Survey and study on yield and quality of patchouli oil in Aceh Barat Daya District, Indonesia based on original area of raw materials, methods and length of distilation

Arpi N, Cut Erika and Dewi Ermaya

Department of Agricultural Product Technology, Syiah Kuala University, Banda Aceh, Indonesia. Corresponding Author: lina_arpi@yahoo.com

Abstract. Patchouli oil from patchouli plant (*Pogostemon cablin* Benth) is one of important essential oils as a source of Indonesian foreign exchange. It is about 90% of world patchouli oil from Indonesia (Suara Merdeka, 2006). The objectives of this research were to assess the yield and quality of patchouli oils from four different villages in the sub district of Kuala Batee, Aceh Barat Daya based on the original area of raw material and the method of distillation, also based on length of distillation. The nested design was used in this research with the treatment of two factors combination, with the level of one factor similar but not identical. The treatments were the original area of raw material and the distillation method used in the original area of the raw material (BM1-4), and the length of distillation (5, 6, and 7 hours). Parameter observed were yield, specific gravity, refractive index, alcohol solubility, the concentration of patchouli alcohol, ester number, acid number, and the sensory test on color and clarity. The results indicated that the original area of raw material and distillation method (BM) had a significant effect on yield, refractive index, clarity, and acid number. The yield was 2.85%-4.5%, and patchouli oil from BM4 and BM2 gave higher yield but lower patchouli alcohol concentration, and clarity. The results also indicated that the longer time of distillation the higher patchouli oil yield, specific gravity, and patchouli alcohol concentration. However, it affected the lower alcohol solubility and clarity, the higher ester number, and the darker color of the patchouli oil. The concentration of patchouli alcohol in this study ranges from 21.36% to 34.03%. Patchouli oil yielded in this research have complied the SNI 06-2385-2006.

Key words: yield, quality, patchouli oil, patchouli alcohol**.**

Introduction

Patchouli oil from the plant (*Pogostemon cablin* Benth) is one of the important resources which contribute greatly to Indonesian foreign exchange reserve. Approximately 90% of world's patchouli oil is produced in Indonesia (Suara Merdeka, 2006). Indonesian patchouli's field in total take up to 16639 ha, recorded in 2004, and produced 2424 ton of patchouli oil. Patchouli oil industry Indonesia, especially the patchouli oil industry from Aceh, has contributed up to 70% of Indonesian patchouli oil production, equivalent to 1696.8 ton/year from 2876 ha wide of field (Ditjenbun, 2005).

Patchouli world market developments nowadays has started to reach stalemate, since the world's patchouli demand of 2300-2400 tons/year can already be met by some patchouli producer countries. Other common constraints in patchouli agribusiness are the low level of concentration of the produced patchouli oil, low oil quality and homogeneity of oil, unsteady supply of product, and the fluctuation in product's price (Satriana, 2008).

Preliminary survey in four villages in the district of Kuala Batee, Southwest Aceh, shows that the distillation process in each distillation plant from the four villages are different. This is due to the different distillation method and tools used, as well as different raw materials sourced from different areas. Aceh's patchoulis produce high concentration of oil which varies from 2.5-5%. In addition, the distillation time is determined based on whether or not there is still oil to be distilled. Distillation is stopped whenever the distilled liquid coming out of the instrument does not contain oil anymore. It is expected that the distillates will also vary, thus affecting the yield and quality of the distillates. The yield obtained from the distillation plants of the sample village on average is 2.8% or 0.56 kg of oil for every 20 kg distilled raw material. The produced patchouli oil generally has brownish color.

The research is aimed to assess yield and quality of patchouli oil from 4 (four) different villages in Kuala Batee sub district, Aceh Barat Daya based on various raw materials, methods, and length of distillation time.

Materials and Methods

Raw material

Leaves, stems, and branches (twigs) of patchouli plant cv. Aceh (*Pogostemon cablin*) was obtained from Aceh province. Water source was supplied from each village where the experiment was conducted.

Chemicals

Aquadest, khloroform, acetic acid, potassium iodide, sodium thiosulphate 0.1 N, alcohol 95 %, KOH 0.1 N, HCl 0.5 N, starch, and phenolphthalein.

Distillation process

The raw materials, patchouli leaves, twigs, and stems are dried until the moisture content reach ± 14% (± 3 days). Then the material is cut into pieces with a machete (knife) with a length of ± 5 cm. 20 kg of dried patchouli materials which have been cut into pieces (per unit of nested trial) is put into the refiner kettle and treated with appropriate distillation treatment time according to W1, W2 and W3. Distillation is carried out continuously with a pressure of ± 1 atm. after W1 is reached (5 hours) the product is taken and the distillation is continued for W2 and W3.The product of distillation, which are the refined patchouli oil and water are stored in the reservoir container, and patchouli oil is separated. Some of patchouli oil that has been distilled for 5 hours are taken and used as a sample for W1. The rest of W1 is mixed with the distilled product of W2 and used as W2. The mix of W1 and W2 is then mixed with distilled product of W3 and used as sample of W3. Next, the patchouli oil's yield is calculated and physical and chemical analysis as well as organoleptic test (sensory analysis) is conducted.

Analytical methods

Yield was calculated and is made to satisfy the Indonesian national standard (SNI 06-2385, 2006). The specific gravity, refractive index, ethanol solubility, GC-MS method, ester and acid number were also measured and compared with the standard of SNI 06-2385, 2006. Whereas sensory test on color and clarity analysis was determined using sensory test method adapted from Soekarto, 1985.

Experimental design

The nested design was used in this research with the treatment of two factors combination, with the level of one factor similar but not identical. The first treatment factor is the original area of raw material (B) with distillation method nested in the original area of raw material (BM), and the second factor is the length of distillation (W) nested on each distillation method. The first factor, BM consist of 4 levels which is the original area of raw material and distillation method Jeumpa village (BM1), Krueng Panto village (BM2), Gudang village (BM3), and Blang Panyang village (BM4). The second factor, W consists of three levels which are W1 = 5 hours starting from the time when the water evaporates, W2 = 6 hours, and W3 = up until there is no more oil to be distilled (± 7 hours). The analysis is repeated two times, so there are 4x3x2 = 24 experimental units. The distillation method are, M1= distillation method using water and vapor in a kettle, with flowing cooling water, M2= vapor method, with cooling water in a stagnant (not flowing) tub, M3 = water and vapor method, with cooling water in a stagnant tub, and M4 = vapor method, with flowing cooling water.

Result and Discussion

The yield of patchouli oil ranges from 2.85% -4.5%, with a general average value of 3.73%. High yield of patchouli oil (3.95%) comes from the village of Blang Panyang (BM4) and from the village of Krueng Panto (BM2), whereas that of a village Jeumpa (BM1= 3.71%) and Gudang village (BM3 =3.29%) has lower yield ($P \leq 0.05$) (Figure1). The yield of patchouli oil increased with increasing distillation time ($P \leq 0.5\%$), which are 3.31%, 3.71% and 4.15% for 5, 6, and ± 7 hours of distillation respectively (Figure 2). This is because the longer the distillation is, the more heat is received by the material to vaporize the oil fraction which is difficult to be vaporized before. Patchouli oil fraction which is hard to be evaporated is expected to have higher boiling point.The yield of patchouli oil in this research range 3.31% - 4.15% indicating the yield agrees with the reference, which is 2.5 - 5% (Suyono, 2001).

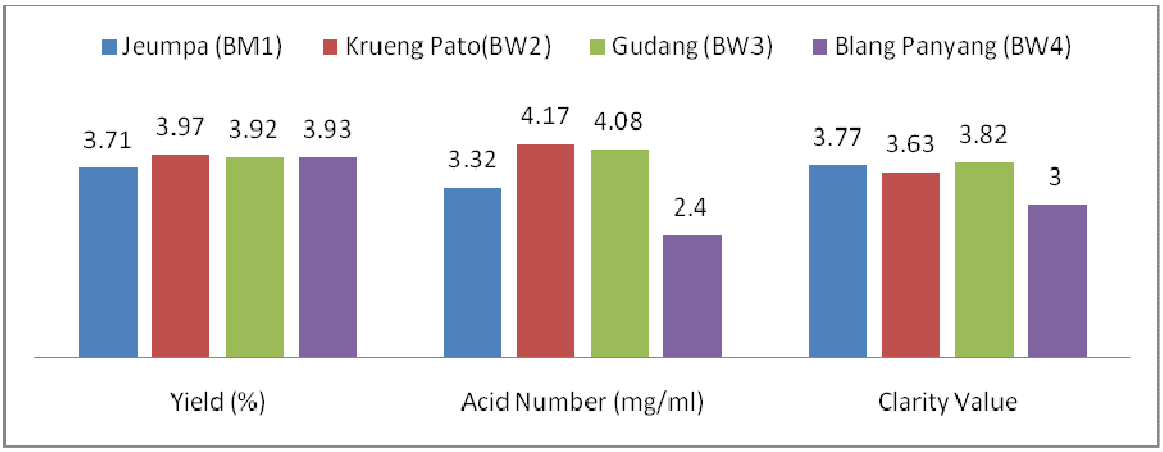

Figure 1. Yield, acid number, and clarity value of Patchouli oil from four different villages.

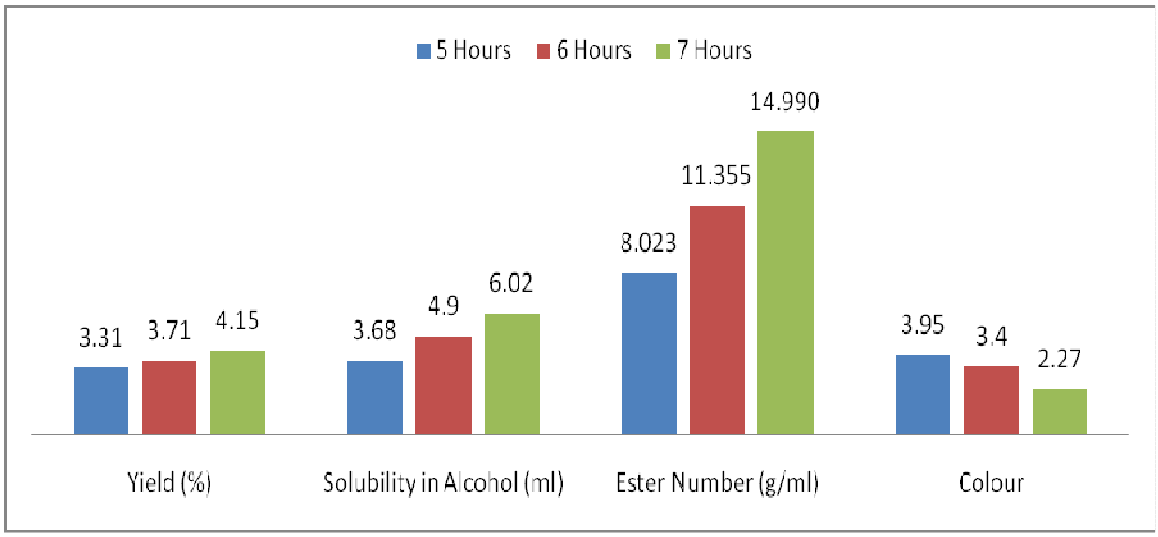

Figure 2. The effect of distillation length towards yield, solubility in alcohol, ester number, and colour of Patchouli oil.

Figure 3 indicated that the longer the distillation time is the higher (P≤0.05) specific gravity of the patchouli oil will be(0.939-0.955). It is expected that the longer the time and the higher temperature of distillation is the more patchouli oil component with high specific gravity will vaporize. Specific gravity is influenced by constituent of essential oil which is influenced by the nutrients in the soil where the plant grows. Patchouli oil with high specific gravity has high weight fraction of patchouli oil, which usualy contain more oxygenated terpene component. However, according to Ginting (2004), the increases of specific gravity is due to the long distillation time. This causes polymerization of chemical components with high boiling point, which is the patchouli alcohol, in patchouli oil, thus causing the purity of patchouli oil to decrease caused by the formation of higher molecular weight polymers.
The refractive index of each treatment ranges between 1.5010 - 1.5056 (Figure 4). Compared to Indonesian National Standard of patchouli oil, refraction index found in this study were lower and does not satisfy the SNI 06-2386-2006 standard of 1.507 – 1.515. Refractive index of essential oil is strongly related to the composition of the oil; however the composition depends on the nutrients contained in the soil. Just like the specific gravity, the composition of the essential oil affects the refractive index of the oil. The more long chained components such as sesquiterpene or oxygenated components being distilled the higher medium density of the essential oil will be, thus it becomes difficult for light to be refracted and lead to higher refractive index of the essential oil. Patchouli oil with high refractive index has better quality than the lower counterpart.

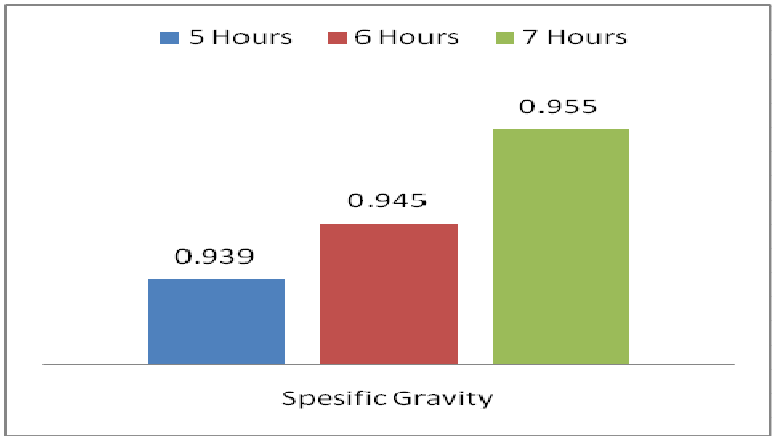

Figure 3. Spesific gravity of Patchouli oil influenced by distillation length.

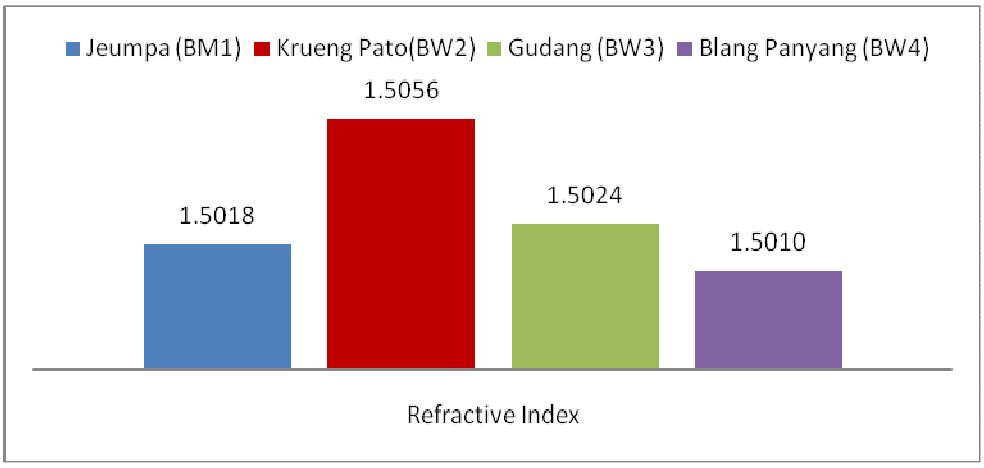

Figure 4. Refractive index of Patchouli oil from four different villages.

The solubility of patchouli oil in 90% ethanol with different distillation time (W) varies from 3.68 to 6.02 ml. Figure 2 showed that the fastest solubility rate was obtained at the treatment of 5 hours-distillation time (3.68 ml ethanol was used to dissolve 1 mL patchouli oil). The longer distillation time is the more ethanol quantity needed to dissolve the patchouli oil ($P \leq 0.05$). This is due to chemical component in patchouli oil is polimerized due to increase of temperature during distillation. Moreover the solubility of essential patchouli oil in ethanol is determined by the amount of terpene and oxygenated terpene. Essential oil with a lot of oxygenated terpene compound has lower solubility in ethanol. While on the other hand, essential oil with more oxygenated terpene compound in its composition is easier to dissolve in ethanol.

Quality of patchouli oil is influenced by its patchouli alcohol compound. The higher the patchouli alcohol concentration is the better the oil quality will be. Patchouli alcohol concentration level which is determined by using *Gas Chromatography-Mass Spectrometry* (GC-MS) shows that patchouli oil produced using the raw material from Krueng Panto which has been distilled using vapor method, with stagnant cooling water in a tub, and distillation time of 5 hours (BM_2W_1), contains 21.36% of patchouli alcohol compound as its main composition while the other 72.511% are non-patchouli alcohol compound. However when the distillation time is increased to 7 hours (BM_2W_3), the patchouli alcohol compound in the oil also rose to 28.11%.

Patchouli oil coming from Jeumpa village which has been distilled using water and vapor method, with condenser in flowing water, and distillation time of 7 hours (BM_1W_3) has higher composition of patchouli alcohol compound that reach up to 34.03%. Patchouli alcohol concentration does not only depend on the raw material source, but also the time used for distillation process. The longer the distillation is conducted the higher the temperature inside the distillation kettle, thus increasing patchouli alcohol concentration in

the oil. This is due to the high boiling point of patchouli alcohol fraction, thus it will only vaporizes at high temperature.

The ester number increases along with the increase in distillation time (P≤0.05). Figure 2 shows that ester number range from 8.023 – 14.990 g/ml which still fit the quality criteria of SNI 06-2385-2006 that state the maximum ester number of 20 g/ml. With a longer distillation time there will be more chemical compound with high boiling point inside the patchouli's leaf that get polymerized, thus resulting in higher ester number, darker oil's color, and lower oil's quality.

There are differences in patchouli oil's acid number due to the difference in the source of the raw materials and methods of distillation used between each treatment site. Acid numbers of the oil from each of the different sources and methods of distillation ranges from 2.40 to 4.17 mg/ml, which still satisfy the quality requirements of SNI 06-2385-2006 that states the maximum number of 8 mg/ml. Patchouli oil acid number which the raw material comes from Jeumpa village (BM1) and the Blang Panyang village (BM4) were lower (P ≤ 0.05) than the two other villages. Essential oils contain small amounts of organic acids that formed naturally or are produced from the oxidation and hydrolysis of esters (Ketaren, 1985). In addition, according to Guenther (1970), patchouli leaves that are dried and protected from air and light have a relatively low number of free acids. Since during the drying process of the leaves the organic acids present in the leaves are evaporated.

The results of the research show that the distillation time gives a significant influence (p≥0.01) to the color of patchouli oil. The highest color number is found in the patchouli oil that has been distilled for 5 hours is with color number found as 3.9 which tends to show dark yellowish color, while the lowest one is the one that has been distilled for 7 hours, which gives 2.2 color number and with light brown color. This is presumably due to the long distillation time, which increases the content of weight fraction of patchouli oil, which in turn causes the color to darken. In addition, the changes in color also occur due to the rise in temperatures as the length of distillation time increases, causing the oil that is close to the wall of the kettle become easily damaged. The color of patchouli oil found in this research is yellow to light brown color which is still within the range of SNI 06-2385-2006 quality requirement of yellow to reddish brown patchouli oil's color.

Patchouli oil with high clarity value is obtained from the oil produced in Jeumpa village (BM1) and Gudang village (BM3) by using water and vapor distillation methods (Figure 1). This value is higher than the clarity value of patchouli oil obtained from the village of Blang Panyang (BM4) which use vapor distillation method. Clarity of patchouli oil is also influenced by the time used for distillation, the longer the distillation process is the less clear the color of the oil produced (Figure 2).

Conclusions

The source of raw materials and distillation method used(vapor versus water and vapor, condenser in a stagnant water bath or inside flowing water) will affect the yield, refractive index, patchouli alcohol content, acid number, and the clarity of the patchouli oil produced. Patchouli oil produced in general has yield range from 2.85% -4.5%, refractive index of 1.5010-1.5056, and acid number of 2.40 to 4.17 g/ml.

The longer the time used for the distillation process is, the higher the yield of patchouli oil, the higher the specific gravity (reach up to 0.955), and the higher the patchouli alcohol concentration is (34.03%). On the other hand, the lower the solubility of patchouli oil in alcohol, the less clear, the higher the ester number (14 990 g / ml), and the darker the color of the produced patchouli oil will be.

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