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Effect of Distillation Duration on Patchouli Oil Utilizing Steam and Water Techniques

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Abstract. Patchouli oil is derived through distillation. This study sought to assess the impact of distillation duration on the output and quality of patchouli oil through steam and water distillation methods. This study employed a fully randomized design with treatments based on distillation length, incorporating four replications. The treatments in this study consisted of distillation times of 4 hours, 6 hours, 8 hours, and 10 hours. The variables in this study are yield, specific gravity, refractive index, and acid number. Statistical analysis was conducted using analysis of variance (ANOVA), subsequently followed by Duncan's Multiple Range Test (DMRT) at the 5% significance level. The research findings indicate that distillation time significantly influences yield, specific gravity, refractive index, and acid number. The alcohol concentration of patchouli oil exceeds 30%. The chosen treatments from this study include a distillation duration of 10 hours, yielding yellow-brown patchouli oil with a 2.23% yield, a specific gravity of 0.973, a refractive index of 1.514, an acid number of 0.5439, and 36.68% patchouli alcohol.

1. Introduction

Indonesia is the largest producer of essential oils globally, and 70% of the world's oil needs are exported from Indonesia. One of the essential oil-producing plant is patchouli. Patchouli plants are spread in several regions in Indonesia, specially located in West Sumatra, precisely in the Batusangkar area, Tanah Datar Regency. The patchouli plant in Batusangkar is a type of Acehnese patchouli (Pogostemon cablin Benth.). Patchouli oil distillation in Indonesia is known in several ways: water distillation, steam distillation, and steam and water distillation [1].

The principle of distillation using steam and water is that patchouli is distilled separately with water. The principle of distillation using steam and water has a co-op system where the water that comes out of the separator is flowed back into the distillation boiler to minimize water loss [2]. Steam and water distillation produces stable steam because of constant steam pressure, which is generally advantageous because the quality and yield produced are the same as direct steam distillation and use in steam and water distillation equipment is easier and more economical [3].

Most farmers who carry out distillation do not pay attention to the condition of the treatment of raw materials, the distillation tools used, and the method of distillation. This can decrease the yield and quality of patchouli oil [4]. In order to fulfil the quality requirements for the oil that is being sold, it is essential to enhance both the quantity and the quality of the patchouli oil. The length of distillation affects the yield and quality of patchouli oil [5].

Generally, the distilled patchouli plant is the leaf part, because the yield produced in the leaf part is more than in other patchouli plants [6]. The duration of the distillation process influences the quantity and quality of patchouli oil. The longer the refining of patchouli oil is carried out, the yield of the patchouli oil obtained increases, and the quality obtained is good, but each ingredient has an optimal time limit where if the oil is distilled for too long, it will cause the quality contained in the oil to be damaged [7]. The length of the distillation duration is essential

because this process will affect the quality and yield of the patchouli oil produced so that it gets a higher profit value [5].

2. Research Methods

The research was carried out at IP2TP IACRI Laing Solok, West Sumatra. Agricultural Product Analysis Laboratory, Faculty of Agriculture, University of Riau, Pekanbaru, and Biotechnology Laboratory, Faculty of Animal Husbandry, Andalas University, Padang.

The material used in this research is dried patchouli leaves, the sample of which was obtained from a patchouli plantation owned by a patchouli farmer in the Batusangkar area, Tanah Datar Regency. The materials used for the analysis are acetone, ethanol 95%, alcohol 96%, phenolphthalein, KOH and aquadest.

Tools used in the initial treatment are knife, container, and burlap materials. The tools used in the study were steam and water distillation devices consisting of gas cylinders, stoves, distillation boiler separators, boiler covers, condensers, oil droplets, separators, condensates, and dark glass bottles. The instruments used for the analysis are measuring cups, test tube racks, drop-pipettes, erlemeyers, test tubes, analytical scales, micrometers, refractometers, burettes, alcohol meters, and Gas Chromatography-Mass Spectrometry (GC-MS).

The research was conducted using a steam and water distillation method, using a complete random design (RAL) with four treatments and four replicates, so that 16 experimental units were obtained. The treatment in this study is the duration of distillation on patchouli leaves:

W1 = Distillation duration of patchouli leaves: 4 hours
W2 = Distillation duration of patchouli leaves: 6 hours
W3 = Distillation duration of patchouli leaves: 8 hours
W4 = Distillation duration of patchouli leaves: 10 hours

The parameters in this research are yield, specific gravity, refractive index, and acid number. Patchouli Alcohol is calculated using GCMS, and color analysis using descriptive analysis. Data obtained from the observation results are analyzed statistically using analysis of variance (ANOVA). If Fcal ≥ Ftable, the next test is carried out by Duncan's Multiple Test (DMRT) at the level of 5%.

3. Results and Discussion

3.1 Yield

Yield is a comparison between the oil produced and the refined plant material. The study results indicated that varying distillation times of patchouli leaves significantly influenced the output of patchouli oil.. The yield produced ranged from 1.53-2.23%. The highest yield of patchouli oil was found in the W4 treatment. The yield in patchouli oil tends to increase with each increase in hours. The longer the patchouli leaf distillation is carried out, the more the yield of patchouli oil is produced. This is because the time of contact of water vapor in the distillation with the material is longer, and the evaporated oil increases. The yield of patchouli oil increases with the increase in distillation time; the increase is because the longer the distillation, the more heat and moisture are received by the patchouli so that the more patchouli oil compounds are evaporated [1]

3.2 Specific gravity

Specific gravity is the ratio of the weight of a sample to the weight of an equal volume of water at the same temperature. The weight of the type of patchouli oil obtained in the study ranged from 0.950–0.957. During the distillation process, the material's content evaporates so that the weight of the patchouli oil type increases. Found that the longer the warming process lasts, the more water evaporates [6]. The distilled patchouli oil will be separated according to its specific gravity. Oil and water are separated by a difference in specific gravity, where water's weight is heavier than oil's.

3.3 Refractive index

The refractive index was measured to ascertain the purity degree of patchouli oil.. The longer the leaves is distilled, the resulting refractive index increases. The results of the color test showed that the darker the color of the patchouli oil produced, the higher the refractive index value. The darker the color produced, the harder it is for light to penetrate the oil, thus increasing the refractive index result.

Color is difficult to refract because the speed of light entering a dense medium is smaller than that of light entering a less dense medium [5]. In a 10-hour distillation that has a darker color, the yield is higher than in a 4-hour distillation with a lighter oil color. The main compound of patchouli oil is patchouli alcohol, where this compound also influences the value of the refractive index; the higher the level of patchouli alcohol, the higher the refractive index value will increase [3].

3.4 Acid number

An increase in the number of acids in patchouli oil can change the quality and distinctive aroma of the oil. The number of acids increases as the distillation takes longer. The number of acids increases as the distillation time increases. Stated that the higher the number of acids, the more free fatty acids are contained in patchouli oil [5]. This can be seen from the color obtained from the refining of patchouli oil.

The length of the distillation time causes free fatty acids to be high, so the darker the patchouli oil color, the greater the amount of acid obtained [6]. A higher number of acids can affect the quality of patchouli oil, such as these compounds can change the distinctive color and aroma. This change was caused by the length of the distillation time and the contact between the patchouli oil produced and the air when the oil was stored.

The increase in the number of acids can affect the quality of the oil; namely, the color of the oil will change, and the aroma produced will be more robust. Acid numbers with values below 5 are relatively difficult to become rancid [8]. In this study, the acid number increased with each increase in the hour in the W1 treatment for 4 hours of distillation time, obtained an acid number result of 0.540, and then increase in the W4 treatment for 10 hours of refining time obtained an acid number result of 2.292.

Table 1 presents the research findings on the yield, specific gravity, refractive index, acid number, and patchouli alcohol content of patchouli during the distillation of patchouli oil.

Table 1. Results of a lengthy study on the time of distillation of patchouli oil.

Observation	SNI	Treatment			
		W1	W2	W3	W4
Rendemen	-	1,53%	2,11%	2,14%	2,23%
Specific gravity	0,950–0,975	0,950	0,955	0,955	0,957
Refractive index	1,507–1,515	1,507	1,512	1,513	1,514
Acid number	Mak. 8	0,540	0,957	1,280	2,292
Patchauli Alcohol	Min. 30%	32,37%	33,67%	34,57%	36,68%

3.5 Patchauli Alcohol

Patchouli alcohol in patchouli oil is the main compound of patchouli oil. The determination of the level of patchouli alcohol is the main requirement for the quality of patchouli oil. Gas Chromatography Mass Spectrometry (GC-MS) with type GC-MS QP2010 PLUS is a combination of gas chromatography and mass spectrometry. Stated that gas chromatography is performed to identify volatile compounds under high vacuum conditions and low pressure at heating[9]. While mass spectrometry determines molecular weights, molecular formulas, and produces charged molecules. The area (peak point) indicates the high or low concentration of a compound in the sample based on the area being measured. The graph peak in GC-MS is located at the end of the chromatogram, showing the results of the identified component or compound during retention

time. Retention time is a specific number of the interaction mass between compound molecules in the chromatography column [10]. Concentration indicates the purity of the analyzed results.

In this study, the time variation in patchouli oil distillation was 4 hours, 6 hours, 8 hours, and 10 hours. The addition of patchouli oil distillation time is known to affect the yield of patchouli alcohol in patchouli oil. The determination of patchouli alcohol in patchouli oil can be seen from the compounds produced from the GC-MS analysis table. The compound referred to is patchouli alcohol, which is the compound that has the highest levels in patchouli oil, by adding up the area (peak point) at each occurrence of the compound [11].

The results of determining the alcohol patchouli level from two methods, namely alcohol meter and GC-MS, do not look much different. The alcohol meter method is used on a laboratory scale or in household industries because the cost required is small, while the analysis using GC-MS is not only used in GC-MS laboratories but also in large industries [12]. Of course, the cost incurred to analyze oil samples is quite large.

Table 2. Alcohol patchouli values using GC-MS

Treatment	PA (%)
W1 = Distillation duration of patchouli leaves: 4 hours	32,37
W2 = Distillation duration of patchouli leaves: 6 hours	33,67
W3 = Distillation duration of patchouli leaves: 8 hours	34,57
W4 = Distillation duration of patchouli leaves: 10 hours	36,68

3.1 Colour

The hue of patchouli oil is assessed visually from a distance of 30 cm. The color results of patchouli oil can be seen in Figure 1. Research shows that the results of patchouli oil obtained are light yellow to brownish-yellow, depending on the length of time the patchouli oil is refined.

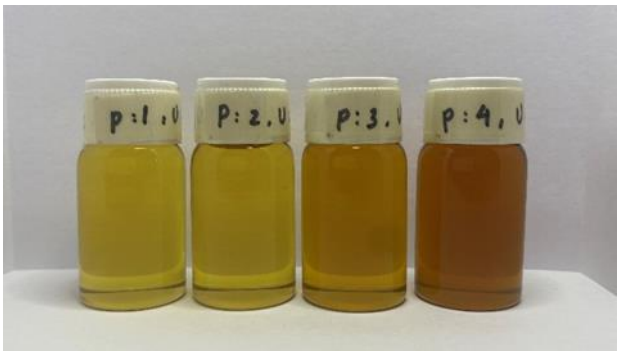

Figure 1. The color of patchouli oil in each distillation.

The longer distillation time causes the color to change to darker, which is caused by the length of distillation time and the prolonged contact of patchouli with hot steam[5]. Patchouli oil generally contains hydrocarbon compounds such as terpenes, sesquiterpenes, and oxygenated hydrocarbon compounds. Heat contact in patchouli oil distillation causes the carbon chain length of organic compounds to increase in length like hydrocarbons and experience an increase in the number of double bonds in patchouli oil, increasing the oil density, thus making the patchouli oil pigment darker [3].

4. Conclusions

This study's results indicate that extending the refining duration of patchouli oil influences both its production and quality. The study results indicate that the yield of patchouli oil increases with each additional hour of distillation, resulting in a larger yield with prolonged distillation duration. The selected treatment from this study was distillation duration of patchouli leaves: 10 hours, This yielded patchouli oil of a brownish-yellow hue, yield of 2.23%, specific

weight of 0.957, refractive index of 1.514, acid number 2.29, and alcohol patchouli content of 36.50% using alcohol meter, and 36.68% using GC-MS.

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