

# The development of citronella oil distillation results into commercialized products

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## ABSTRACT

Citronella is one of the essential oil-producing plants that can be processed into health and beauty products. This community service activity aims to apply the results of innovation in the form of appropriate technology from the results of citronella oil distillation equipment. This community service activity aims to produce mosquito-repellent cream from citronella oil which is processed at the Chemical Engineering Laboratory, Engineering Faculty of Universitas Riau as well as applying citronella oil distillation tool innovation results in the form of appropriate technology from a citronella oil distillation tool. The service activities are carried out by socializing distillation techniques, a distillation of essential oil from citronella, and testing the characteristics of essential oils from citronella. Based on the test results and observations, the citronella oil produced has physical and chemical characteristics that are in accordance with the requirements. The characteristics of citronella oil produce essential oil with a specific gravity of 0.86 mg/L, a viscosity at 45°C of  $2.41 \times 10^{-6}$  N.S/m<sup>2</sup>, a free fatty acid rate of 1.1%, and a moisture content of 3.1%. The citronella oil produced has been analyzed chemically and physically. Then citronella oil is used as the main ingredient for making mosquito repellent lotion, under the TABIR brand, and has been published in the Directorate of Intellectual Property of the Republic of Indonesia.

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## 1. INTRODUCTION

As a spice-producing country, Indonesia has earned the nickname “Spice Island Country”. More than 40 types of spice plants in the world are found scattered in almost all parts of Indonesia. Spice plants are producers of essential oils, which are the main components of spices, which have several characteristics such as liquid form at room temperature, evaporating easily, and having a distinctive aroma [1-3].

Essential oils are often used as fragrances, but apart from that this oil has several properties including anti-bacterial, anti-fungal, and preventing atheromatous [4]. One of the essential oils can be obtained by the distillation method. The highest yield of citronella oil was produced with a steam distillation system of 1% [5]. Most citronella plants are used as a cooking spice, and flavor generator in drinks and herbal medicines [6]. In addition, citronella plants are widely used as the main ingredient in fragrances in detergents, soaps, and lotions. Essential oils have physical characteristics in the form of a viscous liquid that can be stored at room temperature, which is around 20°C – 25°C [7].

One of the plants that produce essential oils and has been successfully cultivated in Siabu Village, Salo District, Kampar Regency, Riau Province is citronella plants. This plant is very easy to grow and is suitable for planting in various soil conditions, often used as a mixture of food and medicine [8]. The distribution of citronella plants and production of citronella oil in Indonesia is centered on the island of Java, especially West Java and Central Java. Regions that develop citronella are only Riau, West Java, Central Java, West Kalimantan, and Central Sulawesi [1]. The citronella plant is cultivated to extract its essential oil because it has quite a high economic value [9].

From the distillation of the leaves, citronella oil is obtained, which in world trade is known as citronella oil. Indonesian citronella oil in the world market is known as "Citronella Oil of Java". The export volume of citronella oil in recent years has decreased due to competition from citronella oil produced in China and Sri Lanka, which has better quality and lower prices [10].

Most of the citronella oil business in Indonesia is only managed by common people, so the quality of the oil produced does not meet the quality requirements set by the international market. Compounds that makeup citronella oil include 30 to 40 types of chemical compounds, such as alcohols, hydrocarbons, esters, aldehydes, ketones, lactone oxides, and terpenes, with the main ingredients citronella, citronellol, and geraniol. The quality of citronella oil is determined by the natural characteristics of the oil and the foreign materials mixed in it. Refined citronella oil contains 32% – 42% citronellal, 11% – 15% citronellol, 10% – 12% geraniol, 3% – 8% geranyl acetate, 2% – 4% citronellal acetate, and a few other compounds [11]. The quality standard of citronella oil on the international market requires high levels of citronellal and geraniol.

To improve the yield and quality of citronella oil resulting from the community's efforts, Azriyenni *et al.* (2020) conducted community service in Siabu Village, Salo District, Kampar Regency in 2020 and succeeded in installing a citronella distiller with a capacity of 130 kg per distillation column. From 130 kg of citronella ingredients, around 1.3 kg of citronella oil can be produced. This distillation system consists of a boiler to generate steam, which is connected to a distillation column. The steam produced by the boiler is flowed through a two-inch diameter pipe to the distillation column to evaporate or separate the essential oil from the lemongrass plant. The steam will carry the essential oil components through the top of the column, to the condenser which is equipped with a spiral-shaped pipe. As a cooling medium in the condenser, clean and clear pool water is used, which is also used as boiler feed water. For boiler fuel, firewood or solid citronella waste is used within a certain range [8].

The use of proper distillation equipment has increased the yield of essential oil from citronella by a group of farmers in Siabu Village, Salo District. However, the quality of the essential oil produced has never been analyzed. Therefore, in this 2021 dedication, essential oils produced through a distillation process using distillation equipment that has been designed in 2020 will be tested for some of the physical and chemical properties of citronella oil.

Lotion is a liquid preparation in the form of a suspension or dispersion which is used as an external drug that can be in the form of a solid suspension in a fine powder with the addition of a suitable suspending agent [12]. The lotion is an emulsion product in the form of a solid dispersion with the appropriate emulsifier. Generally, lotions are lighter and absorbed by the skin more quickly than creams, so they are more suitable for use on normal or slightly dry skin. Creams are more suitable for use on very dry or irritated skin. Creams are usually thicker than lotions because of the high levels of wax and oil. The viscosity test is a test performed on each lotion formula using a viscometer to determine the thickness and flow of the lotion.

The use of lotion is one of the stages of skincare that can keep the skin moist. The lotion will lock in moisture and keep the skin hydrated because damp skin can better prevent irritation, acne, or other problems. The pH tolerance of the lotion ranges from 4.0 – 7.5 [13]. The lotion is only intended for external use as a protective barrier. The liquid consistency allows for quick and even application on the skin surface so it spreads easily and dries quickly after application and leaves a thin layer on the skin surface [14].

Skin is the most extensive organ as a body protector from the dangers of chemicals, sunlight, mosquitoes, and microorganisms and maintains the balance of the body and the environment. The skin can also function as an indicator to get a general impression by looking at changes in skin color, for example pale, yellowish or reddish. Changes in the skin can be caused by an increase in skin temperature which causes abnormalities so that it is susceptible to the growth of fungi and microorganisms and eventually causes infection of the skin.

Mosquitoes are the main insects that cause infectious and deadly diseases. For example, the *Aedes aegypti* mosquito is a vector for Dengue Fever, an infectious disease that has a high level of endemicity in tropical countries and has always had a tendency to increase every year. Efforts to eradicate mosquito breeding usually use insecticides, both spray, burn, and electric. The use of insecticides in this way easily enters the respiratory system to the lungs and can be passed on to the blood circulation. The effects can vary, such as nervous, liver, and respiratory disorders, and even long-term use can cause cancer [15].

The use of natural ingredients as active ingredients in lotions has started a lot at this time. Widawati (2014) used betel leaf with the addition of essential oil from patchouli leaves as a fixative that can bind repellent odors from anti-mosquito lotion preparations [15]. Safitri *et al.* (2022) used lemongrass stems as a source of essential oil in an anti-mosquito lotion made with the addition of pandan leaves and olive oil [16]. Ameliana and Winarti (2011) used essential oils from turmeric (*Curcuma longa*) in the manufacture of mosquito-repellent lotions to prevent the spread of dengue fever [17].

## 2. IMPLEMENTATION METHOD

Testing the quality of citronella oil is carried out through analysis in the laboratory. Before installing the citronella refining equipment, it is necessary to provide data information related to the refining system that will be designed. Testing the quality of essential oils with citronella raw materials is carried out by analysis in the laboratory. There are three tests conducted; they are viscosity test, density, and free fatty acid test.

### 2.1 Viscosity test

Viscosity testing uses a measuring instrument called the Ostwald viscometer. This gauge can determine viscosity by measuring the time it takes for a liquid to pass through two marks as it flows due to gravity. The ways to use the viscometer measuring instrument are:

- a) Make sure the Ostwald viscometer is clean before use,
- b) Place the sample in the form of essential oils through a pipette into the Ostwald viscometer,
- c) Suction the essential oil sample in the Ostwald viscometer using a rubber push-ball until it can pass two limits,
- d) Loosen the sample oil liquid to the first limit,
- e) Observe the time on the stopwatch required for the sample to reach the specified limit,
- f) Calculate the number obtained by the viscosity formula.

### 2.2. Density test

Density testing was carried out using a pycnometer measuring instrument. The pycnometer measuring instrument is an instrument made of glass that has a certain volume and is equipped with a stopper at the top. The density testing procedures are:

- a) Make sure the pycnometer has been washed and rinsed thoroughly, then dried it,
- b) Weigh the empty weight of the pycnometer, record the result ( $m_0$ ),
- c) Fill the pycnometer with the sample in the form of essential oil which has been heated to a temperature of 40°C until it is full,
- d) Cover with a stopper and calculate the weight ( $m_1$ ),
- e) Calculate the density of essential oils using the density formula.

### 2.3. Free fatty acid test

In this Free Fatty Acid test, a method can be carried out by collecting data using a titration test (fat test) in determining the acid level in oil, with the following steps:

- a) The sample is weighed first, approximately 20 grams of fat or oil, put into Erlenmeyer, and add 50 ml of 95% neutral alcohol,
- b) After being covered with a cooler, heat until boiling and shake vigorously aiming to dissolve the free fatty acids,
- c) Allow the oil sample to boiling, then remove it from the heat to cool.

- d) After cooling, the solution was titrated with 0.1 N, standard KOH solution using Phenol Phitalein (PP) indicator,
- e) The end of the titration is reached when a pink color persists for 0.5 minutes
- f) The acid number is expressed as mg of KOH used to neutralize free fatty acids in 1 gram of fat or oil,
- g) To determine the high and low levels of free fatty acids must be measured using a predetermined formula.

#### 2.4. Program objectives

The target of this community service activity is the community of lecturers and students in the production business unit of mosquito repellent cream, from citronella oil raw materials which are under the guidance of the LPPM Business Incubator Study Center of Universitas Riau which has been established by LPPM Universitas Riau.

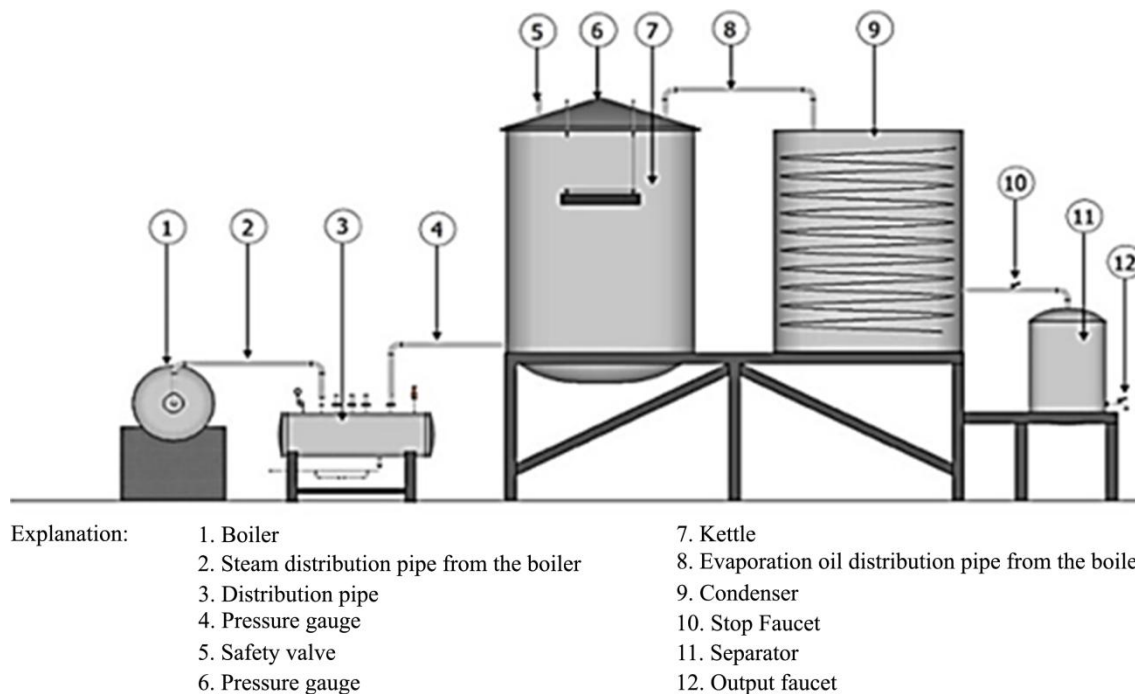
#### 2.5. Program implementation

This socialization is to provide information and explain the essential oil distillation techniques to farmers. In this activity, the community service team explained the technique of distilling essential oils using a steam system.

The success of socialization can be seen from the aspects of increasing knowledge and conformity to needs [18]. After this activity, the people of Siabu Village increased their knowledge regarding distillation techniques, and the material provided was in accordance with the needs of the community who had carried out essential oil distillation activities using the manual method.

#### 2.6. The process of distillation of essential oil from citronella

The scheme of the distillation equipment used in Siabu Village, Salo District, which was designed by the 2020 service group [19] is shown in Figure 1. The essential oil distillation system uses distillation equipment with a capacity of 130 kg per distillation column, producing clear yellow essential oil.



**Figure 1.** Scheme of distillation tools [19].

#### 2.7. Characteristic test of essential oil from citronella

Figure 2 is testing the characteristics of essential oils derived from citronella leaves. Analysis of the specific gravity of citronella oil was carried out based on SNI 06-3953-1995.



**Figure 2.** Testing the characteristics of essential oils.

The specific gravity of citronella essential oil is calculated using the following formula:

$$\text{Density} = \frac{m_2 - m}{m_1 - m} \quad (1)$$

Explanation:

$m$  = empty pycnometer mass (gram)

$m_1$  = pycnometer mass + water (gram)

$m_2$  = pycnometer mass + citronella essential oil (gram)

Indonesia's national standard of 06-3959-1995 with specific gravity values is in the range of 0.880 – 0.922 gr/mL. This test was carried out using an Ostwald viscometer at a temperature of 40°C. Based on the BSN regarding standards for citronella essential oil, there is no standard regarding oil viscosity. The equation used to test the viscosity at 40°C.

$$\text{viskositas } \eta^o = \frac{\eta^o_0 \times \rho^o \times t}{\rho^o_0 \times t_0} \quad (2)$$

Explanation:

$\eta^o$  = the viscosity of the sample liquid

$\eta^o_0$  = the viscosity of the reference liquid

$\rho^o$  = density of the sample liquid

$\rho^o_0$  = density of the reference liquid

$t$  = sample liquid flow time

$t_0$  = flow time of the reference fluid

The acid number indicates the free acid content in the essential oil. The greater the acid number can affect the quality, including changing the characteristic smell of essential oils. Indonesian National Standard 06-3959-1995 for free acid content in essential oils is a maximum of 3.

## 2.8. Water content test of citronella essential oil

Analysis of the water content of citronella essential oil was carried out by heating a clean porcelain cup containing essential oil in an oven at 105°C until the weight was constant.

$$\% \text{ of Water Content} = \frac{m_1(g) - m_2(g)}{m_0(g)} \times 100\% \quad (3)$$

Explanation:

$m_1$  = sample mass + initial container mass (gram)

$m_2$  = sample mass + container mass after being dried

$m_0$  = sample mass

### 3. RESULT AND DISCUSSION

Before installing the citronella refining equipment, it is necessary to provide data information related to the designed distillation system. Table 1 presents field data related to components related to raw materials and others. The longer the process of the distillation system, the more process of heat or diffusion of the raw material increases. In other words, the refining process will be faster, and the resulting oil yield will be better.

**Table 1.** Field data of citronella plantation.

<b>Distillation Need</b>	<b>Condition</b>	<b>Total</b>
Citronella leaves	Fresh, withered	300 kg
Water (steaming)	Clean	150 liters
Firewood	Dry, flammable	1 – 1.5 m <sup>3</sup>
Water (cooler)	Clean	10 – 100 m <sup>3</sup>
Distillation tool	Good, usable	1 pair
Distillation time	-	6-7 hours

This distillation tool uses a direct steam system. The steam distillation method is a faster way to produce essential oils for citronella plants. When installing the existing foundation distillation equipment, the boiler is installed lower than the distillation kettle, when the top of the boiler is flush with the bottom of the distillation kettle. The top of the boiler with the bottom of the distillation kettle, is connected by a pipe. Water as a source of hot steam is in a boiler which is separate from the distillation boiler. In boilers where firewood or refining fuel is spaced with a certain size, the ideal distance is obtained from the experience of the distillers. Figure 3 shows the essential oil obtained from citronella raw materials using the steam distillation method, which is clear yellow in color with a strong citronella aroma.



**Figure 3.** Distilled essential oil.

### 3.1. Citronella essential oil test

The demand for citronella oil is increasing, so attention must be paid to the quality of citronella oil as the final product to meet market requirements [20]. Testing of citronella oil was carried out at the Laboratory of the University of Riau. There are three tests conducted, they are; viscosity test, density, and free fatty acid test. In addition, observations of color, water content, and pH of citronella oil were also carried out. Table 2 shows the results of tests and observations, essential oils produced from distillation using distillation equipment that has been designed by Azriyenni *et al.* (2020) which have physical and chemical characteristics that are in accordance with the requirements [8].

In the community service program at the Universitas Riau, this essential oil service group has succeeded in making a lotion using essential oils from citronella. This service group involves integrated community service lecturers and students from Universitas Riau. From 2020 to 2022, the group has succeeded in empowering the people of Siabu Village, Kampar Regency, to utilize unproductive land as gardens to plant citronella. Citronella, the result of community cultivation, is processed to extract its essential oil. The essential oil produced has been analyzed for its chemical and physical properties. In the final stage, essential oil from citronella is used as the main ingredient for making TABIR mosquito repellent lotion and has been registered in the brand category at the Directorate General of Intellectual Property registered with DID2021072029.

**Table 2.** Citronella oil analysis result.

Kinds of Test	Test Result	Unit	Requirement SNI 06-3953- 1995
Color	-	-	Pale yellow to yellow-brown
Specific Gravity, 45 <sup>0</sup> C	0,86	g/mL	0.880 – 0.922
Viscosity 45 <sup>0</sup> C	2,41x10 <sup>-6</sup>	N.S/ m <sup>2</sup>	-
acid number	1.1%	mg KOH/g	Max 3
Water content	3.1	%	-
pH	5	-	-

Figure 4 is the process of making anti-mosquito cream from raw citronella oil which is processed at the Chemical Engineering Laboratory, Faculty of Engineering, Universitas Riau.



**Figure 4.** Manufacture of mosquito repellent lotion.

Figure 5 and Figure 6 show the results of the lotion that has been packaged in tube form, and the team has participated in exposseveral times in the framework of promoting products resulting from community service at the tertiary, regional, and national levels.



**Figure 5.** The results of the packaged mosquito repellent lotion.



**Figure 6.** Participate in the lotion product commercialization event.

#### 4. CONCLUSION

Based on the results of this refining process, related to the tool foundation which is not dry enough due to rain and poor road access can be overcome by good teamwork. The essential oil produced from the citronella plant, using steam distillation has characteristics in accordance with SNI 06-3953-1995. This essential oil from citronella has a specific gravity of 0.86 mg/L, viscosity at 45°C of  $2.41 \times 10^{-6}$  N.S/m<sup>2</sup>, free fatty acid rate of 1.1%, pH 5 and water content of 3.1%. This community service group has succeeded in making lotion using essential oils from citronella. This is because essential oils have been analyzed with several chemical and physical properties. Thus, in the final stage, essential oils were successfully used as the main ingredient for making mosquito-repellent lotions.

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