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Hydro Distillation of Java Citronella Using Microwaves Technique: Effect of Mass Ratio and Irradiation Time on Physical Characteristics of Java Citronella Oil

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ABSTRAC--*Java citronella is a bush plant that commonly grows in a tropical and semi-tropical climate. Extraction of Java Citronella can produce essential oils that are very useful for fragrances in soaps, perfumes and also beneficial in the medical application. Essential oils can be obtained through extraction methods such as hydrodistillation and modification of this method aims to correct existing deficiencies. Hydrodistillation using microwave technique was carried out at a fixed power of 300 watts with variations mass ratio of the java citronella of 3:40 (w / v), 4:40 (w / v) and 5:40 (w / v) and time variations of 30 minutes, 45 minutes and 60 minutes. Then the java citronella oil density and the refractive index were analyzed. The density value at ratio 5:40 (w/v) within 45 and 60 minutes has reached the standard value for java citronella oil and the refractive index for all variations also has reached the standard value for java citronella oil.*

Keywords*—java, citronella, microwaves, technique irradiation, physical, characteristics citronella oil*

I. INTRODUCTION

Java citronella is the common name of essential oil from *Cymbopogon winterianus* that is native in tropical and semitropical areas of Asia, India, Indonesia and is cultivated in South and Central America. It is consisting of citronellol, citronellal, and geraniol as the major compounds (Simic, et al., 2008). This oil is widely used as a source of fragrance chemicals which are widely used in the soap, perfume and cosmetics industries throughout the world. In addition, this oil is also used in the pharmaceutical industry as an anti-bacterial (Wany, et al., 2013).

Essential oils can be obtained through extraction methods such as maceration, hydrodistillation, steam distillation, and steam and water distillation. Of the many existing extraction methods, the hydrodistillation method is the most common method used for the extraction of essential oils from medicinal plants and other plants. However, this method has several disadvantages including long extraction time, high risk of losing volatile constituents, high energy use and others (Jeyaratnam et al., 2016). Therefore many improvements have been made to this hydrodistillation method in various ways to obtain better processes and results. One way is to use microwave technology.

Microwaves are electromagnetic fields such as electric fields and magnetic field frequencies that are in the frequency range of 300 MHz to 300 GHz and have two fields that oscillate perpendicularly (Soquetta, et al., 2018).

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In the extraction process, microwaves have a function as a non-contact heat source where the heating process is based on heat generated by ionic conduction and / or rotation of the dipole in a material, and its efficiency depends on the dielectric properties of the material. Microwaves can not only make heating more effective and selective, but also help accelerate energy transfer and response to heating control, and to reduce temperature variations. Microwave extraction is now recognized as an efficient technique that can reduce extraction time, increase extraction yield and improve extract quality (Yu, et al., 2017).

II. MATERIALS AND METHODS

2.1 The Essence of the Study

There are several stages in this study, which are illustrated in Figure 1.

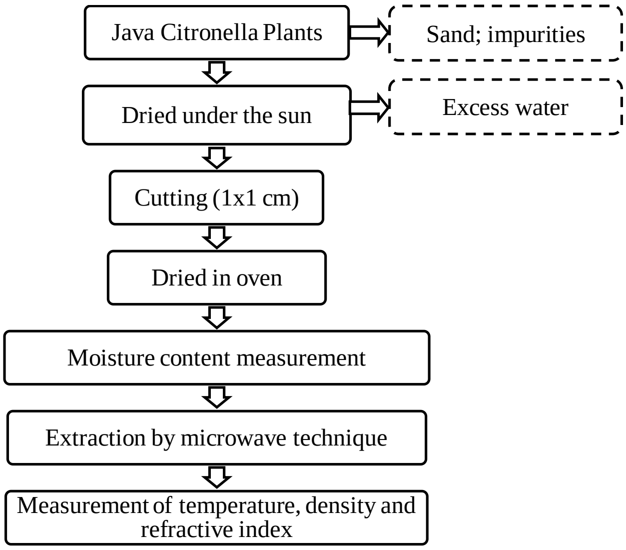

Figure 1: Experimental Process flowchart

The equipment used to measure temperature during the extraction process is a K type thermocouple (Krupp and Closs diameter size of 3x300 mm (mineral insulated) C / w cable 2 m) connected to a thermal controller (Shimaden). The temperature is also monitored using Arduino software to obtain the temperature profile during extraction. The java citronella oil density and the refractive index were analyzed using a pycnometer and refractometer.

2.2 Plants Sample Preparation

Java citronella is obtained from a local plantation located in Tarutung, North Tapanuli, North Sumatra Province. After washing from dirt, these plants are dried in the open area to reduce the water content, cut into 1x1 cm pieces. Java citronella that has been cut is weighed as much as 1-2 grams and wrapped using aluminium foil. Then the sample is dried in an oven (Memmert, 230 V) at 40 C for 2 hours, and placed in a desiccator until the sample reaches room temperature and the sample is re-weighed. This procedure is repeated until a constant weight is obtained. Water content is calculated as the ratio of vaporized water to the initial content. The average water content of the sample is approximately 75.23%.

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2.3 Extraction Process Using Microwave

The equipment used in the extraction process is a modified commercial microwave oven (Samsung MS23K3515ASR, 230 V, 23 L) with a frequency of 2450 MHz, which has been added to the microwave oven with distillation flasks and connected to condensers and separating funnels. The solvent used is 400 ml of water (H_2O) and the mass used is 30 g, 40 g, and 50 g. The extraction was carried out at a fixed power of 300 watts with variations of the java citronella and H_2O ratio of 3:40 (w / v), 4:40 (w / v) and 5:40 (w / v) and time variations of 30 minutes, 45 minutes and 60 minutes.

III. RESULT AND DISCUSSION

3.1 Java Citronella Mass Ratio and Irradiation Time Influence on Java Citronella Oil Density at Fixed Microwave Power

Oil density is a collection of molecular weights of various constituent components of an essential oil in a predetermined volume. The value of density is related to the weight fraction of the components contained in java citronella oil. The molecular weight of the compound is directly proportional to the oil density. The greater the molecular weight of a compound, the greater the density it will produce (Feriyanto, et al., 2013).

Mass ratio and irradiation time influence on java citronella oil density is shown in Fig. 1. There are three variations of ratio which are 3:40, 4:40 and 5:40 (w/v). The density is obtained within 30 minutes are 0.858; 0.860; 0.867 g/ml, the density is obtained 45 minutes, are 0.885; 0.888; 0.901 g/ml. The density is obtained 60 minutes are 0.883; 0.887; 0.904 g/ml. The density value at ratio 5:40 (w/v) within 45 and 60 minutes has reached the standard value for citronella oil according to ISO 3848:1976 which is in the range 0.880 – 0.895.

The power usage at low levels was obtained the highest density on the longest irradiation time, this is due to the longer the irradiation time, it will be more the active substances are released by cells of java citronella, so it will affect the molecular weight and density.

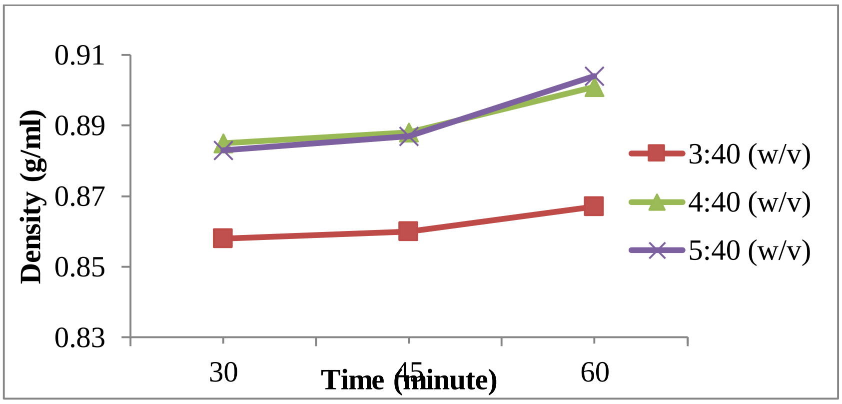

Figure 2: Java Citronella Mass Ratio and Irradiation Time Influence on Java Citronella Oil Density at Fixed Microwave Power (300 watt)

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3.2 Java Citronella Mass Ratio and Irradiation Time Influence on Java Citronella Oil Refractive Index at Constant Microwave Power

Physical properties that can be used as a reference for java citronella oil quality parameters are the refractive index of oil. Java citronella mass ratio and irradiation time influence on refractive index of java citronella oil is shown in Table. 1. The refractive index of java citronella oil on the variation of mass ratio and irradiation time did not show a significant increase, but the refractive index value of java citronella oil has reached a standard value according to ISO 3848:1976, which in ranges 1,466 - 1,473.

The longer processing time will increase the value of the refractive index, this is because the longer the extraction process, the more weight fraction components are extracted so that the refractive index of oil is greater. The refractive index is influenced by the length of the carbon chain and the number of double bonds. An increase in the value of the refractive index indicates an increase in the length of the carbon chain, and the number of double bonds. Thus an increase in the value of the refractive index indicates an increase in the components of chemical compounds that have long carbon chain arrangements or many double bonds. Essential oils with large refractive index prices have better quality than oils with small refractive index.

Table 1: Refractive Indexes of Java Citronella Oil

Solvent	Microwave Power (watt)	Mass Ratio*	Time (minute)	Refractive index
H_2O	300	3:40	30	1,467
			45	1,468
			60	1,468
		4:40	30	1,468
			45	1,468
			60	1,469
		5:40	30	1,469
			45	1,468
			60	1,469

*(w/v)

3.3 Temperature Profile of Hydro Distillation Process of the Java Citronella Using Microwave Techniques with Variations in The Ratio of Mass and Constant Power for 30 Minutes

Temperature is a key factor for all extraction techniques. As the temperature increases, the solvent has a higher capacity to dissolve the active compound, while the surface tension and viscosity of the solvent are reduced, which increases sample permeation and matrix penetration. Efficient desorption of compounds from active sites in the matrix takes place, which leads to high recovery of extraction. In hydrodistillation using microwave technique, temperature depends on the microwave power and the ability of the solvent to absorb microwaves (Destandau et al., 2013).

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The effect of the ratio on the temperature profile for 30 minutes is shown in Fig. 3. It can be seen that the temperature profile for the three variations of the Java Citronella mass ratio has the same trend. For the java citronella mass ratio 3:40 there was a significant increase in temperature until the 20th minute, then there was a drastic decrease in temperature up to the 30th minute. For the java citronella mass ratio 4:40 there was a significant increase in temperature until the 20th minute and then the temperature became constant until the 30th minute, and for the 5:40 ratio there was a significant increase up to the 20th minute and a slight decrease up to the 30th minute.

The temperature elevation is very much dependent on the non-uniform heating due to 'hotspot' formation phenomenon in microwave cavity.This thermal uncertainty ascends because of the creation of standing waves within the microwave cavity results in some regions being bare to higher energy than others (Kormin et al., 2014)

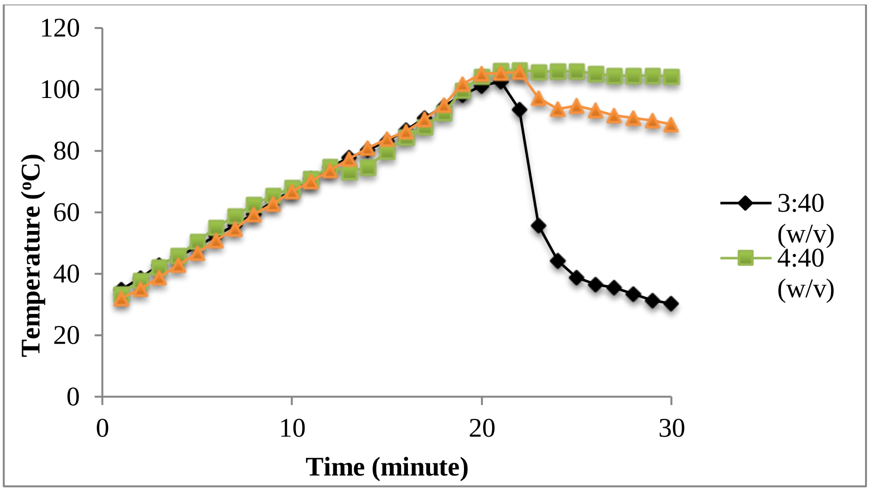

Figure 3: Temperature Profile of the Hydro Distillation Process Using Microwave Techniques with Variations In The Ratio Of Mass And Constant Power For 30 Minutes

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