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Extraction of Citronella Oil (*Cymbopogon winterianus* Jowitt) using Hydrodistillation Method: The Effect of F/S Ratio and Extraction Time

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Abstract

Essential oils are volatile aromatic compounds produced by plants. Essential oils are known by various names, including ethereal oils because they have ether properties, volatile oils because they evaporate easily at room temperature, and essential oils because they contain the essence of a plant. Lemongrass is one of the plants that produce essential oils. Extraction of citronella oil can use several methods such as hydrodistillation, pressing, solvent extraction, and adsorption by vaporizing solid fat (enfleurage). In this study the method that will be used is hydrodistillation. This study aims to determine the effect of the mass ratio of citronella oil to the volume of solvent, namely aquadest, on the yield of citronella oil and to determine the effect of the length of extraction time required on the yield of citronella oil.

Keywords: Hydrodistillation, citronella oil, F/S ratio, extraction time, Cymbopogon winterianus Jowitt

INTRODUCTION

Lemongrass is one of the essential oil-producing plants that have economic value, efficacy and usefulness to domestic demand and as an export commodity as a source of foreign exchange. There are two species of lemongrass from the genus Cymbopogon, namely Ceylon Citronell (*Cymbopogon nardus* Rendle) and Java Citronella (*Cymbopogon winterianus* Jowitt) [1]. According to the Badan Pusat Statistik (BPS), some areas that develop citronella are Riau, West Java, Central Java, West Kalimantan, and South Sulawesi. This development of area and productivity shows that the productivity of citronella tends to increase significantly since 2009 compared to the development of the distribution area which is almost the same every year.

Essential oils are essences of aromatic plant species obtained by the hydrodistillation of whole plants or from certain parts such as flowers, fruits, leaves, roots, barks and seeds [2]. Different methods of extraction like distillation (hydro and steam), solvent extraction and supercritical fluid extraction can be used to extract essences or volatiles. However, the quality and quantity of the oil yield depend on extraction technique used [3]. Therefore, the type of Java is more widely cultivated in tropical and sub-tropical countries such as India, Sri Lanka, Malaysia, Taiwan, Ecuador, Madagascar, Guatemala, Honduras, Brazil, Argentina, Mexico, and the West Indies [4].

According to Sastrohamidjojo (2004) [5], essential oils are found in the oil glands. The release of oil in the oil glands occurs due to hydrodiffusion or penetration of water in plant tissues. Cutting into small pieces or comminution can increase diffusion thereby speeding up evaporation and distillation because it makes it easier for the oil glands to penetrate water. And this cutting or chopping serves to increase the bulk density of the material, so that in quantity more ingredients can be put into the distilled kettle. This chopping affects the yield of oil that will be produced because during the chopping process there is a small amount of oil that will evaporate into the free air.

Selection of the appropriate solvent can make the extraction process run more efficiently. The choice of this solvent itself also depends on several things such as the solubility of the component to be extracted, its penetration ability and interaction with the matrix of the sample or material, as well as the dielectric constant [6]. The F/S (Feed/Solvent) ratio is the ratio of feed (material) to solvent. In this study, the material used was citronella and the solvent was distilled water. In the hydrodistillation process, sufficient water is needed so that the material can move freely in the water. If the water used is small or

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insufficient, there will be overheating which causes the citronella to be scorched and the quality of the oil obtained will be low. The reaction between esters in essential oils with water at high temperatures can produce acids and alcohols. If the water is used in excess, the acid and alcohol formed will also increase so that the yield of the essential oil produced can be reduced [7].

Akhihiero et al. (2013) [8] also explained that the larger size of the material, the more it has a larger surface area and is filled with lemongrass essential oil compared to lemongrass with a small surface area. So that lemongrass with small particle size will give higher yield of essential oil at the beginning of extraction. However, with increasing time, the yield of essential oils will decrease because most of the cells containing oil have been extracted. However, the large particle size will give the essential oil yield smaller at the beginning of the process and will increase with time. This volatile citronella oil is miscible with solid compounds which differ in composition and melting point, soluble in organic solvents and insoluble in water. Based on these properties, the citronella oil can be extracted in 4 ways, namely distillation (destillation), pressing (pressing), solvent extraction (solvent extraction), and adsorption by vaporizing solid fat (enfleurage). Thus, the quality and quantity of the oil yield depends on the extraction technique used [9]. Generally in Indonesia, citronella oil is obtained from traditional citronella leaf distillation, namely by steaming (Steam-Hydro Distillation or SHD). In addition, methods that have been developed include the method of boiling or Hydro Distillation (HD) [10] and the method of steam or Steam Distillation (SD) [11]. The yield of oil that can be obtained using the SHD method is lower, ranging from 0.69 to 2.17% [12], while the HD method is able to reach 2.43% [10] So, in this study, we intend to perform Citronella Oil Extraction used the Hydrodistillation method to determine the effect of the mass ratio of citronella oil to the volume of solvent, namely aquadest, on the yield of citronella oil and to determine the effect of the length of extraction time required on the yield of citronella oil.

MATERIALS AND METHODS

Materials

In this study, Serai Wangi aged about 5-6 months was obtained from Jalan Godean Km. 7.5, Sidoarum, Kecamatan Godean, Kabupaten Sleman, Daerah Istimewa Yogyakarta, while the chemicals used were 96% Technical Ethanol, Technical Heksana, and Aquades obtained from CV Progo Mulyo, Yogyakarta.

In this study, the part of the citronella selected for extraction was the stem, where the citronella stem was pretreated being cut uniformly by ± 0,5-1 cm and withered by allowing it to stand at room temperature for 1 day (24 h) and observed levels of citronella water per day.

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Extraction of citronella oil using hydrodistillation method

Extraction was carried out by inserting chopped citronella stems and distilled water into a boiling flask with a variation of the ratio F/S 0.2 (w/v) for 240 min. After that turn on the cooler Liebig back. The material is started to be heated with a 1000 mL heating mantle with a power specification of 350 W and a voltage of 220 Volt/50 Hz and a maximum temperature of 450^{o}C. The calculation of the first time (t=0) is considered as the first drip of the distillate. The distillate dripping on the beaker was accommodated at intervals of 0, 5, 15, 30, 60, 90, 120, 150, 180, 210 and 240 min. Once obtained at each time, observed and separated the mixture of water and oil obtained using a separatory funnel. Repeat this step with variations in the F/S ratio of 0.3, 0.4 and 0.5 (w/v). Yield obtained from each experiment is calculated using the equation:

$$\text{Yield (\%)} = \frac{\text{Amount of citronella oil obtained (g)}}{\text{Amount of materials used (g)}} \text{ x } 100\ \%$$

RESULTS AND DISCUSSION

Research on the extraction of citronella oil was carried out using the hydrodistillation method. In this method, citronella stems are used with a size of ± 0,5-1 cm. This makes the extraction process more efficient, because by reducing the size of the material, the surface area of the material will be even greater.

Effect of F/S ratio on yield of citronella oil

In this experiment, the F/S ratio of citronella was used, namely 0.2, 0.3, 0.4 and 0.5 (w/v) with the same extraction time of 240 min. From the experimental data carried out on the extraction using the F/S ratio of citronella, namely 0.2, 0.3, 0.4 and 0.5 (w/v) with a solvent volume of 400 mL, it can be studied the effect of the mass of the material on the weight of the oil produced. The experimental results can be seen in Figure 1.

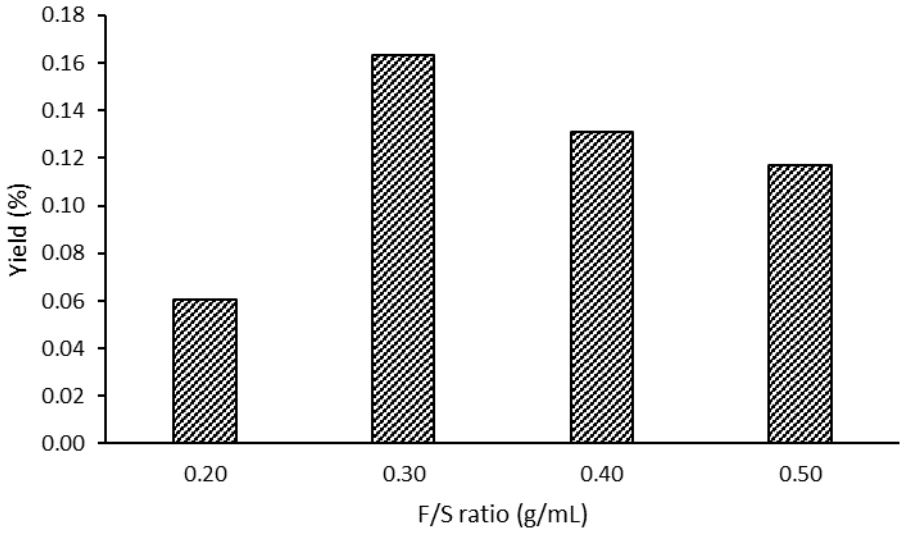

Figure 1. The effect of F/S ratio on yield of citronella oil

It can be seen in Figure 1 that as the weight of the raw material increases, the yield of the citronella oil produced increases. This is because with the increase in the mass of raw materials, the oil content also increases. So that the yield obtained by increasing the weight of the raw materials also increases. This is different from the research conducted by Fachrudin et al. (2016) [13] conducted research, namely the extraction of essential oils from cempaka flower as raw materials by varying the weight of the raw materials and extraction time. As the weight of the raw material increases, the yield of oil obtained decreases. The thing that causes a decrease in yield is the mass of raw materials used is too much or in other words the extractor used becomes full so that the refining process is hampered because steam is difficult to get out of the material. So it can be concluded that the condition of the material and the mass weight of the raw materials used greatly affect the yield of citronella oil produced.

Effect of extraction time on yield of citronella oil

Extraction time is one of the important factors that affect the results of the extraction process, a long extraction time will cause the material to be exposed to excessive microwave radiation. This has an impact on a decrease in extraction yields because the bioactive components are degraded. The use of a long time will also increase production costs [14]. Based on the observations in this experiment, the experimental data can be seen through Table 2.

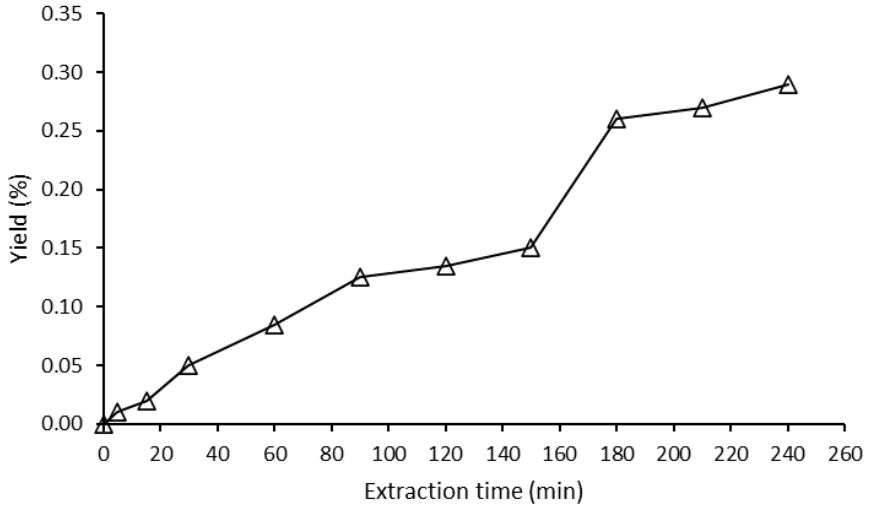

Figure 2. The effect of extraction time on yield of citronella oil

From Figure 2, it can be seen that the yield produced has an upward trend. Based on the experimental results, it is known that the increase in yield that occurs is due to the longer the contact of the solvent with the extracted sample, the more circulation occurs so that more oil is included in the solvent, so as to increase the percentage of yield obtained. In general, the longer the extraction time, the higher the yield obtained. However, the longer the extraction time, the smaller the increase in yield obtained [15].

CONCLUSION AND FURTHER RESEARCH

The results of this study revealed that citronella oil can be easily extracted using the hydrodistillation method. The extracted citronella part is the stem, with the aim of getting a better quantity and quality of citronella oil. In this study, the optimum yield of citronella oil was found at F/S ratio of 0.5 within 240 min with the highest yield percentage at 0.2900%. So it can be concluded that the mass of citronella and the time of extraction will affect the extraction of citronella oil using hydrodistillation method. To obtain better results of citronella oil, it is advisable to do further research on the modification of the distillation apparatus with the addition of a stirrer, then it can also provide variations on the size of the citronella material, for example with a size of 1 cm, 2 cm or 3 cm to see the effect of the size of the material on the yield of citronella oil produced.

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