CHEMICAL COMPOSITION OF TREATED AGARWOOD (*Aquilaria malaccensis)* ESSENTIAL OIL

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Minyak gaharu mempunyai nilai yang tinggi kerana penggunaannya yang meluas dalam industri termasuk minyak wangi, farmaseutikal, dan perubatan tradisional. Aroma gaharu yang kuat dan unik bergantung kepada kandungan *sesquiterpenes* dan *sesquiterpenoid*. Sedikit yang diketahui tentang kesan pendedahan minyak gaharu terhadap haba, cahaya ultraungu, aliran gas oksigen, dan cahaya matahari dalam satu tempoh masa untuk mendorong penghasilan kandungan *sesquiterpenes* dan *sesquiterpenoid* untuk meningkatkan aroma kayu. Kajian ini bertujuan menganalisis komposisi kimia minyak gaharu (*Aquilaria malaccensis)* komersial dan makmal yang diekstrak dengan kaedah penyulingan hidro (HD) dan menkaji kesan teknik rawatan ke atas komposisi kimia minyak gaharu berdasarkan kaedah kromatografi. Akhir sekali, kajian juga menilai parameter terbaik yang menyumbang kepada penghasilan minyak *A. malaccensis* berkualiti tinggi. Permasalahan kajian ini diatasi dengan pendedahan rawatan terhadap minyak *A. malaccensis* komersial dan makmal melalui teknik rawatan melibatkan empat parameter iaitu pendedahan haba pada suhu malar 40 ^{o}C, cahaya ultraungu pada panjang gelombang UV-B 365 nm, gas oksigen pada aliran malar 15L/min, dan cahaya matahari untuk tempoh 3, 7, 14, 20 dan 30 hari. Komposisi kimia dianalisis menggunakan kromatografi gas pengesan nyalaan pengionan (GC-FID) dan kromatografi gas spektrometri jisim (GC-MS). Daripada kajian ini, peratusan hasil minyak makmal *A. malaccensis* yang diperoleh daripada HD ialah 0.15 %, dengan masa pengekstrakan selama 72 jam. Empat kumpulan komposisi kimia dalam minyak *A. malaccensis* telah dikenal pasti menggunakan analisis GC, iaitu asid karboksilik, sebatian lain, *sesquiterpenes,* dan *sesquiterpenoid*. Kesimpulannya, 29–51 sebatian telah diperolehi dalam minyak *A. malaccensis* makmal yang dirawat dan 17-56 sebatian dalam minyak *A. malaccensis* komersial yang dirawat, kedua-duanya didominasi oleh sebatian *sesquiterpenoid*. Enam sebatian telah dikenal pasti dalam kesemua sampel kajian ini: n-hexadecanoic *acid*, epi-α-cadinol, α-eudesmol, guaia-1(10),11-dien-9-one, selina-4,11-dien-14-oic *acid*, dan karanone. Penilaian terhadap pendedahan kepada aliran oksigen pada 15L/minit dalam tujuh hari menunjukkan parameter terbaik untuk menghasilkan minyak *A. malaccensis* komersial berkualiti tinggi, disokong oleh jumlah peratusan tertinggi *sesquiterpenes* dan *sesquiterpenoid* (71.17 %) dengan nilai min tertinggi (1.52). Sementara itu, parameter yang menyumbang kepada minyak *A. malaccensis* makmal yang berkualiti tinggi ialah rawatan minyak kepada cahaya matahari selama tiga hari, disokong oleh jumlah peratusan tertinggi sebatian *sesquiterpenes* dan *sesquiterpenoid* (42.76 %) dengan nilai min tertinggi (0.93). Hasil kajian menunjukkan peningkatan jumlah kandungan *sesquiterpenes* dan *sesquiterpenoid* daripada 20.01 % kepada 42.76 %, menunjukkan bahawa teknik rawatan terhadap minyak *A. malaccensis* makmal telah meningkatkan jumlah kandungan *sesquiterpenes* dan *sesquiterpenoid* seperti yang dikehendaki. Oleh itu, aliran gas oksigen dalam masa tujuh hari dan rawatan cahaya matahari dalam tempoh tiga hari boleh digunakan pada minyak *A. malaccensis* untuk mendapatkan minyak pati yang diperkaya dengan molekul bioaktif yang disasarkan. Penemuan ini boleh digunakan sebagai pendekatan alternatif untuk menyediakan profil minyak pati gaharu berkualiti tinggi daripada genus Aquilaria di mana kurangnya maklumat pada ketika ini.

ABSTRACT

Agarwood oil has a high value due to its widespread use in industries including perfumes, pharmaceuticals, and traditional medicine. The aroma strength and uniqueness of the agarwood oil depend on sesquiterpenes and sesquiterpenoid contents. Not much is known about the outcome of exposing agarwood oil to heat, ultraviolet light, oxygen gas flow, and sunlight over a significant time (days), producing sesquiterpenes and sesquiterpenoid contents to increase the woody aroma. This study aims to analyze the chemical compositions of the commercial and laboratory agarwood oil (*Aquilaria malaccensis*) extracted by hydro distillation (HD) method and investigate how the treatment techniques affect the agarwood oil chemical compositions using the chromatography method. Finally, the study evaluated the best parameter contributing to the production of high-quality *A. malaccensis* oil. The problem was addressed by exposing the commercial and laboratory *A. malaccensis* oil through four parameters treatment techniques which are constant 40 ^{o}C heat exposure, exposure through the ultraviolet light, set at a UV-B wavelength of 365 nm, exposure to oxygen gas, set at a constant flow of 15L/mins, and sunlight over three, seven, fourteen, twenty and thirty days. Then, gas chromatographic flame ionization detection (GC-FID) and gas chromatographic-mass spectrometry (GC-MS) were used to analyze the chemical compositions. From this study, the percentage yields of laboratory *A. malaccensis* oils obtained from HD was 0.15 %, with an extraction time of 72 hours. Four groups of chemical compositions in *A. malaccensis* oil were identified using GC analyses, namely carboxylic acids, other compounds, sesquiterpenes, and sesquiterpenoid. In conclusion, 29–51 compounds were obtained in treated laboratory *A. malaccensis* oil and 17–56 compounds in treated commercial *A. malaccensis* oil, both dominated by sesquiterpenoid compounds. Six compounds were identified in all samples in this study: n-hexadecanoic acid, epi-α-cadinol, α-eudesmol, guaia-1(10),11-dien-9-one, selina-4,11-dien-14-oic acid, and karanone. Evaluation of exposure to oxygen flow at 15L/mins in seven days showed the best parameter for producing the high-quality commercial *A. malaccensis* oil, supported by the highest total percentages of sesquiterpenes and sesquiterpenoid compound (71.17 %) and the highest mean value (1.52). Meanwhile, the parameter that contributed to the high quality of laboratory *A. malaccensis* oil was treating oil to sunlight for three days, supported by the highest total percentages of sesquiterpenes and sesquiterpenoid compound (42.76 %) and the highest mean value (0.93). The results showed an increase in sesquiterpenes and sesquiterpenoid contents from 20.01 % to 42.76 %, indicating that the treatment techniques on laboratory *A. malaccensis* oil did increase the total amounts as desired. Hence, oxygen gas flow in seven days and sunlight treatment in three days could be applied to *A. malaccensis* oil to obtain essential oil enriched with targeted bioactive molecules. These findings could be used as an alternative approach to preparing the high-quality agarwood essential oil profiles from the genus Aquilaria which are presently lacking.

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