Extraction of citral oil from lemongrass (*Cymbopogon Citratus*) by steam-water distillation technique

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**Abstract.** In Indonesia, production of citral oil from lemon grass (*Cymbopogon Cytratus*) is done by a traditional technique whereby a low yield results. To improve the yield, an appropriate extraction technology is required. In this research, a steam-water distillation technique was applied to extract the essential oil from the lemongrass. The effects of sample particle size and bed volume on yield and quality of citral oil produced were investigated. The drying and refining time of 2 hours were used as fixed variables. This research results that minimum citral oil yield of 0.53% was obtained on sample particle size of 3 cm and bed volume of 80%, whereas the maximum yield of 1.95% on sample particle size of 15 cm and bed volume of 40%. The lowest specific gravity of 0.80 and the highest specific gravity of 0.905 were obtained on sample particle size of 8 cm with bed volume of 80% and particle size of 12 cm with bed volume of 70%, respectively. The lowest refractive index of 1.480 and the highest refractive index of 1.495 were obtained on sample particle size of 8 cm with bed volume of 70% and sample particle size of 15 cm with bed volume of 40%, respectively. The solubility of the produced citral oil in alcohol was 70% in ratio of 1:1, and the citral oil concentration obtained was around 79%.

1. **Introduction**

Indonesia is a country famous for its essential oil potential. Lemon grass (*Cymbopogon Cytratus*) is a plant that could be processed to produce essential oils. Oil from lemongrass is one of the most important and widely used essential oils to produce citral oil, which is one of major components in essential oil. Citral oil is widely used in cosmetic flavors and as a raw materials for the manufacture of ionons (a synthetic liquid aromatic compound). Besides, due to its strong lemon odor, lemon grass is often used as fragrant in soap, detergent and various technical products. As medicinal materials, essential oils used in industry and trade must meet the requirements as stated in official book [1].

Botanically, lemon grass falls in family of grasses (*Poaceae*), cultivated for its leaves as traditional herbal medicine, spices or refined to obtain its essential oil. Despite of aforementioned benefits, the utilization of lemon grass oil is relatively small compared to other essential oils derived from patchouli oil, ylang, nutmeg, cloves, sandalwood, eucalyptus, fragrant root, ginger and cubes that have been cultivated and used as a source of essential oil commercially. This fact causes the low production of Indonesian lemongrass oil [1-3].

Currently, the price of raw lemon grass in the market is around Rp 60.000/kg, while its extracted essential oil (*with a simple process*) reaches Rp 60.000/10 ml. This significant margin also occurs in
other volatile production. The amount of selling value is certainly not very profitable if the post-harvest lemon grass directly sold to market as raw material. On the other hand, this condition will open up business opportunities in the industrial sector of processed products of lemon grass.

In general, the physical properties of chemistry of essential oils vary, so difficult to obtain a fixed quality. This is caused by many factors, including post-harvest handling of the plant, such as on the patchouli leaves are fermented before the essential oil is distilled. Another factor is caused by pretreatment of raw materials prior to distillation. Lemongrass leaves are usually distilled when they are fresh, but when large harvests of newly cut or trimmed clumps cannot be immediately distilled, so as a clump of crops spread over the field or left buried in a room that causes the clump to become semi-dried or wilted. This stockpiling is often done due to the lack of distillation equipment impediments or the absence of a distillation plant that can accommodate large quantities [1]. The aim of this research is to improve the rendement and quality of lemongrass oil by varying the effect of particle size and bed volume.

The objective of this research is to improve the distillation technique of lemongrass oil for enhancement of its yield and quality. It is expected that this research can help lemongrass farmers in Indonesia especially in Aceh to increase its selling price.

2. Materials and methods

2.1. Materials
In this work, leaves of the lemongrass, stem, ethanol 70% as solvent, Na₂SO₄, H₂O and filter paper, erlenmeyer, beaker, measuring cup, burette, picnometer, water bath, spatula, raction tube, funnel, separator funnel, dropper pipette, volume pipette, scales and refractometer. In the steam distillation process the drying and distillation times are determined for 24 hours and 2 hours, respectively, for the bed volume and size varied as mentioned in the working procedure.

2.2. Methods
A quarter volume of the steam boiler filled with water and heated electrical steam. A 2:1 proportions of mixed lemongrass leaf and stem put into the distillation kettle equipped with grid where the material was placed. Set the proportion with various density according to the varied. Flow the steam produced by direct contact with raw material to the shelter through the distillate pipe. Drain the oil steam mixture out of the distilled boiler to the condensate through the steam distillation pipe. Accommodated distillate produced on the column of essential oil storage. Repeat the above work by varying the volume of the bed (40%, 60%, 70%, 80%) and sample particle size (3 cm, 5 cm, 8 cm, 12 cm, 15 cm).

3. Results and discussion

3.1. Effect of packed bed volume and particle size on citral oil rendement
Distillation of lemongrass oil used bed volume with variation 40%, 60%, 70% and 80%. The effect of bed volume and sample size on citral oil yield as can be seen in Figure 1. It shows that with the increase of bed volume, the yield of lemon grass oil is less due to the larger volume of the lemongrass bed the harder the vapour produced from the distillation boiler to extract its essential oil components. The vapors will be difficult to carry out the volatile oil components due to the density of the bed, and low vapour pressure generated from the distillation boiler. In Figure 1 it can be seen that the highest yield is on the sample particle size of 15 cm and the volume of bed 40% is 1.95%. In addition, there are several factors in determining the yield of lemon grass oil produced, such as the timber which has exceeded the time specified in this study it was 24 hours. As a consequence, many components of volatile oil that evaporated due to the timber. In addition, at the time of chopping will also affect the results, inappropriate cooking method also will damage the lemongrass so that the essential oil components contained will be more volatile before refining.
3.2. Density

Weight values are shown in Figure 2 below for all bed volumes. It can be seen that at 70% bed volume with sample size of 3 cm, the specific gravity of 0.902 gram / mL, the sample size of 5 cm by 0.873 g / mL, by sample size 8 cm by weight of the type achieved 0.897 gram / mL, the sample size is 12 cm, the specific gravity is 0.905 gram / mL, and the sample size is 15 cm by 0.892 gram / mL. The specific gravity of kitchen sereh oil according to EOA standard ranges from 0.869 to 0.894. There are some samples of specific gravity that do not meet EOA standards, this is due to the presence of a mild fraction contained in lemon grass oil. It is also because at the time of distillation is not much fraction of coconut oil oil that distilled perfect. The weight fraction is referred to as sitral. As the sample size increases, the resulting density is lower. On the other hand, there are several factors that influence the low value of the weight of a component, such as the type and number of functional groups, the number and position of double bonds, the number of carbon atoms and others [4].
In Figure 2 it can also be seen that the lower volume of the essential oil bed of lemon grass is lower than the value of the specific gravity to be obtained on the lemon essential oil. This is due to the less volume of the lemon grass oil bed, the less weight or citral fraction can be distilled from the lemon grass oil. In Figure 2 it is found that the optimum density of the lemongrass oil is at 70% bed volume.

### 3.3. Refractive index

If a monochromatic light passes through a medium (A) to a more densely packed medium (B), then the change in velocity and refraction of the light approaches the normal line, or the angle of the incident ray (i_A) greater than the angle of the bias ray (i_B). The comparison of the incident angle of light with this refracted beam angle is called the refractive index. In this study to determine the refractive index of an oil sample used Abbe Refractometer. Figure 3 is an acquisition of refractive index for each lemon grass sample of at each bed volume.

![Graph showing refractive index vs particle size and volume](image)

Figure 3. Effect of particle size and volume on refractive index.

Figure 3 shows that the refractive index obtained ranged from 1.480 to 1.495 for all samples. The refractive index obtained largely meets the established standards of EOA of 1.4830-1.4890. However, there are some that are still below and above the EOA provisions such as the lemon oil oil refractive index with sample size 15 cm and 40% bed volume is 1.495, sample size 8 cm and 70% bed volume is 1.480, sample size 3 cm and bed volume 80% is 1.481. This happens because there is still water contained in the lemon grass. The more water content, the refractive index value will exceed the predefined EOA standard. This is because the nature of the water is easy to refract the incoming light, but if the refractive index value is smaller below the EOA standard this means that the citric content contained in the lemon grass is little. From the results of the research obtained generally the refractive index obtained has met the EOA (Essential Oil of America) standard, only a few samples that do not meet the EOA standard due to the presence of water contained in the lemon grass. The high value of the refractive index of a material is one of the parameters to determine the purity of the material is no longer guaranteed, in other words the material has been mixed with other materials. In addition, chemical changes such as the occurrence of resinification due to polymerization, hydrogenation or isomerization of a substance can cause changes in the refractive index values [4].

### 3.4. Solubility of citronella oil kitchen in ethanol 70%

Since many essential oils dissolve in alcohol and are rarely water soluble, the solubility can be readily known by using alcohol at various concentrations. Determining the solubility of the oil depends also on the speed of solubility and the quality of the oil. Oxygenated oils are usually more soluble in
alcohol than those rich in terpenes. In lower alcohol concentrations, the terpene fraction will separate as is the case with wax. Based on this, this method is widely used for the manufacture of free oil terpen and sesquiterpen, concentrate and extract. Oil solubility may also change due to the influence of oil age. Unfavorable storage conditions can speed up polymerization. Factors such as light, air and the presence of water usually cause unfavorable effects. The concentration of alcohol used to determine the solubility of essential oils is: 50% - 60% - 70% - 80% - 90%. In this study, alcohol (ethanol) used as a solvent in the analysis of lemon grass oil quality is 70% ethanol. The solubility of kitchen lemon oil obtained from the research in ethanol 70% still meets the EOA standard, that is, by an average ratio of 1: 1 for each sample of oil tested.

3.5. Gas chromatography
In this study used GC-MS in order to evaluate the components contained in the essential oil of lemon grass. From result of GC-MS analysis for lemongrass oil with particle size 3 cm and bed volume 40% hence obtained level of α-sitral equal to 28.18% and β-citral equal to 43.11%. And at the size of 3 cm and 60% volume of beds obtained α-sitral levels of 27.30% and β-cyral of 42.40%. As well as the size of 3 cm and the volume of bed 80% obtained α-sitral rate of 31.69% and β-cyral of 48.08%.

![Chromatogram](image)

**Figure 4.** Gas data chromatography lemon grass 800 grams.

3.6. Color
Lemongrass oil obtained from this experiment is dark yellow color. This is in compliance with the EOA (Essential Oil of America) standard. The lemon oil oil color can be seen in Figure 5 below.

![Citronella oil](image)

**Figure 5.** Citronella oil produced.
4. Conclusions
From the experimental study, the maximum yield obtained is at 40% bed volume and sample size 15 cm that is 1.95%. The quality of lemon grass oil obtained meet the EOA (Essential Oil Association) Standards, i.e the specific gravity ranged from 0.80 to 0.903, the refractive index is 1.484 and the solubility in alcohol 70% is average produced by 1:1. Citral oil content obtained on citronella essential oil based on GC-MS analysis of 79% on sample size 3 cm and bed volume of 80% and oil color is old yellow of already meets the EOA quality standards.

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