The Effect of Air-Drying on Yield of Essential Oil from Sereh Wangi Plants Cultivated on Degraded Land

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Abstract. Citronella (Cymbopogon nardus L) is a kind of plant producing essential oil. The cultivation does not require special requirements, can be grown on less fertile soil, and able to rehabilitate degraded and critical lands. In this study, 5 levels of drying duration (0, 1, 2, 3, and 4 days) were observed for their effect on the yield of citronella oil grown at 3 critical levels of land (quite critical, critical, and very critical). The experiment was designed in a completely randomized block design with 3 replications. The distillation of whole citronella leaves was carried out for 4 hours using steam distillation method. The result showed that the air drying significantly affected the yield of citronella oil. An increase in drying duration decreased the yield of oil in a linear trend. The highest yield of oil was produced from fresh raw material (0 days drying duration). The decrease of the oil yield due to the increase of drying duration at three levels of critical land (quite critical, critical, and very critical) followed the equation Y1 = -0.024x + 0.711; Y2 = -0.017x + 0.704; and Y3 = -0.012x + 0.704 (for y = yield [%] and x = drying duration [day]).

1. Introduction

There are three types of distillation methods commonly used to produce citronella oil, namely water distillation, water and steam distillation, and steam distillation [1, 2]. In small-scale installations, the use of water distillation method and water and steam distillation method is more beneficial, because the equipment is simple, allowing it to be moved around.

Prior to the distillation process, in order to ease the steam absorption and essential oil extraction, sereh wangi leaves were subjected to some treatments. Some of the common treatments included air-drying, size reducing and curing. Air drying will speed up the extraction process and maintain the quality of essential oils produced, but during the drying, some essential oil will be lost due to evaporation [1]. During the air drying, some part of oil cells in sereh wangi leaves will break to facilitate oil extraction during distillation [3].

Air-dried sereh wangi leaves produced higher oil yield (1.52%) compared to fresh ones (0.75%) and higher citronellal level (85.73%) compared to fresh ones (75.16%) [1]. The yield of essential oil of sereh wangi leaves was lower (0.65%) compared to air-dried leaves (0.85%) [4]. Moreover, the yield of essential oil from fresh sereh wangi leaves was only 0.28-0.69% while that of dried leaves was 1.30-2.17%, and the best quality of essential oil was obtained from the combination of air-drying treatment for 2 days and distillation by steam method for 6 hours [5].
This study aimed to determine the effect of air-drying duration prior to steam distillation on the yield of sereh wangi oil, which was cultivated on three levels of land degradation and determine the optimal air-drying time that can produce the highest yield of citronella oil.

2. Materials and Methods
The main ingredient used in this study was the whole sereh wangi leaves (Cymbopogon nardus L) obtained from Desa Kebon IX, Sungai Gelam Muaro Jambi District, which was cultivated on 3 critical levels of land degradation. The main equipment used was a pilot-plant-scale steam distillation unit with a capacity of 50 kg. The research was carried out in three stages: preparation of raw materials, distillation of essential oils, and separation of oil from condensate and calculation of yield.

The experiment was arranged in a completely randomized block design with three replications, grouping based on three levels of criticality of the land where the citronella plants were cultivated. Air-drying was carried out by spreading 10 cm-thick sereh wangi leaves in a roofed room and flipping through it every 2 hours. The length of the air-drying process is set according to experiment design, namely 0, 1, 2, 3, and 4 days. Distillation is conducted by steam distillation method at a temperature of 100-110°C for 4 hours, duration of distillation process was calculated after the first condensate droplets were observed in the oil reservoir. Oil is separated from condensate water by filtering using a monel cloth. The yield was measured at 4 long durations of drying process, the data obtained was analyzed using variance at level 5 and 1%, followed by orthogonal polynomial analysis at level 5 and 1%.

3. Results and Discussions
Based on the analysis of the yield of essential oils obtained from groups of plants cultivated at 3 levels of degraded land, it was found that although not clearly visible, the more critical the condition of the land where the citronella was cultivated, the yield of essential oils tended to be higher (Figure 1). In critical lands, sereh wangi plants experience a lot of stress so that secondary metabolites formation is more intense than in normal land [6].

Meanwhile, air-drying duration of sereh wangi leaves had a significant effect on the decrease in yield of essential oils produced. Further analysis using orthogonal polynomials showed that in regression, the yield of fragrant citronella oil decreased linearly in line with the increase in air-drying process duration (Table 1).
Table 1. Polynomial orthogonal analysis on yield of citronella oil

| Contrast | ECi² | r*ECi² | JK = KT | F Calc | F Table 5% | F Table 1% | Sign |
|----------|------|--------|--------|--------|------------|------------|------|
| Air Drying duration (W) | | | | | | | |
| P1: W-linear | 0 | 0.0099 | 80.8901 | 5.5914 | 12.2464 | ** | |
| Ci² | 10 | 30 | | | | | |
| Q | -0.544567 | | | | | | |
| P2: W-square | 0 | 0.0000 | 0.0194 | 5.5914 | 12.2464 | ns | |
| Ci² | 14 | 42 | | | | | |
| Q | 0.0099667 | | | | | | |

Remarks:
- ns not significant
- ** different at sig level 1%

The decrease in yield of citronella oil due to the effect of air-drying duration at three levels of criticality of the soil (either critical, critical, and very critical), all occurred linearly with the following equations:

\[
Y = -0.024x + 0.711 \quad (1)
\]
\[
Y = -0.017x + 0.704 \quad (2)
\]
\[
Y = -0.012x + 0.704 \quad (3)
\]

for \( y \)=yield [%] dan \( x \)=the air-drying duration[days] (Figure 2).

Figure 2. The effect of air-drying and critical land on yield of citronella oil

Figure 2 described that the cultivation of sereh wangi in very critical areas obviously produce higher yields of essential oils. Based on equation (3) it was observed that if it is cultivated in a very critical area, every one-day air drying duration reduced the yield of essential oil by 0.012%. The rate of reduction in yield of essential oils due to air-drying treatment was observed to be higher in plants cultivated on less critical land.

4. Conclusions and Recommendations

Air drying significantly affected the yield of citronella oil. An increase in drying duration decreased the yield of oil in a linear trend. The highest yield of oil was produced from fresh raw material (0 days drying duration). In a very critical area, every one-day longer duration of air drying reduced the yield of essential oil by 0.012%, it was the lowest compared to cultivation on less critical land. Sereh wangi/citronella cultivation on critical land will provide many advantages such as rehabilitating the land and producing essential oils with higher yield as well.
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