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MICROWAVE EXTRACTION OF ESSENTIAL OILS FROM ‘PENAGA LILIN’ (*MESUA FERREA* L.) LEAVES

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By

RUDY NURDIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

September 2007

DEDICATION

Specially dedicated to:

My Mother,
My Brothers,
My Sisters,
My Cousins,
My Friends,
My Lecturers
for their encouragement and support.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

MICROWAVE EXTRACTION OF ESSENTIAL OILS FROM 'PENAGA LILIN' (*MESUA FERREA* L.) LEAVES

By

RUDY BIN NURDIN

September 2007

Chair : Kaida bin Khalid, PhD

Faculty : Science

The purpose of this research is to compare the performance of the Microwave Extraction Technique (MET) with the Conventional Extraction Technique (CET) in extracting an essential oils from *Mesua ferrea* L. leaves using various methods such as dry distillation (DD), wet distillation (WD), hydro distillation (HD) and steam distillation (SD) in terms of its rapidity and efficiency to extract the quality percentage of yield and chemical composition of essential oil. The important extraction process parameters, i.e, time, temperature and microwave power output are controlled to obtain the highest quantity and quality of essential oil rapidly. The MET is performed using DD and WD at irradiation power of about 450 W and temperature about 100^{o}C for 1 hour whereas CET is performed using HD and SD at extraction power of 450 W and temperature 100^{o}C for 8 hours. The absorption power of microwave irradiation by *Mesua ferrea* L. leaves are also estimate for DD and WD. This is to determine which method gives higher value of absorption power. By estimating the absorption power in order to know which method is more efficient in heating process. The MET provides a rapid extraction, with about 8 times faster than

CET. After 1 hour of MET, it is possible to collect sufficient essential oil which provides comparable yields to those obtained 8 hours using CET. From 200 g actual weight of leaves, during HD gives the highest yield of extracted essential oil with 0.057% of weight compared to WD with 0.039% whereas DD gives 0.031% and SD which provides the least yield contributes 0.021%. Although more compounds are detected in the essential oil extracted by CET, substantial higher amounts of highly odoriferous compounds are present in the MET extract. During MET, DD requires only 5 minutes to obtain its first essential oil droplet and WD requires 19 minutes whereas during CET, both HD and SD requires 27 and 36 minutes, respectively. DD requires less time to obtain its first oil droplet compared to the other methods due to higher absorption power for dry sample than for wet sample. It is found that the absorption power in DD is 3 times higher with 4.2×10^{6} W/m^{3} compared to WD with only 1.5×10^{6} W/m^{3}. This is due to higher electric field strength inside the dry sample with 2.7×10^{4} V/m compared to the wet sample with 2.0×10^{3} V/m. This shows that MET is 70% more efficient in heating proses compared to CET only 50%. In terms of the power output consumed for 1 hour of MET and 8 hours of CET, DD requires the least energy with 12 kW whereas WD requires 17 kW while both HD and SD consume higher energy 216 kW. This shows that energy can be saved about 13 to 18 times using MET. In terms of the economical aspect, the MET is cost saving compared to CET. The rate of cost energy consumption for the extraction cost during MET for both DD and WD performed for 8 hours are RM 3.71 and RM 5.23, respectively whereas during CET, both HD and SD involve an extraction cost of RM 11.77, respectively. This shows that about RM 6.54 to RM 8.06 can be saved by using MET. The project successfully proved the MET is an alternative technique for the extraction of essential oils from plant materials like leaves. Essentially, the MET provides an easily controlled system, rapid and safe extraction process; high yield and purity extracts, more valuable and good quality of essential oils, extracts with chemical compositions comparable to conventional method and allows a substantial saving of energy. These advantages not only reduce operating costs, but also result in a more environmental friendly extraction process.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

GELOMBANG MIKRO MENGEKSTRAK MINYAK PATI DARIPADA DAUN 'PENAGA LILIN' (*MESUA FERREA* L.)

Oleh

RUDY BIN NURDIN

September 2007

Pengerusi : Kaida bin Khalid, PhD

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Tujuan penyelidikan ini adalah untuk membandingkan prestasi Teknik Pengekstrakan Gelombang Mikro (MET) dengan prestasi Teknik Pengekstrakan Biasa (CET) dalam mengekstrak minyak pati daripada daun *Mesua ferrea* L. menggunakan pelbagai kaedah seperti penyulingan kering (DD), penyulingan basah (WD), penyulingan hidro (HD) dan penyulingan wap (SD) dari segi kecepatan dan kecekapannya dalam mengekstrak peratusan dan komposisi kimia minyak pati yang berkualiti. Kawalan parameter-paramater penting proses pengekstrakan seperti masa, suhu dan kuasa output gelombang mikro telah dilaksanakan bagi memperolehi hasil ekstrak minyak pati pada tahap tertinggi dari segi kuantiti dan kualiti secepat yang mungkin. MET dijalankan menggunakan DD dan WD pada kuasa sinaran 450 W dan suhu sekitar 100^{o}C selama 1 jam manakala CET dijalankan menggunakan HD dan SD pada kuasa pengekstrakan 450 W dan suhu 100^{o}C selama 8 jam. Perkiraan kuasa serapan sinaran gelombang mikro oleh daun *Mesua ferrea* L. semasa DD dan WD juga lakukan. In bertujuan menentukan kaedah manakah akan memberikan nilai kuasa serapan tertinggi. Dengan perkiraan kuasa serapan tersebut, dapat diketahui

kaedah yang lebih efisien dalam proses pemanasan. MET membekalkan pengekstrakan yang cepat, lebih kurang 8 kali lebih cepat berbanding CET. Selepas 1 jam MET, ianya cukup memungkinkan memperolehi sejumlah minyak pati yang dapat membekalkan hasil ekstrak yang setara berbanding 8 jam pengekstrakan menggunakan CET. Daripada berat asal daun iaitu 200 g, semasa HD memberikan hasil ekstrak minyak pati yang tertinggi dengan 0.057% daripada berat asal berbanding WD dengan 0.039% sementara DD memberikan 0.031% dan SD memberikan hasil ekstrak paling sedikit 0.021%. Walaupun banyak sebatian dikesan dalam minyak pati hasil estrak CET, namun diperlihatkan lebih banyak sebatian wangian dalam hasil ekstrak MET. Semasa MET, DD hanya memerlukan 5 minit bagi memperolehi titisan minyak pati pertama dan WD memerlukan 19 minit manakala semasa CET, kedua-dua HD dan SD masing-masing memerlukan 27 dan 36 minit. DD mengambil masa singkat bagi memperolehi titisan minyak pertama berbanding kaedah-kaedah lain kerana kuasa serapan bagi sampel kering lebih tinggi daripada kuasa serapan bagi sampel basah. Didapati bahawa kuasa serapan dalam DD adalah 3 kali lebih tinggi iaitu 4.2×10^6 W/m^3 berbanding dalam WD dengan hanya 1.5×10^6 W/m^3. Ini disebabkan kekuatan medan elektrik dalam sampel kering lebih tinggi iaitu 2.7×10^4 V/m berbanding dengan sampel basah iaitu 2.0×10^3 V/m. Ini memperlihatkan bahawa MET adalah 70% lebih cekap dalam proses pemanasan berbanding CET hanya 50%. Dari segi kuasa output yang digunakan bagi 1 jam MET dan 8 jam CET, DD memerlukan paling sedikit tenaga iaitu 12 kW manakala WD memerlukan 17 kW sementara kedua-dua HD dan SD masing-masing menggunakan lebih tenaga iaitu 216 kW. Ini menunjukkan tenaga dapat dijimatkan 13 hingga 18 kali menggunakan MET. Dari segi aspek ekonomi, MET lebih menjimatkan kos berbanding CET. Kos kadar penggunaan tenaga proses pengekstrakan semasa MET bagi kedua-dua DD dan WD yang dilaksanakan selama 8 jam adalah masing-masing RM 3.71 dan RM 5.23, manakala semasa CET, kedua-dua HD dan SD masing-masing melibatkan kos pengekstrakan sebanyak RM 11.77. Ini menunjukkan bahawa sebanyak lebih kurang RM 6.54 hingga RM 8.06 dapat dijimatkan dengan menggunakan MET. Projek ini telah membuktikan dengan jayanya bahawa MET merupakan suatu teknik alternatif bagi proses pengekstrakan minyak pati daripada tumbuh-tumuhan seperti daun. Pada amnya, MET merupakan suatu sistem yang amat mudah dikawal, mengekstrak dengan pantas dan selamat, mengesktrak minyak pati yang lebih banyak, tulen dan berkualiti tinggi serta komposisi minyak yang setara dengan CET dan juga memberikan penjimatan tenaga yang banyak. Kelebihan-kelebihan ini bukan sahaja menjimatkan kos malah menyumbangkan kepada suatu proses pengekstrakan yang lebih mesra alam.

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I certify that an Examination Committee has met on 6 September 2007 to conduct the final examination of Rudy bin Nurdin on his Master of Science thesis entitled "Microwave Extraction of Essential Oils from 'Penaga Lilin' (*Mesau ferrea* L.) Leaves" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the student be awarded the degree of Master of Science.

Members of the Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 22 January 2008

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putera Malaysia or at any other institution.

RUDY NURDIN

Date: 1 November 2007

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