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EXTRACTION OF ESSENTIAL OILS FROM PATCHOULI PLANT USING ADVANCED TECHNIQUES OF MICROWAVE-ASSISTED HYDRODISTILLATION

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ABSTRACT

Microwave-Assisted Hydrodistillation (MAHD) is an advanced technique for extraction process, in which microwave heating process is used. MAHD and hydrodistillation (HD) methods have been studied and the results were compared for their effectiveness in the extraction of essential oils from patchouli leaves. In present study the MAHD methods was operated with some levels of electrical power. The results showed that MAHD methods can reduce the extraction time and increase the yield. MAHD was also found to be a green technology since it required less energy than HD. The energy consumption of HD is 30% higher than MAHD. The results also indicated that power levels of MAHD have significant effect on ultimate extraction yield and time consumption. The higher power of MAHD can obtained higher ultimate yield.

Keywords: patchouli, essential oil, microwave-assisted hydrodistillation.

INTRODUCTION

Essential oil of patchouli is extracted by steam distillation of the young leaves of patchouli plant (pogostemancablin). The plant is cultivated in area with hot weather, particularly in Asia. Indonesia is ideal for its cultivation, and at present is also the leader in production with around 90% of global market share. The essential oil of patchouli is commercially used in different industries including perfume, cosmetics, and pharmaceutical. The health benefits of patchouli essential oil can be attributed to its properties as an antidepressant, antiphlogistic, antiseptic, aphrodisiac, astringent, fungicide, and tonic substance.

There are many extraction techniques to isolate the essential oils from aromatic plants. Among them, hydrodistillation (HD) is the most common method for the extraction of essential oils from medicinal herbs and plants [1-3].Conventional methods of HD, however, present several disadvantages such as long extraction times, potential loss of volatile, and high energy use. Thus, developing an alternative extraction technique that is rapid, energy-efficient, and safe, is very desirable [1]. New approaches such as ultrasound-assisted extraction, pressurized solvent extraction, supercritical fluid extraction, ohmic-assisted hydro distillation, and microwave-assisted extraction (MAE) have been sought in order to reduce the extraction time and possibly improve the extraction yield, to enhance the quality of the extracts and also to reduce the operation costs [4-6].

In present study, to take advantages of microwave heating with conventional HD, microwave-assisted hydro distillation (MAHD) is developed and used for the extraction of essential oils of patchouli plant. Microwave energy, with a frequency of 2.45 GHz, is well known to have a significant effect on the rate of various processes in chemical and food industry. The energy of microwave is transmitted as waves that can interact with polar molecules into materials, such as water to generate heat [7]. Fast heating is the main advantage of microwaves. Moreover, when the microwave is irradiated on the biomaterials, it will be able to force the fluid to diffuse out of the cell [8].

Despite some attentions have been paid to application of microwave in extracting essential oil from plants [1, 2, 4, 5], however, it is difficult to find literature related the utilizing MAHD method for extraction patchouli oil. Also, limited information is available on the suitable power levels and the energy consumption of MAHD [9]. Therefore, the objective of the present work is to investigate the potential of MAHD for extracting essential oils from patchouli plant. The extraction time, extraction yield, and energy consumed of MAHD were compared with those of HD in this report.

MATERIALS AND METHODS

Raw Material

Patchouli plants were obtained from local plantation in East Java, Indonesia. Before starting of each experiment, the leaves were separated from the stem and cut with the size about 2 cm. Then the leaves were dried at room temperature for several days. After the drying, the moisture content of leaves was 18.5-22.5%. In this experiment, distilled water was used for the solvent during the extraction.

Procedure of Essential Oil Extraction using MAHD

A modified domestic microwave oven was adopted for MAHD operation. The microwave generator was operated at 280, 420, 560, and 700 Watt power levels. Figure-1 show the installation of MAHD. One hundred grams of patchouli leaves samples were placed in a glass chamber containing 1500 ml distilled water. The glass chamber was setup within the microwave oven cavity. It was connected with a condenser that was applied to collect the extracted essential oils.

Every experiment was started with initial mix temperature of 80 ºC. During the process, the temperature of water was measured using thermocouple. The data acquisition system recorded the change of temperature during the extraction. The obtained essential oils were separated from condensate weighed and kept into closed amber vials for their further analysis.

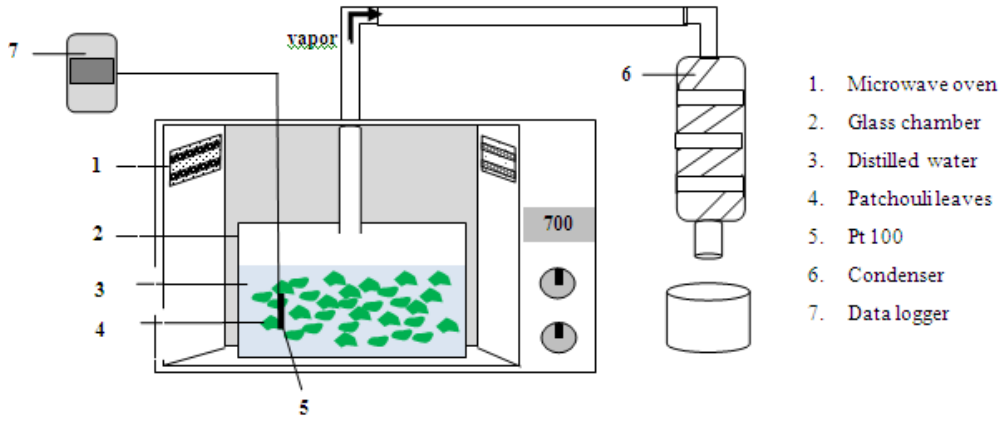

Figure-1. Schematic diagram of the microwave-assisted hydro distillation.

Procedure of Essential Oil Extraction using HD

The experiment on HD was carried out in a similar manner as MAHD. However, we used an extraction chamber made from aluminium and the conventional heating method was done using a LPG stove. In this experiment we used LPG, which has composition of 50% propane and 50% Butane. The heating value of the LPG is 46, 280 kJ/kg.

The processing parameter, i.e. mix temperature and energy consumption, were monitored. The temperature of mix was measured and recorded using Platinum resistance temperature sensors (Pt 100) that was connected to the data logger. Moreover, the input power consumption of MAHD was monitored using a Wattmeter, which was installed at the electrical power supply of the microwave oven. The energy consumption of HD was measured by measuring the gas consumption (mass) during the process. The extraction time, extraction yield, and energy consumed of MAHD were compared with those of HD.

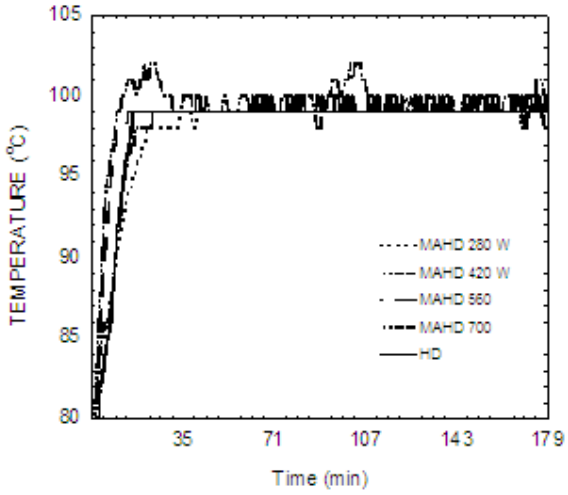

Figure-2. The temperature during extraction using MAHD and HD.

RESULTS AND DISCUSSIONS

Comparison of Temperature Profiles of the Extraction Methods

The profiles of temperature during extraction using MAHD and HD methods are shown in Figure-2. The extraction was started with initial temperature of the mix

of 80 ºC. To reach extraction temperature (about 99 ˚C), it was necessary to heat the mix for 10 min in MAHD 700W, 15 min in MAHD 560W, 23 min in MAHD420W, and 34 min in MAHD 280Wwhileit was about17 min for HD. The MAHD has enough power to heat the mix when the power was set at 560 and 700 W, so that it can heat the mix faster than HD. The rate of temperature raise of MAHD was higher than it of HD when the power levels were set at 560 W and 700 W. But, it was lower than HD when the power level set at 280 and 420 W.

Comparison of Extraction Yield

The results of extraction oil from patchouli leaves using MAHD are compared with that of HD on Figure-3. The extraction oil product is expressed as in millilitres of essential oil per 100 g of leaves. While Figure-4 shows the extraction yield as a function of time for MAHD and HD. This yield are expressed the weight percentage of extraction oil (grams of essential oil per 100 g of dried leaves). The results show that power levels have important effect in extraction process using MAHD. Increasing power levels in MAHD was not only increase the extraction rate, but also increase the ultimate extraction yield of patchouli oil. The full extraction using MAHD took about 260 -280 minutes to obtain the ultimate yield. The ultimate yields of essential oil obtained from dried leaves are respectively 1.33% for MAHD 280W, 2.37% for MAHD 420W, 2.88 for MAHD 560W and 3.84% for MAHD 700W. Essential oil of plant usually exists inside the cell, so that we need effort to extract this oil. In the case of using MAHD, the microwave not only can heat the material, but it also has a kind of pumping effect that can force oil or moisture to diffuse out of the cell. The experimental data show that higher power of microwave is necessary to force the oil to diffuse out of the plant cells, so that we can obtain more ultimate yield. Increasing power level from 280W to 700 W increased the yield for

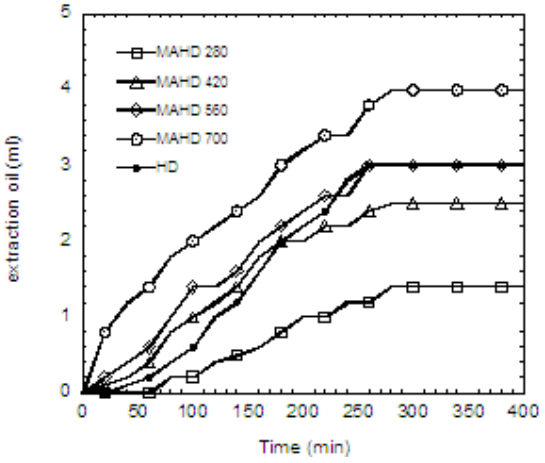

Figure-3. Extraction patchouli oil (millilitre/100 g dried leaves) as a function of time for MAHD and HD.

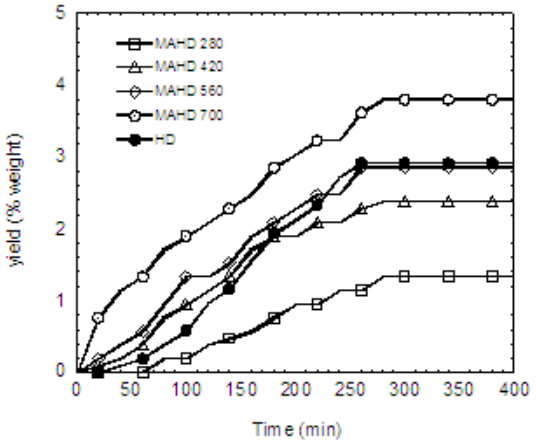

Figure-4. Extraction yield (% weight) as a function of time for MAHD and HD.

almost 3 times. The low power level was not effective for the process since it needed longer time and obtained less ultimate extraction yield.

In term of extraction using HD methods, the results almost similar with the results of MAHD 560 W. It has ultimate extraction yield of patchouli oil about 2.91% with extraction time of 260 min. It was 1% less than it using MAHD 700W. MAHD with high power level of 700W seem to be more effective methods comparing with HD.

Comparison of Energy Consumption

Figure-5 show the data of energy consumption values per millilitre extraction yield of various extraction processes. The data show that MAHD consumed less energy compared to the HD. The energy consumption per millilitre oil using MAHD about 2,620.8 - 2,952 kJ, while it using HD is about 3,656.7 kJ. The energy consumption of HD is 30% higher than MAHD. It indicated that

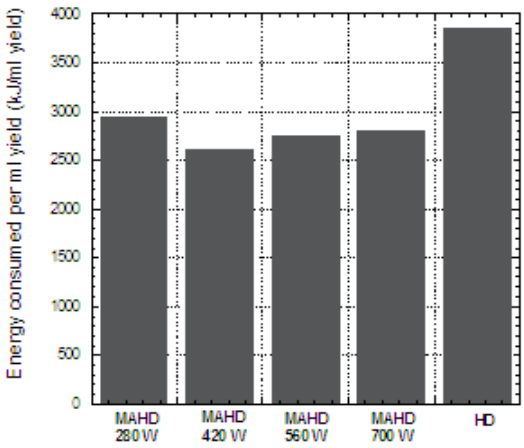

Figure-5. The energy consumed per ml extraction yield.

microwave heating is more efficient comparing with conventional conductive heating. Unlike the conductive heating methods, microwaves can heat the entire sample almost simultaneously at a higher rate [5]. When we use conventional conductive heating, some heat losses occurred since the heat transfer to the environment. However, the microwave heating can minimized these losses. The energy of microwave that is transmitted as waves interact with polar molecules into materials, such as water molecule to generate heat so can reduce the energy losses [7].

The results also indicated that the low power level was not effective for the extraction process. Although, MAHD 420 W exhibited the highest energy efficiency compared with MAHD 560W and MAHD 700W, but it produce less ultimate extraction yield. MAHD seems to be more economical extraction method than HD regarding time and energy consumption.

CONCLUSIONS

Study on the potential of MAHD for extracting essential oils from patchouli plant has been carried out. The extraction time, extraction yield, and energy consumed of MAHD were compared with those of HD in this report. MAHD was presented as the environmentally friendly extraction method suitable for patchouli oils extraction. The results showed that MAHD methods can reduce the extraction time and increase the extraction yield of patchouli oil. MAHD was also found to be a green technology since it required less energy than HD. The results also indicated that power levels of MAHD have significant effect on ultimate extraction yield and time consumption. The higher power of MAHD can obtained higher ultimate yield.

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