

DEVELOPMENT OF A MICROWAVE SYSTEM FOR EXTRACTION OF ESSENTIAL OIL FROM GAHARU (*AQUILARIA MALACCENSIS*)

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ABSTRACT

Microwave-assisted Extraction (MAE) process is a high speed method that has been used to extract constituents from plant material. This method has shown tremendous research interest and big potential in industries. The designed was originally developed for the extraction of fragrance from plants materials, which carried out by different techniques that require lot of energy or a long time or both combinations. In this study, the important process parameters such as microwave power, temperature and extraction time of MAE are controlled to obtain the highest yield of extracted essential oil. The microwave extraction method for the essential oil form *Aquilaria malaccensis* or gaharu is compared with the conventional extraction technique (CET). In such a way to obtain the first droplet of distillation, it is necessary to heat up only 10-13 minutes with MAE against 25 minutes with CET. After 60 minutes, it is possible to collect sufficient essential oil which provides comparable yields to those obtained with 8 hours by CET. MAE gives higher percentage yield of oil with 0.016% for hydro distillation while the percentage yield of oil obtained by the CET is only 0.140% after a long time of extraction. Gas chromatography-mass spectrometry (GC-MS) is used for detection and identification of the extracted compounds. This project is also looking for the various techniques of extraction process such as hydro, dry and steam distillation techniques. The results from each technique were presented.

INTRODUCTION

Aquilaria malaccensis or gaharu is the most expensive wood in the world. It is valued in many cultures for its distinctive fragrance and it is used intensively in incense and perfume. One of the reasons for the relative rarity and high cost of gaharu is the depletion of the wild resource (Broad, S.,1995). Since 1995, the primary source of *Aquilaria malaccensis*, has been listed as a potential threatened species by the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Due to the demand for gaharu, the wild trees have been almost depleted and now considered endangered.

Gaharu oil is very tenacious and only the tiniest of drops is needed to fill the air with its soul evoking aroma. It is a complex aroma with many nuances, deep and ethereal. It can be used as a perfume, an aroma therapy and an essential oil or as an aid for the deepest meditation.

Recently, an original method for extracting natural products by using microwave energy has been developed. Microwave Extraction System (MES) process is a high speed method that has been used to extract constituents from plant material and other high-value substances from a broad range of matrices. It was originally developed for the extraction of flavors and fragrances from plant materials, which is generally carried out by the conventional techniques either by hydro distillation (HD), steam distillation (SD) or solvent extraction (SE). Figure 1 illustrated the extraction system of essential oil from *Aquilaria malaccensis* wood by MES.

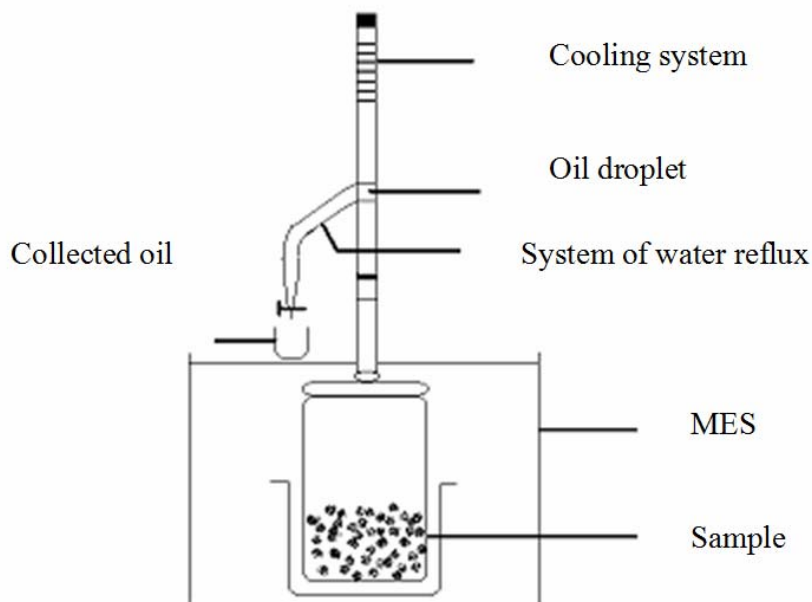


Figure 1: Schematic diagram for extraction system of essential oil from *Aquilaria malaccensis* wood

MATERIALS AND METHOD

Microwave-assisted extraction method was applied to the sample. Water was heated to produce steam, which carries the most volatile chemical of the aromatic material with it. The steam was then chilled in the condenser and the distillate was collected. The essential oil normally floated on top of the distilled water component and maybe separated off. There were few techniques such as solvent extraction, hydro distillation, dry distillation, steam distillation, and conventional extraction technique (CET) that had been test to the gaharu wood sample. Hexane was used for the solvent extraction as it is transparent to microwave and does not heat up under microwave. While for the other techniques, the sample was soaked only in distil water.

Microwave extraction

Microwave extractions are performed in the Milestone Ethos SEL Microwave Labstation, operating at 2455 MHz with a maximum delivered power of 1000W,

variable in 10W increments. The dimensions of the PTFE-coated cavity are 35 x 35 x 35 cm. The time, temperature and microwave power control are adjusted and controlled throughout the process using the Lab terminal 800 Controller. Temperature is monitored with the aid of a fiber-optic temperature sensor. In a typical Microwave Extraction (SFME) procedure which combines microwave heating and dry distillation, 250g of gaharu wood samples are put in a 2 liter vessel and placed in the microwave reactor without any added solvent or water. As for the hydro distillation method, the chopped woods are fully submerged in water but for steam distillation method, a prototype model will be designed. These experiments are performed at 750W, for 30, 45, and 60 minutes. The first essential oil droplet in each extraction is recorded. The essential oil is collected, dried with anhydrous sodium sulphate and stored at 0°C until it can be used.

Conventional Extraction Method

For Conventional Method Extraction, the gaharu wood are submitted to hydro distillation with a Clevenger-type apparatus according to European Pharmacopoeia consisting of a 2 liter round bottom flask set in a heating mantle and extracted at 450W for 8 hours until no more essential oil is obtained. The first essential oil droplet is also recorded. The essential oil is then collected, dried with anhydrous sodium sulphate and stored at 0°C until used.

RESULTS AND DISCUSSION

For MAE and CET, the extraction temperature is equal to boiling temperature of water at atmospheric pressure (100°C). To reach the extraction temperature, 100°C and thus obtain the distillation of the first droplet of essential oil, it is necessary to heat only 7 minutes with dry distillation (MAE), 13 minutes for hydro distillation (MAE) against 25 minutes for hydro distillation (CET). Figure 2-5 represent the heating profile of *Aquilaria malaccensis* wood extraction.

Below are the heating profiles for *Aquilaria malaccensis* using Microwave Ethos SEL Labstation (MELs).

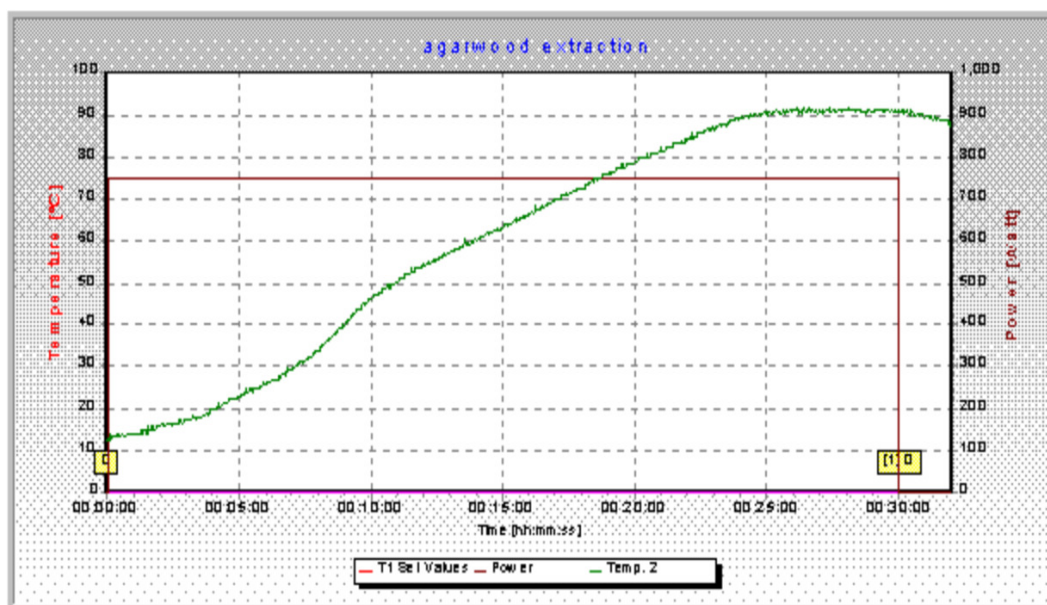


Figure 2: Wet distillation at 100°C, 750W, 30mins

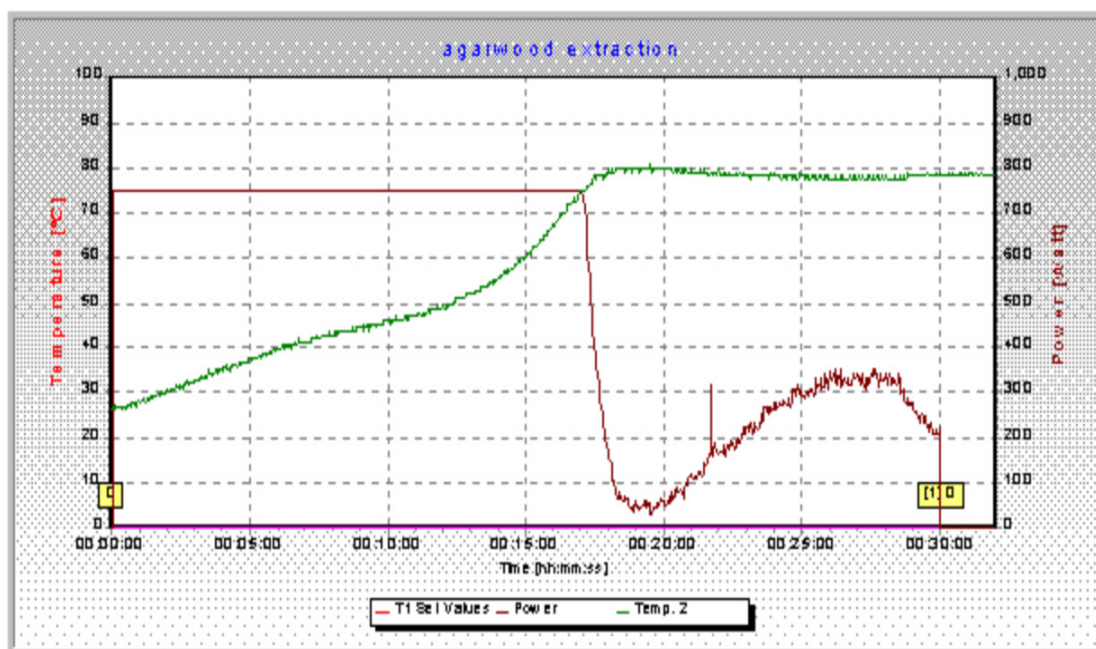


Figure 3: Dry distillation at 80°C, 750W, 30mins

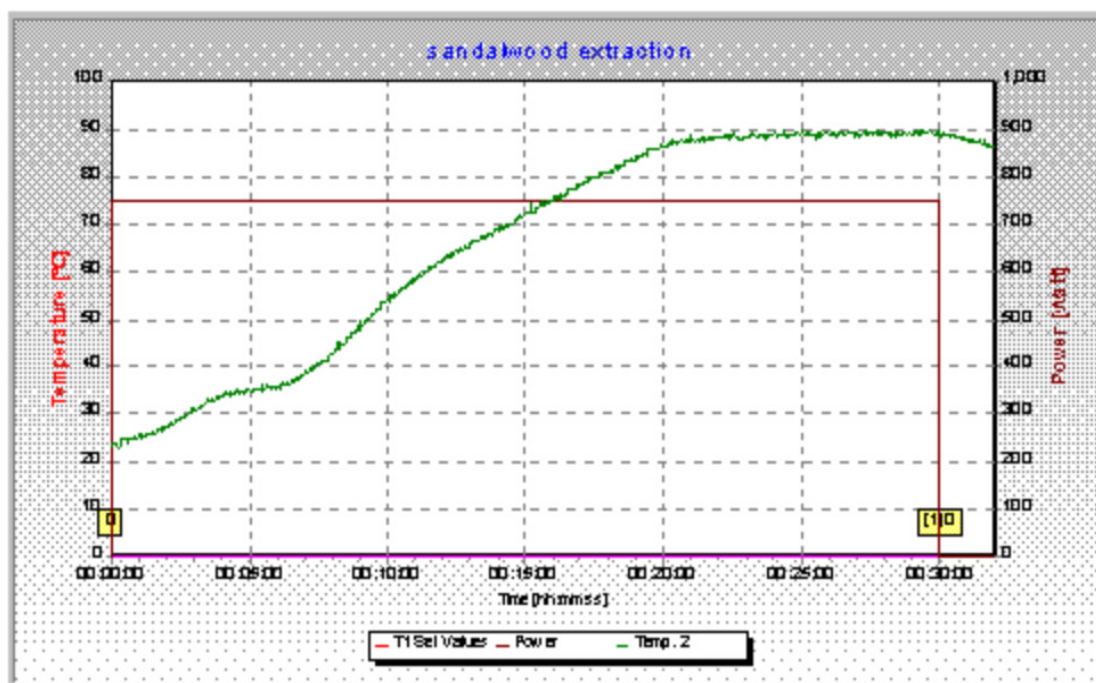


Figure 4: Hydro distillation at 100°C, 750W, 30min

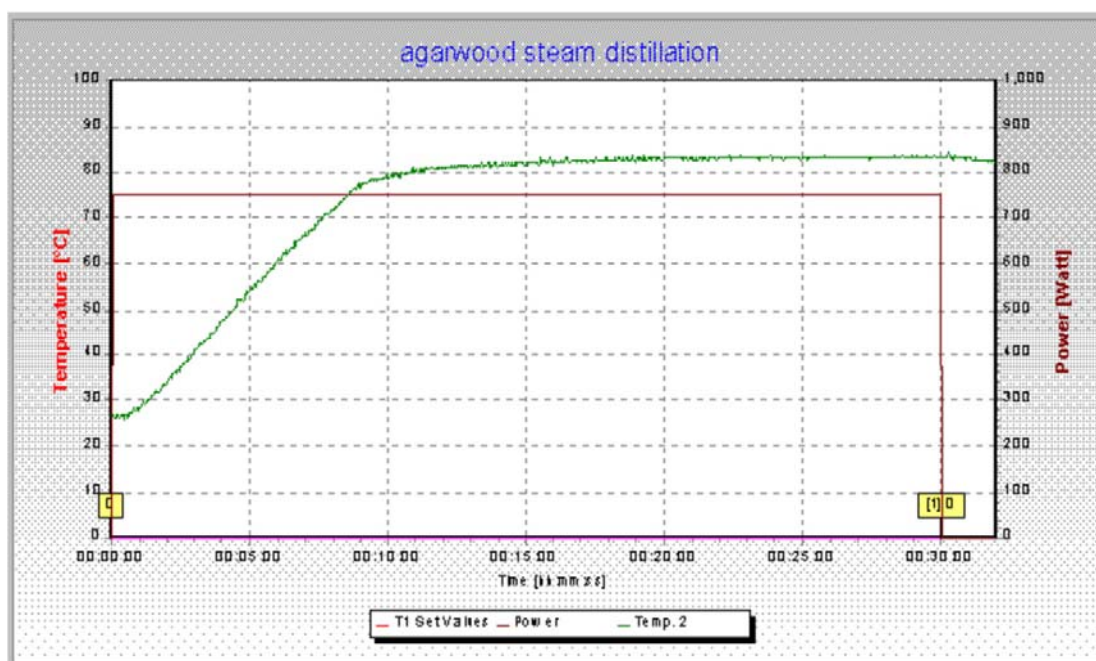


Figure 5: Steam distillation at 100°C, 750W, 30mins

Table 1: Percentage of yield of extraction for the different techniques

Techniques	Parameters used	First droplet of oil	Yield of extract (%)
Solvent extraction : hexane	Power:750Watt Temperature: 60°C Time: 1 hour	11:36 minutes	0.096
Hydro distillation	Power : 750Watt Temperature: 100°C Time: 1 hour	13:12minutes	0.116
Dry distillation	Power 750 Watt Temperature: 70°C Time: 30 minutes	07:03minutes	No yield
Steam distillation	Power: 750 Watt Temperature: 100°C Time: 1 hour	20:13 minutes	0.042
Conventional method	Power: 450Watt Temperature: 100°C Time: 8 hours	25 minutes	0.140

Table 2: Percentage of yield of extract for the different day of soaking

Day of soak/parameter	Yield (g)	Percentage of yield (%)
3 days	0.10	0.040
5 days	0.24	0.096
10 days	0.29	0.116

Table 3: Comparison between conventional, ultrasonic and microwave extraction technique

Methods/ Parameters	Conventional	Ultrasonic	Microwave
Sample (g)	500 g	500 g	250 g
Pretreatment time	7 days	6 hours	24 hours
Extraction time	5 days	3 days	1 hour
Oil yield (%)	0.0988	0.1413	0.116
Oil collected (g)	0.494	0.7065	0.29
Energy usage per process	N/A	2.4k W	750 W

One of the advantages of the Microwave Extraction is rapidity. For Conventional Method or Microwave Extraction, the extraction temperature is equal to water boiling temperature at atmospheric pressure (100°C). To reach the extraction temperature (100°C) and thus obtain the distillation of the first essential oil droplet, it is necessary to

heat only 7-10 minutes for Dry Method and 13-15 minutes for Wet Method using Microwave Ethos SEL against 25 minutes for Wet Method using Heating Mantle. After 60 minutes of Microwave Extraction, it is possible to collect sufficient essential oil for analytical determinations, whereas Conventional Extraction Method requires 8 hours. The Microwave Extraction method also allows a substantial saving of energy. 60-90 minutes of Microwave Extraction at 750 W. Wet distillation method gives 0.116% of yield but no yield occurs in the dry method while for conventional technique, it gives 0.140% after 8 hours of extraction. Different soaking period also plays an important role where by the longer the samples were soaked in distil water, the more the quantity of yield of extraction obtained. The results are shown in Table 2. Comparison between Conventional and Ultrasonic which had been done by other researcher with Microwave techniques in Table 3 shows that the microwave technique gives better performance in extracting the yield from *Aquilaria malaccensis*.

CONCLUSION

The Microwave Extraction has successfully proved that it is more efficient than the CEM in terms of rapidity and the quantity of yield. This method also provides more valuable essential oils, reduces the extraction time, and allows a substantial saving of energy. After 60 minutes of Microwave Extraction, it is possible to collect sufficient essential oil for analytical determinations, whereas Conventional Extraction Method requires 8 hours. Substantial higher amounts of highly odoriferous compounds are present in the Microwave Extraction extract. The gaharu oils are used for many different reasons and in a number of different ways. Medicine, industry, perfumery and of course aromatherapy have all come to rely on the properties of gaharu oil and are likely to do so in the future. Following the results of the various experiments carried out it becomes obvious that extraction using microwave technology is a good alternative to conventional extraction techniques especially for the extraction of essential oil for analytical determinations and for perfumery and aromatherapy purposes. These advantages not only reduce operating costs, but also result in a more environmentally friendly process.

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