Characterization of patchouli oil (*Pogostemon cablin* Benth) production of Tinombala Village, Ongka Malino District, Parigi Moutong Regency

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**Abstract.** Patchouli oil comes from Tinombala village which has never been tested for the Indonesian National Standard (SNI). The purpose of this study was to determine the quality of patchouli oil by characterizing parameters of physical and chemical properties including color, refractive index, specific gravity, solubility in alcohol, acid number, ester number, iron content (Fe), and patchouli alcohol and alpha copaene content. Sampling was done by random sampling. The results show a specific gravity of 25/25oC sample A = 0.9564, B = 0.9658, and C = 0.9590, refractive index (nD20) sample A = 1.5111, B = 1.5085 and C = 1.5086, the solubility in alcohol using ethanol of the three samples is >1:10 while using methanol 1:10, the acid number of the sample A=21.0375, B=9.1162 and C=19.6350, the ester number of the sample A=28 ,05, B=21.04 and C=21.04, iron (Fe) content of sample A=1.84210 mg/L, B=0.186842 mg/L and C=6.78950 mg/L, patchouli content alcohol sample A=,16,96%, B=15,52% and C=14,55% and for alpha copaene not detected. The results showed that the quality of patchouli oil in Tinombala village did not meet the Indonesian National Standard (SNI). Only the specific gravity, refractive index, and iron content are by the quality requirements, while the acid number and ester number and the main component determining the quality of patchouli oil, namely the patchouli alcohol content are still below the Indonesian National Standard, which is below 30%.

1. **Introduction**

Patchouli oil production in Indonesia is one of the largest foreign exchange earners when compared to other essential oils. About 80% of the world’s patchouli oil demand is provided by Indonesia [1]. So that the development of patchouli cultivation as a staple for patchouli oil production, has a very good opportunity and potential to help increase farmers' income if it meets its quality standards, it is known that the demand for patchouli oil in the territory of Indonesia continues to increase along with the increasing demand for patchouli oil in the world market. In addition, the prospects for the patchouli oil market in the country are also getting better and have quite a promising world market opportunities [2]. This is driven by the growing demand in various aspects such as the cosmetic and fragrance industry [3].

Patchouli oil has many uses including being used as an important raw material in the chemical field and becoming a much sought after commodity because it contains a chemical compound, namely patchouli oil. The main benefit of patchouli oil is as a fixative or binder in various industries, including in the fields of soap, perfume, cosmetics, aromatherapy because it has a distinctive odor and is often used as a mixture for making drugs [4]. In addition, it is widely used as raw material and
admixture in antiseptics, perfumes, pharmaceuticals, chemicals, insecticides, and aromatherapy treatments [5]. Patchouli oil is also commonly used for preserving goods, food, giving aroma household products, as a mixture, toothpaste, deodorant, lotion as well as other basic industrial needs [6].

According to [3] patchouli cultivation in Indonesia has spread widely in several areas including Aceh, North Sumatra, West Sumatra, Bengkulu, South Sumatra, West Java, Central Java, and East Java. Some areas also began to develop patchouli such as South Sulawesi, East Kalimantan, Central Kalimantan and Central Sulawesi. With the largest distribution of this plant, automatically in Indonesia there are many patchouli oil processing industries, both small and medium scale industries to support market demand, although the demand for patchouli oil continues to increase along with the increasing demand for patchouli oil in the world market, but in terms of quality. Patchouli oil produced in Indonesia has not changed much due to many factors and constraints in the industry such as there are still many farmers who do not know the quality standards of patchouli oil, low productivity, yields and oil quality that are still below standard, patchouli oil processing techniques are still relatively simple, in addition to the low quality of plant seeds, cultivation methods that are still simple and vary from region to region, the development of various diseases, using simple equipment and handling of production results that have not been maximized so that this affects the low selling price of patchouli oil in Indonesia. Patchouli oil with better quality has a higher price when compared to patchouli oil with poor quality, the main component of patchouli oil that affects the quality of patchouli oil is the high content of patchouli alcohol (C15H26O) in patchouli oil meaning that the better the characteristics of patchouli oil produced.

According to Rahman et al. [7], Central Sulawesi Province is one of the areas that in recent years has become interested in developing patchouli commodity and has become one of the leading crops for farmers because it has a fairly good selling value. Based on data from Indonesian Plantation Statistics in 2018 in Central Sulawesi, the patchouli plant area reached 1,584 ha with the total productivity of patchouli reaching 257 kg/ha. Central Sulawesi has the largest planted area on the island of Sulawesi, when compared to other Sulawesi provinces. Parigi Moutong Regency is one of the regencies in Central Sulawesi that produces patchouli oil, precisely in Ongka Malino District. Based on data from Indonesian Plantation Statistics in 2016 in Parigi Moutong Regency, the total productivity of patchouli plants can reach 400 kg/Ha [8]. This is evidenced by the presence of a large number of patchouli oil refining home factories in Tinombala village and almost all farmers grow patchouli. However, the patchouli oil processing process developed by patchouli farmers in Tinombala village still applies a simple cultivation technology, namely the Boiled System method (Water Distillation) using an iron plate which is modified again according to the needs of distillation, farmers do not pay attention to the quality of the tools used in the distillation process. , many farmers have limitations in the field of knowledge of patchouli oil refining, farmers do not know the basic characteristics of patchouli oil which is an important subject of oil that can be traded at relatively expensive prices, farmers have never been given counseling by the Oil Supervisory Agency. In addition, the low production and high costs of refining patchouli oil and the processing process are still far from SNI processing standards and the price of patchouli oil in Tinombala village is still relatively cheap when compared to patchouli oil on the market.

Conducted a study on the effect of fractional distillation temperature range on patchouli alcohol content in patchouli oil [3]. Conducted a study on the effect of the fractional distillation on an increment of patchouli alcohol content in patchouli oil [9]. Conducted research on Applying system dynamics for predicting the strengths, weaknesses, opportunities, and threats of patchouli oil agroindustry in West Sumatra, based on the simulation results, there are six strengths, six weaknesses, two opportunities, and three threats of patchouli oil agroindustry forces in West Sumatra The differences in this study are based on location, time and conditions which are known to vary from region to region [10]. Although many have described this type of research, this location is the type of research that is needed to find out initial information about the quality of patchouli oil produced. This is because patchouli oil refining still uses traditional methods and there are many productivity problems.
So that special attention is needed to increase the production of patchouli distillation in the village with the initial step of conducting a scientific study on the purity and quality of patchouli oil with the aim of the study being to determine the main characteristics of patchouli oil produced by the village of Tinombala, because previously there was no information that could describe the actual quality. From patchouli oil, which is the basic capital as a reference for determining the economic price of patchouli oil in the national and world markets [7].

2. Materials and Methods

2.1 The Tools and materials

Equipment used in this study included a pycnometer, 100 mL measuring cup, 50 mL beaker, 50 mL erlenmeyer, refractometer, polarimeter, boiling stone, electric bath, analytical balance, a set of tools for Gas Chromatography Mass Spectrometry (GC-MS) brand Thermo Scientific Trace 1310 Gas Chromatography-MS, a set of tools for Gas Chromatography Mass Spectrometry (GC-MS) brand Thermo Scientific Trace 1310 Gas Chromatography-MS.

The chemicals used include ethanol, methanol, diethyl ether, KOH, HCl and phenolphthalein indicator solution, ferroammonium sulfate, acetone, silver nitrate (AgNO₃), iron (III) chloride tetrahydrate (FeCl₃.4H₂O), sodium chloride (NaCl), chloroform and nitric acid (HNO₃).

2.2 Data Collection

![Diagram of data collection process]

Figure 1. Collection scheme for patchouli oil refining industry players and patchouli oil sampling

2.3 Data analysis

Data analysis was based on the 2006 Indonesian National Standard [11].

2.3.1 The color

20 mL of patchouli oil sample was put into a test tube, the test tube was propped up on white paper or cardboard, then the color of the oil was observed with an eye distance of ± 30 cm.
2.3.2 Specific Gravity
Weigh the empty pycnometer (m), fill the pycnometer with distilled water. Dip the pycnometer into a water bath at a temperature of 25°C ± 2°C for 30 minutes, then weigh the contents (m₁). Empty the pycnometer, washed and cleaned, then the pycnometer is filled with patchouli oil samples, then put in the bath under the same conditions.

2.3.3 Refractive Index
Refractometer at a reading temperature of 25°C ± 2°C. Before the oil sample is placed in the tool, the refractometer prism is cleaned, then the patchouli oil sample is dripped on the prism, the prism is closed and then adjust the slide until a clear boundary line is obtained (dark and light). Further readings are made when the temperature is stable.

2.3.4 Solubility in alcohol (ethanol and methanol)
1 mL of patchouli oil sample was put into a 25 mL measuring cup, add absolute alcohol (ethanol and methanol) dropwise. Shake after each addition until a clear solution is obtained. The absolute volume of alcohol added to the sample was recorded until the solution was clear.

2.3.5 Acid Number
Weigh 4 g ± 0.05 g of patchouli oil sample into an Erlenmeyer, then dissolved in 5 mL of ethanol, added 5 drops of phenolphthalein indicator. Then titrated with 0.1 N KOH until the solution turns pink.

2.3.6 Esters Number
Before testing the sample, a blank test was performed using ethanol. After that, weigh the 4 g patchouli oil sample ± 0.05 g then put it into an Erlenmeyer, added 25 mL of 0.5 N KOH solution in alcohol and boiling stone, then refluxed on a water bath for 1 hour after which the solution was allowed to stand. Add 5 drops of phenolphthalein solution and titrate with 0.5 N HCl until a color change is obtained.

2.3.7 Determinants of Iron (Fe), Patchouli Alcohol and Alpha Copaene
Content of the iron (Fe) of patchouli oil samples can be determined using the AAS tool by comparing the absorbance value of patchouli oil samples with the standard solution curve. Meanwhile, the patchouli alcohol and alpha copaene levels of the oil samples were determined based on the analysis of the relative area of the gas chromatogram as measured by the GC-MS instrument by comparing the peak area with the total area of all detected components.

3. Results and Discussion
The results of the analysis of the physicochemical properties of the oil patchouli obtained from the industry Tinombala distillery in the village community (samples A, B, and C) are presented in Table 1. Patchouli oil sampling in Tinombala village, Ongka Malino district, Parigi Moutong district, using a random sampling technique by taking patchouli oil samples at 3 refining industries from 10 patchouli oil refining industries in Tinombala village. The sampling technique using this method provides equal opportunities for each member of the sample to become the research sample. This is done by considering the basic ingredients of the kettle or distillation equipment used by the community, namely iron plate material and the method used in 10 industrial distilleries using the same distillation method, namely the water distillation system.
Table 1. Results of quality analysis of patchouli oil production in Tinombala Village, Ongka Malino District, Parigi Moutong Regency.

| Characteristics/Parameters of Observation of | SNI Quality Requirements for 2006 | Patchouli Oil Samples in Tinombala Village | Average |
|---------------------------------------------|-----------------------------------|------------------------------------------|---------|
| Color                                       | Yellow-brown light reddish         | brown reddish yellow red more reddish     | 0.9590 |
| Specific Gravity (25°C)/ (g/L)              | 0.950-0.975                       | 0.9564 0.9658 0.9548                     |         |
| Refractive Index (nD20)                     | 1.507-1.515                       | 1.5111 1.5085 1.5086                     | 1.5094 |
| Solubility in Alcohol (Ethanol and Methanol)/ (mL) | Clear solution or light opalescence 1:10 1:10 1:10 1:10 | Ethanol Methanol Methanol Methanol |         |
| Acid Number                                 | Maximum 8.0                        | 21.0375 9.1162 19.6350 16.5962           |         |
| Esters Number Iron (Fe)/ (g/mL)             | Maximum 20.0                       | 28.05 21.04 21.04 23.38                   |         |
| Alpha Content (%)                           | Maximum 25                         | 1.84210 0.186842 6.78950 2.93948         |         |
| Patchoul Alcohol Content (%)                | Minimum 30%                        | 16.96 15.52 14.55 15.67                   |         |

3.1 Color
Color is the first visual attraction that can state that patchouli oil has good quality, the results of patchouli oil color testing by visually visualizing the three samples ie patchouli oil sample A is reddish brown, sample B is yellow and sample C is more reddish brown when compared to sample A. So in general, when compared with the Indonesian National Standard, the three patchouli oil samples are following the standard parameter specifications. The color intensity of patchouli oil is also determined by the amount of color pigment contained in it. In addition, storage time and storage place also affect the color of patchouli oil. The storage area used in the patchouli oil refining industry in Tinombala village uses used jerry cans made of plastic [12].

3.2 Specific Gravity
Gravity The specific value can be determined by comparing the weight of patchouli oil with water (aquades) using the same volume and temperature (25°C). The specific gravity of patchouli oil according to the standard ranges from 0.950 to 0.975 g/mL [3]. The results in Table 1 above show that the specific gravity of the three patchouli oil samples (samples A, B, and C) has met the SNI standard. Sample A was 0.9564 g/mL, sample B was 0.9658 g/mL and sample C was 0.9548 g/mL. The density of patchouli oil is not influenced by the volume of patchouli oil itself but the mass of the chemical components contained in patchouli oil itself such as patchouli alcohol and other chemical compounds. In addition, the content of water, fat and minerals in patchouli oil can also affect the specific gravity of patchouli oil. So that the specific gravity of patchouli oil cannot be used as the only measure of the quality of patchouli oil is said to be good. Therefore, it can be said that each mass of chemical components contained in patchouli oil such as sesquiterpenes, patchouli alcohol, patchouli, eugenol benzoate, has different specific gravity, namely the higher the concentration of patchouli oil components, the higher the specific gravity [12].

3.3 Refractive Index
The refractive index is the ratio of the speed of light in a substance with the speed of light in air. The refractive index value of patchouli oil is strongly influenced by the density and viscosity of the oil, namely the higher the density of the oil, the higher the refractive index value of the oil [13]. The
refractive index of patchouli oil can be determined by the amount of light that passes through a less dense medium to a denser medium so that the light will bend from the normal line [14].

The refractive index value of patchouli oil produced in this test showed satisfactory results in the three samples, in sample A the refractive index value was 1.5111, sample B was 1.5085, and sample C was 1.5086. The average refractive index of patchouli oil is 1.5094 so that all samples of patchouli oil meet the specifications of patchouli oil quality standards. The value of the refractive index shows its constituent chemical components associated with molecular weight. The value of the refractive index following the quality standard is caused by the large content of chemical components with large molecular weights. The more components with large molecular weights such as long-chain components, namely sesquiterpenes or chemical components that contain oxygen, the density of patchouli oil medium will increase so that the incoming light will be difficult to refract. On the other hand, if the refractive index value is not following the quality standard, the molecular weight is low and the density of the medium is also low. This is because the incoming light will be more refracted [15]. The high refractive index value of patchouli oil can also be caused by chemical components, namely oxygenated terpenes in the sample, which are long-chain molecules with unsaturated bonds or contain many oxygen groups [7].

3.4 Solubility in Alcohol (Ethanol and Methanol)

According to [11], quality requirements specify that patchouli oil can be completely dissolved (clear or clear) in alcohol at a ratio of 1:10, meaning that in 1 mL of patchouli oil, 10 mL of alcohol is added or it undergoes mild opalescence (colloidal nature). Patchouli alcohol is one of the groups of oxygenated terpene components contained in patchouli oil characterized by the –OH (alcohol) functional group which has almost the same polarity as the alcohol solvent. Thus, the higher the patchouli alcohol content, the better the solubility of patchouli oil in alcohol and the better the quality of patchouli oil [16].

Testing the solubility of alcohol on patchouli oil samples using ethanol (C₂H₅OH) and methanol (CH₃OH) which is a type of chemical substance that belongs to the alcohol group. The purpose of using ethanol and methanol on the alcohol solubility of patchouli oil is to distinguish between the two solvents whether they have different effects or the same effect. The results of the alcohol solubility test using ethanol and methanol showed that patchouli oil samples tended to be difficult to dissolve in alcohol using either ethanol or methanol, even in the use of ethanol, the solubility of patchouli oil is >1:10, so it requires a larger amount of alcohol to dissolve it. In the use of methanol, the alcohol solubility of sample A and sample B met the SNI quality standards, for sample C it still did not meet. Meanwhile, the use of ethanol showed that the alcohol solubility of the three patchouli oil samples did not meet the SNI quality standards. This is indicated by the number of terpene compounds in the sample. Essential oils containing oxygenated terpene compounds will tend to be more soluble than those containing terpene compounds, because oxygenated terpene compounds are nonpolar compounds that do not have functional groups. So, the higher the terpene content, the more difficult it is to dissolve in alcohol [2].

So it can be concluded that the analysis of the solubility of patchouli oil shows that the use of methanol as a solvent has a different effect when compared to ethanol. It can be seen that ethanol and methanol are polar solvents, although both are polar, methanol is known to be a general solvent and the best when compared to ethanol. Even methanol can bind all chemical analytes found in plants, both polar, semi-polar, and non-polar. Methanol is polar because it has a hydroxyl group (OH) and also can be non-polar because it has an ethyl group (CH₃) as well as non-aqueous methanol as impurities. Meanwhile, ethanol does not have an ethyl group (-CH₃) and contains water as an impurity so that ethanol has greater polarity when compared to methanol and tends to only attract polar chemical analytes [17].

3.5 The Acid Number

principle of acid number is the number of milligrams of potassium hydroxide (KOH) used to neutralize free organic acids in 1 gram of patchouli oil. The specifications for the quality requirements for the acid number of patchouli oil are based on [11], a maximum of 8.00 [14]. The acid number can identify the presence of free acid compounds in the sample. Free acid compounds in patchouli alcohol
can affect the quality of patchouli oil and free acid compounds can catalyze oxygen in the outside air so that it will affect the aroma of patchouli oil [18].

The results obtained from testing the acid number of patchouli oil samples were in sample A of 21.0375, sample B of 9.1162, and sample C of 19.6350. This result is not following the specifications for the acid number requirement, even far beyond the maximum limit. The high number of acids can affect the quality of patchouli oil. This is due to the large number of free acid compounds formed due to the chemical components of patchouli oil which are in direct contact with the surrounding air or are in humid conditions, resulting in an oxidation reaction with air (oxygen) catalyzed by light. Therefore, it will trigger the formation of organic acids. This can happen because the distilled patchouli oil is not stored in dark glass bottles or drums with tin-coated inside, but uses plastic jerry cans and is stored freely for an indefinite period waiting for a stable price. Storage time and storage area that is not good allows the interaction between air and oil directly. The interaction of air (oxygen) with oil results in changes in chemical components such as oxygenated terpenes to carboxylic acids through the process of oxidation of alcohol components and hydrolysis of ester components. So that the acid number can be said to be good if the value of the acid number is getting smaller. So it can be concluded that the acid value of the three samples of patchouli oil has poor quality [7].

3.4 The Ester Number

Number The ester number is one of the parameters that indicate patchouli oil has a distinctive aroma, the ester number of patchouli oil states the number of milligrams of potassium hydroxide (KOH) used to saponify the ester in 1 gram of patchouli oil. The ester number in this analysis has different values for each patchouli oil sample, namely in sample A of 28.05, sample B of 21.04, and sample C of 21.04. This result is not following the requirement for an acid number based on the 2006 Indonesian National Standard, which is a maximum of 20.0. The high ester number illustrates that the oil is not easily oxidized so that the distinctive aroma of patchouli oil is more perfect and the aroma lasts longer. However, an ester number that is too high more than the quality requirement of 20.0 indicates the presence of impurities or other substances such as free fat or the presence of additional ingredients mixed in patchouli oil. not good, the ester number is also influenced by the length of distillation, the longer the distillation time the higher the ester number. However, it is seen again with the temperature used. While the patchouli oil samples analyzed did not pay attention to the temperature used. The role of ester number is very important because ester plays a role in determining the aroma of patchouli oil so that the better the ester number, the better the quality of patchouli oil [7].

3.6 Iron (Fe)

Content Iron metal content is one of the causes of dark and cloudy color in patchouli oil, therefore its presence must be known. The principle of determining the content of iron (Fe) in patchouli oil is to compare the absorbance of the sample solution with the standard curve of iron (Fe) solution. Kusuma et al. [19], conducted research on the analysis of the heavy metal content of lead (Pb) and mercury (Hg) using atomic absorption spectrophotometry based on the absorption of light by atoms, where the atoms formed are the same as the elements in the cathode lamp, so the light from the lamp will be absorbed. The rate of absorption depends on the number or concentration of atoms present in the solution.

The content of iron(Fe) in the patchouli oil sample that has been tested and calculated is significantly different, the iron content of sample A is 1.84210 mg/L, for the iron content of sample B must be concentrated 10 times to determine the level of iron (Fe). ) which is 0.186842 mg/L, while the highest iron content is Sambel C, which is 6.78950 mg/L. The test results for iron (Fe) content are still following the specifications for acid number requirements based on quality requirements [11], even all test results have levels that tend to be slightly far from the maximum limit. The less iron (Fe) content contained, the better the quality of the oil produced. However, it is not only the iron (Fe) content that causes the color of patchouli oil to darken, the presence of free acid compounds, free fats, and other impurities can also affect it. This is because, if the iron (Fe) content is too high in patchouli oil, it can cause an excessive decomposition of organic matter so that which can affect the quality of patchouli oil.
3.7 Patchouli Alcohol and Alpha Copaene Content

The quality of patchouli oil that most determines the characteristics of patchouli oil is the chemical nature of patchouli oil, namely the patchouli alcohol content contained in patchouli oil. Patchouli alcohol is a sesquiterpene alcohol chemical compound that can determine the color and distinctive aroma of patchouli oil. The higher the patchouli alcohol content in patchouli oil, the better the quality and the selling price. According to standard specifications [11], the patchouli alcohol content of patchouli oil is at least 30% and the standard quality is based on the Essential Oil Association (EOA), requires 38% [18]. Patchouli alcohol has a white color in the form of crystals, the more patchouli alcohol content will make the color of patchouli oil brighter [15]. The picture below shows the results of the GC-MS test on the three patchouli oil samples.

**Figure 2.** The results of the GC test are the analysis of the separation of compounds (amount of compounds) in sample A of patchouli oil.

**Figure 3.** The results of the GC test are the analysis of the separation of compounds (amount of compounds) in sample B oil.

**Figure 4.** The results of the GC test are analysis of the separation of compounds (amount of compounds) in sample C of patchouli oil.

**Figure 5.** The results of MS test, namely the identification of compounds (relative molecular mass) in sample A of patchouli oil.
The results of MS test, namely the identification of compounds (relative molecular mass) in sample B of patchouli oil.

Figure 7. The results of MS test, namely identification of compounds (relative molecular mass) in sample C of patchouli oil.

GC-MS analysis of patchouli oil in sample A showed that there was a patchouli alcohol compound of 16.96%, sample B was 15.52% and sample C is 14.55%, the average patchouli alcohol content among the three samples is 15.67%. So it can be concluded that the patchouli alcohol content of the three patchouli oil samples is below the minimum SNI requirements. The quality of patchouli oil in Tinombala village is still below the standard when compared to the quality of patchouli oil in North Kolaka, the patchouli alcohol content of patchouli oil in North Kolaka ranges from 22%-29%. As for the alpha copaene compound in the patchouli oil sample, it was not detected or did not appear on the chromatogram peaks, so the levels could not be known. The low level of patchouli alcohol is caused by several factors including poor patchouli oil refining and storage techniques, in addition, it is influenced by the condition of the raw material of the patchouli plant being refined such as harvest age and post-harvest handling, the quality of various raw materials and the state of soil nutrients [7].

Patchouli alcohol content can be analyzed through chromatogram peaks by looking at the relative content of patchouli alcohol which shows the ratio of components in patchouli oil, while patchouli alcohol concentration is expressed by a large peak area. Where the peak area produced by the chromatogram is related to the total concentration of components in the mixture. While the peak area is directly proportional to the concentration. The larger the peak area, the greater the concentration of patchouli oil components [18]. Patchouli alcohol is a water-insoluble compound, but soluble in alcohol, ether, or other organic solvents, it has a boiling point of 280.37°C, and the crystals formed have a melting point of 56°C [20].

The quality and purity of patchouli oil are influenced by many factors, including the type of patchouli plant. In general, the value plant consists of three types, namely Aceh patchouli, Javanese patchouli, and soap patchouli. Judging from the high amount of oil and the composition of the oil produced, the patchouli type of Aceh is superior so that it is more attractive to farmers. However, it is more susceptible to disease when compared to Javanese species [21]. Harvesting of patchouli in Tinombala village ranges from 3-6 months of age by trimming the patchouli plant without leaving branches that can stimulate growth, with harvest time farmers are generally carried out in the morning until noon or do not pay attention to the best time to harvest. Patchouli harvesting is carried out in several stages, the first harvest is done when the patchouli plant is 6 months old and the next harvest is done every 4 months until the plant is three years old. Harvesting should be done in the morning or at night so that the oil content remains high. If the picking is done during the day, it is known that the leaf cells are photosynthesizing so that the rate of oil formation is reduced, the leaves are less elastic and easily torn [22]. In addition, the method of drying patchouli plants can also affect the quality of patchouli oil produced, patchouli plants should be dried in two stages, namely the first stage of patchouli drying in direct sunlight for only 5-6 hours, after that the next stage of patchouli plants is dried in the wind - air without exposure to sunlight for 3 days. While the drying method used by farmers in Tinombala village is patchouli drying under direct sunlight for 3-4 days until dry and brown plants are obtained. This method can reduce the quality of patchouli plants because some of the oil contained in patchouli plants will easily evaporate or decompose when drying in direct sunlight [7].

In general, patchouli oil distillation is carried out in three ways, namely by boiling (water distillation), this method is considered less efficient and the cost is relatively high. Second, by steaming (water and steam distillation), this method is most widely used by the distillation industry
and the last method is steam distillation, this method uses higher pressure and the material is not in direct contact with water as well as the distillation method. which is considered the best when compared to the two previous distillation methods. However, nowadays many patchouli oil refining industries have modified the distillation method to obtain better oil quality [21]. Meanwhile, the distillation method used by farmers in Tinombala village uses water distillation so that there are still many quality parameters of patchouli oil produced that are still below standard. In addition to the method of distillation, the temperature used for refining patchouli oil also affects the oil produced. However, there is no valid information regarding the optimum temperature used for patchouli oil refining. Dalimunthe et al [23] conducted a study on the effect of temperature using direct steam on the quality of patchouli oil with temperature variations of 95°C, 100°C and 105°C obtained the lowest free fatty acid content at 100°C. Lestari et al [24] also researched the effect of the temperature range of fractional distillation to patchouli alcohol content obtained the highest patchouli content in the temperature range of 290-300°C, which is 90.38%. Patchouli alcohol is known to have a boiling point of 150-160 °C at 8 mmHg and 280.73 °C at atmospheric pressure. So it can be said that the temperature used for patchouli oil refining must be ± 100°C because the main compound content of patchouli oil, namely patchouli alcohol, has a high boiling point for evaporation. Mahinda et al [25] said that the temperature difference can cause the color of patchouli oil to vary. The higher the distillation temperature can cause the color of the oil to turn dark brown. This can be caused by the effect of decomposition or decomposition of hydrocarbon components that occur during the process so that soot appears in the resulting patchouli oil product. Meanwhile, patchouli farmers in Tinombala village did not pay attention to the distillation temperature used. The temperature used is erratic because it uses firewood as a source of fire, the bigger the fire source, the faster the patchouli oil refining will be completed and result in damage to the components that make up patchouli oil, thus affecting its quality and purity.

4. Conclusion
Patchouli oil (Pogostemon cablin Benth) produced by Tinombala village, Ongka Malino district, Parigi Moutong district, has color, specific gravity, refractive index, iron (Fe) content which is appropriate so that it meets the quality requirements of the 2006 Indonesian National Standard. Alcohol solubility (ethanol) and methanol), the methanol samples A and B still meet the SNI for sample C not yet complied with. While the alcohol solubility using ethanol (>10:1), the acid number, ester number, and patchouli alcohol content of patchoulı oil are still below the quality requirements of the 2006 Indonesian National Standard. Patchouli alcohol content in sample A is 16.96%, sample B is 15.52%, and sample C is 14.55%.

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