaharu or kalambak is used to treat various conditions such as weakness, pain in the stomach or chest, oedema and as tonic for men and women as well as post partum medicine [2] and [3]. Studies on the chemistry of agarwood have reported presence of sesquiterpenes, chromone derivatives, sesquiterpene furanoids, tetradecanoic acid and pentadecanoic acid [7], [4], [5], [8], [7] and [10].

Species in the genus *Aquilaria* from the family Thymelaeaceae are reported to produce agarwood or gaharu. Throughout the range states (producer countries), there are 25 species of *Aquilaria* and 15 species are reported to form gaharu [1]. But only *A. malaccensis* (syn. *A. agallocha*) and *A. crassna* are more frequently associated with agarwood or gaharu. Agarwood has also been reported from species in several other genera [2] within the same family. In the Malaysian forests, the main species producing gaharu is *A. malaccensis* or karas as it is commonly known. As part of an on-going research on the chemical profiling of some Malaysian gaharu oils and evaluation of their potential beneficial properties; gaharu oils obtained from different sources in Peninsular Malaysia were analysed by chromatographic methods and reported.

Materials and methods

Plant materials and oil isolation

Grade C Gaharu essential oils and wood samples (*Aquilaria* malaccencis) were obtained from different sources mainly from Gua Musang, Kelantan, Kuala Terengganu, Terengganu, Gombak, Selangor and Merapoh, Pahang. The gaharu wood samples were initially powdered and soaked for 7 days and were hydrodistilled using Clavenger-type apparatus. Distillation of the wood materials was run for 16 hours. The oil collected was then dried over anhydrous sodium sulfate and their physical characters like colour and odour were recorded.

Essential oil chemical analysis
Shimadzu GC 2010 equipped with a FID detector and fused silica capillary column CBP5 (Shimadzu 30 m x 0.25 mm, 0.25 μm film thickness) was used. The samples were injected in the split mode, using pressured-controlled helium as the carrier gas at a flow rate of 1ml/min. The gas chromatograph was programmed, initially at 60°C for 10 minutes, then to 230°C at 3°C/min. The relative amounts of individual components are based on peak areas obtained. Retention indices were determined from the gas chromatogram by logarithimic interpolation between bracketing alkanes using a homologous series of *n*-alkanes as standards and in accordance with established method (Kovats 1965).

GC-MS analysis was performed using a Hewlett–Packard GCMSD 5890 series II /5971A equipment, on fused silica capillary column DB1 (J & W Scientific 30 m x 0.25 mm, 0.25 μm film thickness). The column oven temperature was programmed from 60°C to 230°C with an increase of 3°C/min. The injector and GC/MSD interface temperatures were maintained at 250°C and 300 °C respectively with helium as carrier gas and electron energy (70eV).

Component identification: Chemical compounds were identified by matching their retention indices with retention times with literature values [6] and further verified by GC/MS where peaks were compared with the Wiley and Adams library search data.

Results and discussion

All of the gaharu oils gave out the distinctive gaharu aroma, however, the colour of the oils may vary from greenish brown to dark reddish brown. In general, all of the gaharu oils were complex mixtures of sesquiterpene hydrocarbons, sesquiterpene alcohols and aliphatic hydrocarbons and difficult to be identified based on MS alone. Some of the chemical constituents of the gaharu oils were identified by comparison of their mass spectral data with the existing Wiley library and reference library spectral data and comparison of their calculated retention indices with literature values. The list of common chemical compounds detected in selected gaharu oils from various locations is shown in Table 1. The results of this work indicate that there are some similarities and variations in the chemical composition of various of Grade C gaharu oil samples tested. 3-Phenyl-2-butanone, β-agarofuran, α-agarofuran, agarospirol and 10-epi-γ-eudesmol were some of the chemical compounds found occurring in all the oils studied. Nor-ketoagarofuran (2.09%), jinkohol II (4.71%) and kusunol (18.94%) were notably present in the oils collected from Selangor but however absent in the other oils. Agarospirol is significantly presented in the oils from Selangor and Terengganu contributing to 14.86% and 18.86% of the total oil respectively. GC and GC/MS profiles are currently being used to assist the detection and authentication of gaharu. Generating GC and GC/MS profiles of gaharu samples of various grades and from different sources will be helpful towards developing suitable chemical marker for grading gaharu.

Table 1: Some chemical compounds detected in some Malaysian gaharu oils

Chemical compounds	RI	Selangor (%)	Kelantan (%)	Pahang (%)	Terengganu (%)
3-phenyl-2-butanone	1249	1.50	5.77	7.80	0.79
α-guaiene	1448	-	0.67	-	-
β-agarofuran	1477	1.69	1.98	0.69	0.50
α-agarofuran	1553	4.83	2.96	1.48	1.57
Nor-ketoagarofuran	1557	2.09	-	-	-
10-epi-γ-eudesmol	1618	11.54	9.03	8.10	3.32
Agarospirol	1631	14.86	5.49	7.11	18.86
β-eudesmol	1649	-	-	-	5.74
Jinkoh-eremol	1650	10.62	7.70	6.31	-
kusunol	1659	18.94	-	-	-
Jinkohol II	1751	4.71	-	-	-

Temperature programmed linear retention indices on CBP5, relative to alkanes

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