Effectiveness of Citronella Oil Distiller Steam Method with One and Two Furnaces

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Abstract. The effectiveness of citronella oil distillers with one and two furnaces was studied. The parameters measured were the ability of the distiller to extract essential oils, distillation time, and the cost of the fuel used. The ability of the distiller to extract essential oils was measured based on the amount of essential oil produced. The distillation time was calculated from the time the distiller was operated until no oil was observed in the condensate. Fuel costs were calculated based on the amount of fuel used. The results showed that compared to single furnace distillers; two furnace distillers have faster and more effective extraction capabilities. The yield of citronella oil that could be extracted by distillers one and two furnaces was respectively 0.73 and 0.77%. Activation of the second furnace in the two-furnace distiller caused an increase in production costs of Rp.5416.67 for the distillation of 25 kg of raw material. The increase in production costs contributed to a decrease in processing time of 15.16% (from 296.33 to 257.33 minutes), an increase in the amount of oil that could be extracted by 5.44% (from 186.00 to 193.67 ml), an increase in effective capacity by 19.92% (from 37.66 to 45.16 ml / hour), and increased distillation effectiveness by 4.12% (from 85.52% to 89.04%).
Keywords: essential oil, modified distiller, oil extraction

1. Introduction

Citronella oil is an important commodity in the agribusiness sector that has a wide market share and high competitiveness both outside and within the country. Citronella is a plant that can produce essential oils known as citronella oil. Citronella oil is widely used as a basis for making perfumes, aroma therapy, beauty soaps, anti-mosquito repellent, pesticides, and bio additives for vehicle fuel savers [1], [2], [3]. Citronella plant could survive in the critical land or degraded land [4].

Citronella oil is the result of distillation (distillation) of citronella leaves. Distillation of citronella oil can be done by three methods, namely distillation with water (water distillation), distillation with water and steam (water and steam distillation) and distillation with steam (steam distillation). The process involves the evaporation of the liquid by heating it, followed by condensation of the vapor into liquid again (distillate). The temperature and duration of distillation affect the quality and yield of oil produced [5]. The yield of citronella distillation are affected by many factors. One factor is the condition of the land where the citronella was cultivated. The more critical land will result the more yield. It is assumed that citronella planted in critical land were having stressed and led to form secondary metabolite compound compared to citronella plants cultivated in normal land condition [6].

Distillation of essential oils from cananga flowers using the water method at 180 minutes distillation temperature at 105ºC produces distillates with oil yield of 1.1% [7]. Steam-distilled water on clove leaves at 180 minutes distillation time at 105 ºC resulted in an oil yield of 1.2% [8]. The distillation of patchouli leaves by the steam method at 105ºC for 180 minutes produced an oil yield of 1.3% [9]. This is consistent with the statement of Khabibi [10], that engineering of distillation technology can improve the yield and quality of essential oils produced. Beside that, the treatment to citronella leaves before being distilled affected the yield produced. Air-drying duration prior to steam distillation on sereh wangi leaves were significantly affected the yield of citronella oil. An increase in drying duration decreased the yield of oil in a linear trend [11].

The priority needs of practitioners for citronella oil distillers included four criteria, namely an effective heating mechanism, a high level of safety, the use of strong and safe materials, and a high yield of citronela oil [12]. For this reason, distillers must be designed using strong, non-corrosive materials and with more effective heating mechanisms. The intended distillation model can only be fulfilled if a more intense heating system is used, for example by using a two-furnace heating system.

In this research, the research was aimed to study the effectiveness of using one and two furnaces in the distillation process of citronella oil. It will also be seen whether the use of two furnaces in refined citronella oil produces better yields and quality. The purpose of this study was to compare the effectiveness and efficiency of the steam method of citronella oil refining with one and two furnaces.

2. Methods

2.1. Tools and Materials

The tools used included a steam method distiller with one and two furnaces, scales, blowers, thermometers, pressure gauges, gas cylinders, stopwatches, knives, bottles, and scissors. The materials used included the main ingredients in the form of leaves and stems of citronella (*Cymbopogon nardus*) originating from farmers on the citronella plantation from reclamation area that have been degraded in Desa Kebon IX Muaro Jambi Regency, Jambi Province and supporting materials such as water and fuel (used oil).

2.2. Methods

This study aimed to analyze and compare the effectiveness of a single furnace steam method for refining citronella oil (a common steam method distiller) with a two furnace steam method for refining citric oil (with higher steam pressure and temperature).

Placement of the second furnace is placed between the steam boiler and distilled boiler. The first stove uses fuel in the form of used oil while the second stove uses gas fuel. To measure the performance of one furnace distiller is done by not activating the second furnace.

The capacity of the distiller used in this study is 25 kg. The amount of water used in the boiler at each distillation for the two types of distillers is always the same, which is as much as 155 liters. The material used is citronella plants (sereh wangi) with the variety of mahapengiri at the age of 3.5 months after the previous harvest.

The parameters observed were distillation process time, effective capacity, and the amount of fuel procurement costs for each one and two furnace distillers. Distillation process time is determined based on the accumulation of time needed by the distiller for the extraction of essential oils from furnace activation to the separation of oil from condensate. The effective capacity of the tool is measured based on the amount of oil that can be produced (ml) divided by the processing time (hours). The amount of fuel procurement costs is calculated based on the accumulation of fuel used during the refining process multiplied by the procurement price. The data generated is the result of measurements from three observations.

2.3. Distilation Process of Citronela Oil

Distillation process conducted in this research was using one and two furnaces. The stages of the distillation process of essential oils from citronella plants are as follows:

2.3.1. For distillation with one furnace

As much as 25 kg of fragrant sereh wangi leaves and stems that have been chopped are put into a distilled kettle then the kettle is sealed tightly except in the part where the steam flows which will bring the oil extract to the condenser. Meanwhile, 155 liters of water in the boiler has been heated using used oil fuel which is placed in the furnace just below the boiler. Steam produced from the boiler is directly distributed to the boiler (without further heating in the second furnace) by allowing the faucet connecting the steam pipe to the boiler to remain open. Right when the condensate starts to form then that time is determined as the time the extracted oil starts, after that every 40 minutes the condensate that is formed will be analyzed for its oil content. The refining process is stopped after there is no more oil in the condensate produced.

2.3.2. For distillation with one furnace

All the criteria and requirements as well as the steps for carrying out the distillation in a distiller with one furnace are applied the same to a distiller with two furnaces, except in the heating stage of steam before being distributed into the boiler. Further heating of the steam is done by closing the tap that connects the steam pipe to the boiler and activates a second furnace that is fuel with gas to heat the steam during the distillation process. The steam pipe connecting faucets with the distilled kettle are only opened after the pressure and steam temperature increase respectively to at least 1.2 atm and 105oC. Once opened, the tap is left in a condition that remains open during the distillation process. Similar to what is done in a distiller with one furnace, the time the commencement of the extracted oil is marked by the formation of the first condensate, after that every 40 minutes the condensate formed will be analysed for its oil content. The distillation process is stopped after there is no more oil in the condensate produced**.**

3. Results and Discussion

3.1. Distillation Time

The distillation time required by the distillers of one and two furnaces is 296.33 and 257.33 minutes, respectively. Although more time is needed for the activation of the second furnace, the time needed for the distribution of steam to the boiler is faster in the distiller with two furnaces. The oil extraction process also occurs more quickly on a distiller with two furnaces. Comparison of distillation time of distillers with one and two furnaces can be seen in Table 1.

Steam which is heated further turns out to have the ability to spread into distilled boilers faster and more effectively. The increase in temperature and steam pressure due to further heating in the second furnace in a two-furnace distiller can significantly improve its ability to extract oil. The increase in the speed of the distillation process due to the addition of a second furnace to the distiller was 15.16% (from 296.33 minutes to 257.33 minutes).

Table 1. Comparison of distillation times with one and two furnaces

No	Process Items	Time needed (minutes)					
		One-furnace			Two-furnace		
		1	2	3	1	2	3
1	Activation of the first furnace to boil water in a boiler	85	83	86	84	83	85
2	Activation of the second furnace to heat citronella from the boiler	0	0	0	3	2	2
3	Steam distribution in the distilled boiler until the first condensate is produced	25	22	24	16	15	15

4	The process of extracting essential oils through steam distillation (until the condensate no longer contains oil)	160	156	159	129	130	125
5	Separation of water and oil	30	32	27	28	29	26
	TOTAL	300	293	296	260	259	253
	Average process time		296.33			257.33	

3.2. Effective Capacity

To measure the effective capacity of the two distillers, a measurement of the content of the condensate oil produced is made every 40 minutes from the start of the extraction process (since the release of the first condensate). The measurement results can be seen in Table 2. The measurement results for the oil content in the condensate are then mapped based on the distillation time, the results can be seen in Figure 1.

Table 2. The content of condensate oil is produced every 40 minutes from the start of the extraction process

Distiller Type	Rep	The content of oil in condensate (ml) was observed at					Oil yield (ml)
		First 40 minute	Second 40 minute	Third 40 minute	Fourth 40 minute	Fifth 40 minute	
One-Furnace	1	71	59	46	4	0	183.67
	2	76	48	48	6	0	
	3	74	66	50	3	0	
	Average	73.67	57.67	48.00	4.33	0.00	
Two-Furnace	1	75	70	39	3	0	193.67
	2	71	66	53	5	0	
	3	77	62	55	5	0	
	Average	74.33	66.00	49.00	4.33	0.00	

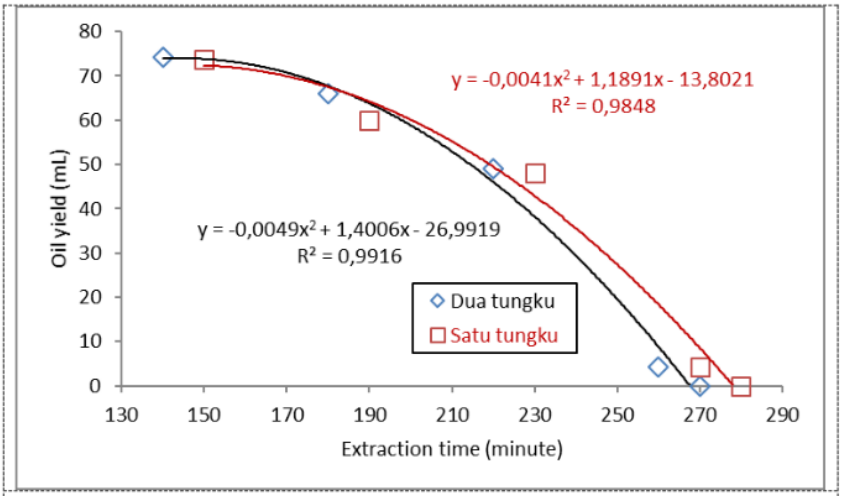

Figure 1. The relationship between the extraction time and the amount of oil produced in one- and two-furnace distiller

In Figure 1, it can be seen that the effect of extraction time on the amount of oil extracted from sereh wangi leaves and stems decreases quadratically in both one and two furnace distillers. Changes in the amount of oil that can be extracted all the time for one and two furnace distillers respectively met the

equation $y=-0.0041x^2+1.1891x-13.8021$andy$=-0.0049x^2+1.4006x-26.9919$. Based on Figure 1 it can be seen that for the distillation of one furnace, the extraction time that produces the highest oil is 145.01 minutes with the amount of oil 72.41 ml and the extraction time of more than 277.91 minutes no longer produces oil. For the distillers of two furnaces, the extraction time that produced the highest oil was 142.92 minutes with the amount of oil 73.09 ml and the extraction time of more than 265.05 minutes no longer produced oil.

Based on the equation in Figure 1 it can be seen that the total amount of oil extracted for distiller one and two furnaces is 187.60 and 189.31 ml, respectively. For the duration of the distillation process respectively 296.33 and 257.33, it can be seen that the effective capacity of the distillers of one and two furnaces is respectively 37.98 and 43.69 ml / hour. If it is known that the weight of the raw material of leaves and stems of citronella used is 25 kg with an oil content of 0.87%, it can be seen that the actual yield of distillers of one and two furnaces is respectively 0.75 and 0.76%. Thus, the effectiveness of distillers one and two furnaces was 86.25 and 87.04%, respectively. Calculation of the effective capacity and effectiveness of one and two stove distillers for the observational data and the intrapolated data from the equation in Figure 1 can be seen in Table 3.

Table 3. Calculation of effective capacity and effectiveness of the distiller

One-furnace Distiller			Two-furnace Distiller		
$y = -0.0041x^2 + 1.1891x - 13.8021$			$y = -0.0049x^2 + 1.4006x - 26.9919$		
X (minute)	Y (ml)		X (minute)	Y (ml)	
	Actual	Prediction		Actual	Prediction
150	73.67	72.31	140	74.33	73.05
190	60.00	64.12	180	66.00	66.36
230	48.00	42.80	220	49.00	43.98
270	4.33	8.36	260	4.33	5.92
277.9113		0.00	265.0540		0.00
Amount	186.00	187.60	Amount	193.67	189.31
Process time	296.33	296.33	Process time	257.33	257.33
Effective capacity (ml/menit)	0.63	0.63	Effective capacity (ml/menit)	0.75	0.73
Effective capacity (ml/jam)	37.66	37.98	Effective capacity (ml/jam)	45.16	43.69
Actual yield	0.744%	0.75%	Actual yield	0.775%	0.76%
Ideal yield	0.87%	0.87%	Ideal yield	0.87%	0.87%
Effectiveness	85.52%	86.25%	Effectiveness	89.04%	87.04%

Distiller with two furnaces turned out to have a greater effective capacity (45.16 ml / hr) compared to distiller one furnace (37.66 ml / hr). This shows that the distiller with two furnaces has higher usability compared to the distiller with one furnace. The effective capacity of two furnace distillers for distillation of citronella oil in this study (45.16 ml / hr) is greater than the results reported by Sinaga [13] for distillation of clove oil by the steam method (13.33 ml / hr), but smaller than reported by Mustaqimah [14] for the distillation of patchouli oil by the steam and water (steamed) method, which is 150 ml/hour.

Distillers with two furnaces also have higher effectiveness (89.04%) compared to distillers with one furnace (85.52%). This shows that the use of a second furnace can increase the effectiveness of distillers in extracting essential oils from the leaves and stems of citronella plants.

3.3. Cost of Fuel supply

There are two kinds of fuel used in this study, namely used oil for the first furnace and LPG for the second furnace. Activation of the second furnace begins after steam begins to be produced from the boiler due to heating carried out in the first furnace. The heating in the second furnace aims to increase

the temperature and pressure of the steam so that it can more quickly be distributed to the distilled kettle and extract the essential oils present in the material.

The heating in this distiller is divided into three periods, namely the heating period to produce steam (applicable to both types of distillers), starting from the initial heating to boiling water in the boiler, the fuel used is used oil at a price of Rp. 2000 / liter. The heating period to increase the temperature and pressure of steam (applies only to distillers of two furnaces), starting from the steam produced by the boiler until the end of the distillation process, the fuel used is 3 kg LPG gas at a price of Rp. 21,000 / tube or Rp. 7,000 / kg. The heating period for extracting essential oils in a distilled kettle (applies to both types of distillers), starting from the initial generation of condensate until no longer 4 x 40 minutes thereafter (condensate no longer contains essential oil). Calculation of fuel costs can be seen in Table 3.

In Table 3, it can be seen that the activation of the second furnace in the two-furnace distiller caused an increase in fuel production costs by Rp.5416.67 for each distillation of 25 kg of raw material. This increase in production costs contributed to a decrease in processing time of 15.16% (from 296.33 to 257.33 minutes), an increase in the amount of extractable oil by 5.44% (from 186.00 to 193.67 ml), increase in effective capacity by 19.92% (from 37.66 to 45.16 ml / hour), and increased distillation effectiveness by 4.12% (from 85.52% to 89.04%).

Table 4. Comparison of fuel cost for both distillers

No	Fuel needs and beneficiaries	Type of Distiller	
		1 furnace	2 furnace
1	Used oil/*olibekas* (liters) to produce steam	8.33	8.30
2	LPG (kg) for increasing temperature and steam pressure	-	0,20
3	Used oil/*olibekas* (liters) to processthe extraction of essential oil	7.20	6.00
4	LPG (kg) to process the extraction of essential oil	-	0.75
5	Total need of used oil/*oli bekas* (liter)	15.53	14.30
6	Total need of LPG (kg)	-	0.95
7	Cost of the supply of *oli bekas* (Rp)	15,533.33	14,300.00
8	Cost of the supply of LPG (Rp)	-	6,650.00
	Total cost needed	15,533.33	20,950.00

4. Conclusion

Compared to single furnace distillers, two furnace distillers have faster and more effective extraction capabilities. Activation of the second furnace in the two-furnace distiller caused an increase in production costs of Rp.5416.67 for the distillation of 25 kg of raw material. The increase in production costs contributed to a decrease in processing time of 15.16% (from 296.33 to 257.33 minutes), an increase in the amount of oil that could be extracted by 5.44% (from 186.00 to 193.67 ml), an increase in effective capacity by 19.92% (from 37.66 to 45.16 ml / hour), and increased distillation effectiveness by 4.12% (from 85.52% to 89.04%).

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References

[1] Sukamto M, Djazuli, Suheryadi D 2011 Serai Wangi (*Cymbopogon nardus* L) sebagai penghasil

minyak atsiri, tanaman konservasi dan pakan ternak *Prosiding Seminar Nasional* Bogor
[2] Idawanni 2016 Serai Wangi, Tanaman Penghasil Atsiri yang Potensial *http://nad.litbang.pertanian.go.id/ind/index.php/info-teknologi/712-serai-wangi-tanaman-penghasil-atsiri-yang-potensial diakses pada 18 Desember 2018*
[3] Rusli MS 2010 Sukses Memproduksi Minyak Atsiri Agromedia Pustaka Jakarta
[4] Achmad E, Novra A, and Mursalin 2017 Model pertambahan jumlah anakan sereh wangi yang ditanam pada lahan terdegradasi akibat aktivitas galian tanah timbunan bandara *Prosiding Seminar Nasional Pembangunan Pertanian II*, Fakultas Pertanian UB Malang 329-332 *https://fp.ub.ac.id/semnas2017/prosiding_1.html*
[5] Tanasale MLP 2012 Aplikasi Perlakuan Bahan Baku Dan Penyulingan Air-Uap Terhadap Rendemen dan Sifat Organoleptik Minyak Atsiri *Jurnal Eko Sains* Vol **1** (1) 35-40
[6] Achmad E, Novra A, and Mursalin 2018 Rendemen Minyak Sereh Wangi (*Cymbopogon Nardus L*) Yang Dibudidayakan Di Lahan Terdegradasi Akibat Aktivitas Galian Timbunan Bandara. Prosiding Seminar Nasional Teknopreneur Universitas Pasir Pengaraian Vol **1**
[7] Setyawan MA, Zakariyya M, Mahfud 2013 Pengambilan Minyak Atsiri dari Bunga Kenanga Menggunakan Metode Hydro-Distillation dengan Pemanas Microwave *Jurnal Teknik Pomits* Vol **2** (2) 282-285
[8] Habibi W, Ayong ZH, Pantjawarni P, and Mahfud 2013 Perbandingan Metode Steam Distillation dan Steam-Hydro Distillation dengan Microwave terhadap Jumlah Rendemen serta Mutu Minyak Daun Cengkeh *Jurnal Teknik Pomits* Vol **2**(2) 234-238
[9] Setya NH, Budiarti A, Mahfud 2012 Proses Pengambilan Minyak Atsiri dari Daun Nilam dengan Pemanfaatan Gelombang Mikro (microwave) *Jurnal Teknik ITS* Vol **1**
[10] Khabibi J 2011 Pengaruh Penyimpanan Daun dan Volume Air Penyulingan terhadap Rendemen dan Mutu Minyak Kayu Putih Skripsi Fakultas Kehutanan Institut Pertanian Bogor Bogor
[11] Achmad E, Novra A, Mursalin 2019 The Effect of Air-Drying on Yield of Essential Oil from Sereh Wangi Plants Cultivated on Degraded Land *IOP Conference Series* Earth and Environmental Science **309**(1) 012037 doi101088/1755-1315/309/1/012037
[12] Bestari RT 2019 Rancangan Alat Penyuling Minyak Atsiri Berdasarkan Kriteria *Quality Function Deployment* (QFD) Dan *House Of Quality* (HOQ) *Skripsi* Fakultas Teknologi Pertanian Universitas Jambi
[13] Sinaga OF, Lukman AH, and Adian R 2016 Rancang Bangun Alat Penyuling Minyak Atsiri Tipe Uap Langsung *Jurnal Rekayasa Pangandan Pertanian* Vol **4**(4) 590-595
[14] Mustaqimah, Padhil R, and Ariani R 2010 Analisis Teknik dan Biaya Operasional Alat Penyuling Nilam Dengan Sumber Bahan Bakar Kayu Di Aceh Barat Daya *Aceh Develovment International Conference ISBN 978-967-5742-00-2*

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8