World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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Evaluation of characteristics of cajuput oil by steam-hydro distillation (*Melaleuca leucadendra* L.)

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World Journal of Advanced Research and Reviews, 2023, 20(01), 176–180

Publication history: Received on 15 August 2023; revised on 01 October 2023; accepted on 03 October 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.20.1.1965

Abstract

Cajuput oil is one of the types of essential oil that is most widely used by the society. Cajuput oil is obtained through a distillation process. The aim of this study was to determine the characteristics of cajuput oil. The raw material used is fresh cajuput leaves and the distillation process carried out is the steam-hydro distillation method. The characteristic analysis seen in this research includes yield of oil, water content of cajuput leaves, refractive index and sensory of the aroma and color of cajuput oil. The results showed cajuput oil with a yield value of 0.6%, water content of cajuput leaves of 64.36%, refractive index value of 1.470, aroma of cajuput leaves, and yellow color of cajuput oil. The characteristic of cajuput oil in this research was meet the Indonesian National Standard of cajuput oil.

Keywords: Cajuput oil; Distillation; Essential oil; Steam-hydro method

1. Introduction

Essential oil is oil produced from several extraction processes that generally come from several parts of plants such as leaves, flowers, stems, seeds and roots [2]. One of Indonesia's commodities that has a large market is cajuput oil. In Indonesia, people generally use this oil as medicine used for household purposes to relieve flatulence, nausea, catch a cold and itch. Often this oil is also used for babies [9]. Some factors that affect the production process of cajuput oil are the variety of cajuput tree plants (*Melaleuca leucadendra* L.), the quality of the leaves and the techniques used to extract them overall. These factors will determine the quality and selling price of cajuput oil in the market, for that extraction techniques are needed that can increase the yield and quality of cajuput essential oil in Indonesia. The extraction process can be carried out in various ways such as extraction using solvents, extraction using oil, pressing and distillation.

Distillation is one of the most common methods of extracting essential oils for several reasons, namely: 1) a simple range of tools, 2) easy to handle, and 3) easy to operate. Distillation is a technique used to separate components based on the properties of liquids or solids from two or more types of mixtures based on differences in vapor or boiling points. The vapor points of two insoluble mixtures (water and oil) will separate automatically when the temperature of the boiling point of each component has been reached.

The distillation process is the main step in processing of production of essential oil. The distillation process is divided into several types, namely hydro distillation, steam-hydro distillation and steam distillation. Each distillation process has different effectiveness which will be adjusted to the raw materials used, including structure of plant, ingredients and the purity of the final product [6]. In this case, it is to pay attention to the nature of the plant parts to be extracted oil, the suitability of plant parts with the distillation technique used, and considerations from the economic side of the process. Based on the description above, the aim of this research is to evaluate the characteristics of cajuput essential oil (*Melaleuca leucadendra* L.) produced from the steam-hydro distillation process.

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2. Methods

2.1. Plant materials, chemicals and tools

This research was carried out at the Chemical Engineering Laboratory of the Department of Agro-Industrial Engineering, Faculty of Agricultural Technology, Bogor Agricultural University. In this study, the process of distillation of cajuput oil derived from leaf plant parts will be carried out. The material used is the leaves of cajuput plants that contain essential oils. The tools to be used are a series of distilled kettles, Florentine flasks, measuring cups, scales, knives, cutting boards, Erlenmeyer, Clevenger, condenser, oven, saucer and balance sheet. The stages of research include the process of essential oil production through the distillation process, analysis of yield, analysis of water content of cajuput leaves, analysis of refractive index, analysis of sensory of aroma and color of cajuput oil.

2.2. Steam-hydro distillation

Distillation is carried out by steam-hydro distillation or better known as the steaming system. Filling the distilled kettle with water as much as approximately 5 cm under the filter. The raw material, cajuput leaves that have been weighed is put into a kettle, then attached Florentine flask and flow water through the condenser. Heat the boiler fire with direct heat and wait for the oil to start dripping. Observations were made and recorded at the first condensate hatching. The length of distillation is calculated from the moment of the first droplet. Distillation is carried out for approximately 2-5 hours, then separated by pumpkins that have contained essential oils for analysis and calculation of the yield obtained.

$$\text{Yield} = \frac{\text{mass of essential oil obtained}}{\text{mass of dried sample used}}\ x\ 100\%$$

2.3. Analysis of water content

The water content analysis of cajuput leaves carried out in this research was an analysis using gravimetric methods using an oven drying machine. The sample was weighed approximately 2 g and made twice, coded A and B, then put into an aluminum dish that had been dried first in the oven and weighed. The cup containing the sample is dried in the oven at 100-105°C for approximately 4 hours, then put in a desiccator for 20 minutes. Once the sample weight is constant, the sample is weighed and the final weight is recorded.

2.4. Analysis of refractive index

Refractive index is one of the important characteristics in essential oil measurement, it will determine the quality and purity of essential oils. The refractive index is used to identify the presence of other compounds contained in essential oils, to determine their purity, and to analyze homogeneous binary ratios mixture of known components. Therefore, it will be an useful tools for a quick measure purity and quality [8]. Refractive index testing uses a refractometer by looking at the intersection point between light and dark light. The principle of the refractive index is that the higher the level of purity of the essential oil, the higher the refractive index value. Conversely, if the refractive index value obtained is low then there is a possibility of essential oils mixed with other ingredients so that the level of purity is reduced.

3. Result and discussion

Table 1 Analysis of the quality of cajuput oil by steam-hydro distillation

Parameter	Quality	Indonesian National Standard Number: 06-3954-2006
Yield (%)	0.6	-
Water content (%)	64.36	-
Refractive index	1.470	1.450-1.470
Odor	Aromatic cajuput leaves	Aromatic cajuput leaves
Color	Yellow	Clear to greenish-yellow

3.1. Yield

The yield is the amount of essential oil in volume weight, compared to the amount of raw materials used for distillation. The yield of cajuput oil is also influenced by the quality of the leaves used. Cajuput trees are ready to be harvested at three years of age, at this age the oil content has been maximized and a stable oil yield can be obtained [10]. In this research that has been carried out, the amount of raw materials used in the steam-hydro distillation process is 3,140 g or around 3 kg. The following is a series of distilled boilers in the steam-hydro distillation process in figure 1.

Figure 1 Distilled boilers for steam-hydro distillation

Distillation is carried out for approximately 3-4 hours starting when the first oil droplets drip. The volume weight obtained in the distillation process is 20 mL so that the percentage of yield obtained is 0.6%. This amount is lower than the average yield of cajuput oil in the previous study by [3] which was 1.25%, and by [4] which was 2.84%.

One of the factors affecting the performance of the distilled kettle is the layout design of the condenser connected to the distillate flask. At the time of this research, the tool used the latest steam-hydro distilled boiler design, where the condenser is located at the top of the boiler so that when volatile compounds evaporate upwards the possibility to drip back into the boiler is quite large. This causes the yield produced to show a not too high amount, because the amount of oil volume accommodated is only a small amount.

The yield of cajuput oil has a distinctive cajuput aroma and a deep yellow color. The concentrated color of the essential oil will be proportional to the higher the refractive index value. The following is a figure of cajuput oil produced from the steam-hydro distillation process at the time of this research in figure 2.

Figure 2 Yield of cajuput oil

Yield is a very important factor in the essential oil production process. The greater the yield produced in the essential oil distillation process, the higher the profit and shows the good market potential of the essential oil. So that in the essential oil distillation process, more attention must be paid to the distillation method and the design of the right tool that is adapted to the type of raw material so that it can produce high yields. The composition of the essential oil affected by the type of plant, where it grows and where it grows [7]. For this reason, a good quality yield will also be indicated by a good composition of essential oil.

3.2. Water Content

The water content of cajuput oil in this research uses the gravimetric method. Drying cajuput leaves using an oven at temperatures ranging from 100-105°C. The samples used were made in duplicate and the water content was calculated based on the wet weight of the material. The water content value obtained from the average duplo sample was 64.36%. The water content value obtained in this research is higher than the water content in the research by [5] namely 60.3%. The water content in cajuput leaves has the potential to influence the yield obtained

3.3. Refractive Index

Refractive index is one of the important factors in the characteristic parameters of essential oils. Refractive index is a measurement that shows the point of intersection or refraction of light between oil and air. The refractive index obtained in this research was tested on two samples, namely commercial cajuput oil, cajuput oil resulting from steam-hydro distillation.

For commercial cajuput oil, a value of 1,460 was obtained, for cajuput oil resulting from steam-hydro distillation, a value was obtained for 1,470. The two samples tested for refractive index values met the Indonesian National Standard number 06-3954-2006, with values ranging from 1,450-1,470. The results obtained during the research were also comparable to the results of research by [1] which is 1,463. The large refractive index value is also influenced by the components that make up the essential oil, the more long-chain components and oxygen-ridden components that are extracted, the density of the essential oil medium will increase so that the light passing through the oil will be more difficult to refract. Another possible factor that causes the refractive index value of cajuput oil to be low is the presence of other ingredients such as minerals and oils so that light is more difficult to refract.

4. Conclusion

Based on the results of this research, the distillation method used for extraction the cajuput oil is steam-hydro distillation using a laboratory scale steam distilled kettle. The yield obtained was 0.6% with a distinctive cajuput leaves aroma and a deep yellow color. The analysis has been carried out and obtained results with a water content value of cajuput leaves was 64.36%, and a refractive index of 1.470. When compared with the quality of cajuput oil according to Indonesian National Standard number 06-3954-2006 for several parameters such as color and refractive index, it was meet the requirements.

Compliance with ethical standards

Acknowledgments

Thank you to Andalas University for making it possible to publish this review article.

Disclosure of conflict of interest

The authors state that there are no conflicts of interest in the publication of this article.

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