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Compound Characterization of Citronella Oil from Riau and West Java Using GC-MS

Euis Yuliani[1*], Rini Permata Sari[1], Eneng Siti Nuraisah[1], Dedi Kurnia Abdullah[2], Dinar Rahaju Pudjiastuty[2]

*Correspondence:
yuliani.euis@gmail.com

[1] Department of Chemistry, Sekolah Tinggi Analis Bakti Asih, Bandung, Indonesia
[2] Department of Medical Laboratory Technology, Sekolah Tinggi Analis Bakti Asih, Bandung, Indonesia

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ABSTRACT

Indonesia has various types of oil-producing plants. Essential oils have the characteristics of a liquid, volatile and have a very distinctive aroma. Citronella oil (*Cymbopogon winterianus Jowitt ex Bor*) is an essential oil obtained from steam distillation of the stems and leaves of fragrant citronella. **The aim of this study** was to determine the compounds contained in citronella essential oil from Riau and its differences with citronella essential oil from West Java districts using GC-MS. **Materials and Method:** This study used a sample of citronella from the district of Riau. The results obtained were 5.6 mL of citronella oil from steam distillation of 380 grams of leaves and stems of citronella fragrance in Riau district, with a yield value of 1.3%. And physical tests were carried out which included color, specific gravity and refractive index, all of which met the requirements according to SNI 06-3953-1995. **Results:** Based on the results of compound analysis carried out using GC-MS, there are 12 compounds that comply with ISO 3848 of 2016 in Citronella Oil, Riau and West Java (Alpha-Pinene, Limonene, Beta-Linalool, Citronellal, Citronellol, Geraniol, Citronellol Acetate, Eugenol, Beta-Elemene, Germacrene D, Gama-Cadinene, Elemol). The same 3 main components were found in both samples, namely citronellol, citronellol and geraniol. **Conclusion:** The difference in the main components, namely citronellol and citronellol, in the Riau sample had lower levels, namely, 13.76% and 6.22%, while in the sample from West Java the levels were 37.89% and 10.21%, respectively. However, the levels of geraniol in the Riau district sample were higher (39.47%) than those from West Java (26.84%).

Keywords: *Gas Chromatography-Mass Spectrometry (GC-MS), Citronella Oil, Steam Distillation.*

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INTRODUCTION

Citronella (*Cymbopogon winterianus Jowitt ex Bor*), belongs to the Poaceae family and is an example of an aromatic plant that produces essential oil [1]. Originally from southwest Asia, it now grows spontaneously throughout the world, especially in tropical and subtropical areas [2,3]. They are used in ethnopharmacology to treat gastrointestinal and nervous disorders and as anti-inflammatory, analgesic, sedative, and antipyretic [3,4].

Lemongrass has been reported possessing antimicrobial activity. The antibacterial properties of lemongrass water extract have been reported Furthermore, lemongrass essential oil demonstrated inhibition activity against various microbes including food- borne bacteria [5].

Lemongrass oil or Citronella oil is an essential oil obtained from lemongrass leaves and stems. The quality of essential oils in general and citronella oil in particular is determined by the purity factor. The quality of citronella oil is determined by the main components in it, namely the citronellal and geraniol content which is usually expressed by the amount of geraniol content [6]. Citronella oil must not contain or be contaminated with foreign substances such as fatty oils, alcohol, or kerosene. Citronella oil is usually light yellow to dark yellow and evaporates easily [7]. The specific gravity and solubility in ethanol of citronella oil are important in determining the quality of the oil which will have an impact on oil industry production [8].

The constituent components of lemongrass oil, namely citronellal, citronellol and geraniol [9,10] this plant has been reported possessing antimicrobial activity. The antibacterial properties of lemongrass water extract have been reported. Furthermore, lemongrass essential oil demonstrated inhibition activity against various microbes including food-borne bacteria [11], can be converted into derivatives which are widely used in the perfume industry. The economic value of lemongrass oil can be increased by isolating its main components, namely citronellal, citronellol and geraniol, and converting the main components, namely citronellal, into its derivatives [12,13]. Lemongrass essential oil is extracted from dried leaves, in yields of 0.5 to 2.0%, and the oil has at least 60% citral, which consists of a mixture of two isomers: neral (Z-isomer) and geranial (E-isomer). Citral is the main component and chemical marker of essential oils. *Cymbopogon winterianus Jowitt ex Bor* and its concentration depend on geographical factors, which are higher in tropical areas. The application of essential oils has increased due to the comprehensive requirements for pure natural oils of the ingredients, and exhibits a wide range of biological activity, representing a real potential product for the pharmaceutical industry. In addition, it can be used as a preservative and flavoring agent, as a fragrance, and as an aromatherapy ingredient in the food and cosmetics industry. However, essential oils are difficult to manipulate and apply in industry because of their low solubility in water, high volatility, and easy degradation by heat, oxidation, and light [11,14].

Gas Chromatography and Mass Spectrometry (GC-MS) and obtained citronellal 36.11%, geraniol 20.07%, and citronellol 10.82%. Fractionation of citronella oil was carried out using GC-MS analysis to obtain 80.65% citronellol, 76.63% geraniol, 95.10% citronellal, and 75.95% p-menthane-3,8-diol [15]. Active compounds found in lemongrass oil include citral, citronellol, α-pinene, camphen, sabinen, myrsen, β-felandren, psimen, limonene, cis-osimen, terpinol, citronellal, borneol, terpinen-4-ol, α-terpineol , geraniol, farnesol, methyl heptenone, n-decialaldehyde, dipentene, methyl heptenone, Bornylacetate, geranylformate, terpinyl acetate, citronellyl acetate, geranyl acetate, element β, β-cariophylene, β-bergamotene, transmethylisoeugenol, elemol, and caryophyllene oxide [16-19].

The GC-MS results of citronella oil from Riau district obtained in this study were then compared with the results of testing citronella essential oil in Ganjarsari, Cikalong Wetan, West Java.

MATERIALS AND METHODS

The research materials used include citronella leaves and stems originating from Riau Regency, essential oils of Ganjarsari citronella, Cikalong Wetan West Java Province, distilled water, methylene chloride, 70% and 80% alcohol. The tools used in this research include a set of Gas Chromatography Mass Spectrophotometry (GC-MS) tools, a set of steam distillation tools, scales, measuring cups, micropipettes, yellow type, scissors, drop pipettes, refractometers, pycnometers, technical balances, test tubes, newspapers, white plastic, raffia rope, white duct tape.

Preparation begins by rinsing the vial tube with methylene chloride 3 times then pipetting 10 µL of the citronella essential oil sample then adding 1 mL of methylene chloride and putting it into the vial tube, then homogenizing until evenly mixed. Previously, the syringe was rinsed using methylene chloride solution 3 times. Then the syringe is rinsed using the sample in the vial 3 times. Pipette 1 µL of sample into a vial using a syringe, then inject it into the Gas Chromatography apparatus. Then press the start button.

Determination of citronella begins by cleaning the citronella plant from dirt, then bending the citronella plant, then wrapping it in newspaper and tying it using raffia. Put it in white plastic, then douse it with 70% alcohol and cover it in plastic using white duct tape. Then a determination test is carried out.

Isolating citronella plants using steam distillation begins with cleaning the leaves stem of citronella, then cut into small sizes. Then weigh 380 g of citronella leaves and stems, then place them on a filter in a distillation kettle, dry ingredients that have been filled with water at the bottom of the filter rack. Steam distillation was carried out at a temperature of 100 ˚C with a distillation time of ± 4 hours.

The steam from the distillation is condensed to obtain a distillate and collected in a separating funnel, then the distillate is allowed to stand for approximately 24 hours, until two layers are formed. Then separated. The water that is still contained in the citronella essential oil is separated by adding anhydrous Na_2SO_4 as an indication that

all the water in the essential oil has been removed. Na_2SO_4 and citronella oil are then separated with cotton. The separated citronella essential oil is stored in a glass bottle, dry, and tightly closed.

The yield of citronella oil produced is calculated using the equation:

$$oil\ rendemen\ (\%) = \frac{a}{b}\ x\ 100\%\ (1)$$

The specific gravity test for citronella essential oil is carried out in accordance with the standard procedure for determining specific gravity. Then record the temperature and the results obtained. Calculation of specific gravity can be calculated using the equation:

$$d_{20^\circ C}^{20^\circ C} = \frac{m_2 - m}{m_1 - m}\ (2)$$

The refractive index test for citronella essential oil was carried out using a refractometer. The refractive index calculation can be calculated using the equation:

$$n\,{}_D^t = n_D^{t_1} + 0{,}004\ (t_1 - t)\ (3)$$

Solubility test in 80% alcohol, first pipette 1 mL of citronella oil sample into a test tube. Then add 2 mL of 80% alcohol to the test tube then homogenize until evenly mixed. Then observe the changes that occur.

RESULTS AND DISCUSSION

Based on the results of research conducted at the Indoscience Essential Oils Laboratory on the characterization of citronella essential oil compounds using the GC-MS (Gas Chromatography and Mass Spectrometry) method. In this study, the samples used were citronella leaves and stems originating from Riau district.

Determination of Citronella Grass

Determination of citronella plants was carried out in the ITB laboratory (Bandung Institute of Technology). The results of the determination stated that the citronella plant came from :

Tribe : Poaceae
Type Name : *Cymbopogon winterianus Jowitt ex Bor*
Synonim : -
Local Name : *Serai Wangi*

Steam Distillation of Citronella Oil

The steam distillation process is carried out for ± 4 hours at a temperature of 100°C, before distillation the leaves and stems of citronella are cut until they are small in size, the distillate that comes out of the condenser is in the form of essential oil which is condensed with water. After completing the distillation process, the next step is the process of transferring the essential oil into a measuring cup.

In the observation results, it will form into 2 (two) layers, where the bottom layer is water and the top layer is essential oil. The oil obtained was then separated by adding anhydrous Na_2SO_4 as a dryer. Then the oil obtained is stored in a glass bottle, dry and tightly closed to avoid light oxidation. Next, the yield of the oil obtained is calculated and the physical properties are tested and then characterization is carried out.

Citronella Oil Yield

The yield produced from the steam distillation of citronella, as much as 380 grams of citronella leaves and stems were used, resulting in 5.6 mL of steam distillation of citronella oil which was pale yellow in color and had a very distinctive aroma, with a yield value of 1.3%. The calculation results of the yield of citronella essential oil are said to be greater than the yield according to export quality standards with a yield ranging from 0.70% - 1.2%. It can be observed from the large yield value of citronella oil, namely from soil fertility.

In this research, citronella plants were planted using peat soil as a medium. Citronella planted in peat soil does not have sufficient nutrients for the plant growth process. Peat soil has a soil acidity that is generally 5-7 for citronella plants, while peat soil has an acidity of 2.82 – 3.49. During the growth process, citronella plants are given organic fertilizer such as manure, but chemical fertilizers are not given because this is to obtain oil from citronella planted in real peat soil. Other factors that can cause the high yield value are the age of the plant, the condition of

the material at the time of steam distillation and the time of the distillation process. The citronella plant was 4 months old and the condition of the material when distilled was wilted and distilled for ± 4 hours.

Physical Test with Test Parameters such as Refraction Index, Specific Gravity, and Solubility in 80% Alcohol

From the results of physical tests carried out on the two samples of citronella essential oil, the following results were obtained as seen in Table 1 and Table 2.

Table 1. Physical Test of Essential Oil of Citronella from Riau District

No	Test Type	Result	Terms and Conditions
1.	Color	Pale yellow	Pale yellow to brownish yellow
2.	Specific Gravity	0,894	0,0880-0,902
3.	Refractive Index	1,474	1,466-1,477
4.	Solubility in Alcohol	1:2	1:2 clear solution until opalescence

Table 2. Physical Test of Essential Oil of Citronella from West Java Province

No	Test Type	Result	Terms and Conditions
1	Color	Pale yellow	Pale yellow to brownish yellow
2	Specific Gravity	0,886	0,0880-0,902
3	Refractive Index	1,477	1,466-1,477
4	Solubility in Alcohol	1:2	1:2 clear solution until opalescence

The physical test of citronella essential oil aims to determine the quality of the essential oil obtained. Physical tests carried out on citronella essential oil include color, specific gravity, and refractive index. Lemongrass essential oil has a pale yellow color due to the unextracted citronellal and geraniol compounds. This color meets the requirements, where the color of citronella oil is from pale yellow to brownish yellow. Specific gravity is often related to the heavy fraction of the components contained in essential oils. Based on the analysis, the specific gravity of essential oil from citronella in Riau and West Java districts at a temperature of 20°C is 0.894 and 0.886 respectively. Examination of the refractive index of citronella essential oil was carried out using a refractometer. Based on analysis of the two samples, the refractive index for essential oils for Riau district was found to be 1.4742 and West Java 1.4774.

Solubility in 80% Alcohol

The more soluble the oil is in alcohol, the more polar compounds the oil contains. In Table 1 and Table 2 we can see that the solubility of alcohol in citronella essential oil is 1:2 (clear), where 1 mL of essential oil dissolves in 2 mL of 80% alcohol. Alcohol has a hydroxyl group (OH), therefore it can form hydrogen bonds with the OH group and carbonyl group of the components in lemongrass oil. From the results of the physical tests carried out, in the two samples of citronella essential oil from Riau and West Java districts, each parameter met the quality requirements for citronella oil in accordance with SNI 06-3953-1995.

Characterization Results by Using GC-MS

The chromatogram resulting from the analysis shows thirty-one compound peaks with different retention times.

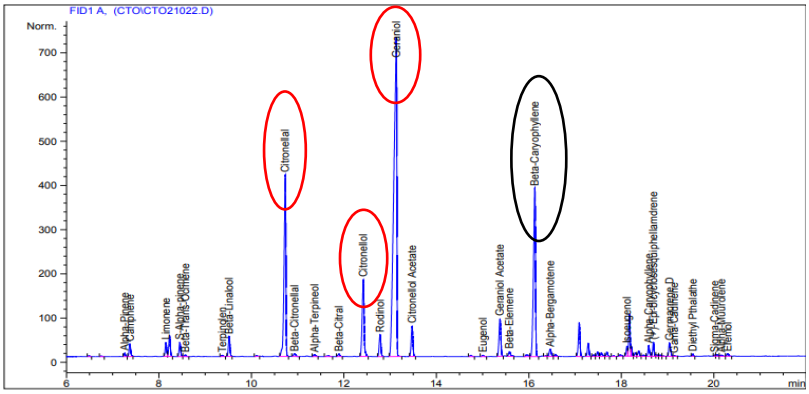

Figure 1. Chromatotographic Pattern of GC-MS Analysis Results from Citronella Oil from Riau District

Table 3. Compound Components of GC-MS Analysis of Riau Citronella Oil

No	Ret Time	Name of Compound	CAS	RI NIST	Mr	4 Main Ions	% Area
1	7,262	Alpha-pinene	80-56-8	948	136	93,92,91,77	0,18699
2	7,375	Camphene	79-92-5	943	136	93,121,79,91	0,8379
3	8,155	Limonene	138-86-3	1018	136	68,93,39,67	0,88315
4	8,452	S-Alpha-pinene	51-64-9	1855	135	44,91,65,42	0,91731
5	8,572	Beta-trans-Ocimene	3779-61-1	976	136	93,41,79,91	0,11097
6	9,373	Terpinolen	586-62-9	1052	136	93,21,91,136	0,08214
7	9,519	Beta-Linalool	78-70-6	1082	154	71,93,55,43	1,30111
8	10,732	Citronellal	106-23-0	1125	154	41,69,55,95	13,76303
9	10,931	Beta-Citronellal	106-23-0	1125	154	41,69,55,95	0,2665
10	11,369	Alpha-Terpinolen	586-62-9	1052	136	93,121,91,136	0,16844
11	11,892	Beta-Citral	106-26-3	1174	152	41,69,27,39	0,18349
12	12,420	Citronellol	106-22-9	1179	156	69,41,67,81	6,22659
13	12,782	Rodinol	106-22-9	1179	156	69,41,67,81	1,55321
14	13,133	Geraniol	106-24-1	1228	154	69,41,68,67	39,47457
15	13,475	Citronellol Acetat	150-84-5	1302	198	43,69,81,95	2,14379
16	15,008	Eugenol	97-53-0	1392	164	164,103,77,149	0,10188
17	15,375	Geraniol Acetate	16409-44-2	1352	196	96,43,91,68	2,85150
18	15,580	Beta-Elemene	515-13-9	1398	204	81,93,68,41	0,40841
19	16,129	Beta-Caryophyllene	87-44-5	1494	204	93,133,91,41	14,11515
20	16,461	Alpha-Bergamotene	17699-05-7	1430	204	93,41,119,91	0,59881
21	17,089	Germacrene D	23986-74-5	1515	204	161,105,91,41	2,29395
22	17,283	Methyleugenol	93-15-2	1361	178	178.163.147.103	0,86337
23	18,121	Isoeugenol	97-54-1	1410	164	164,77,149,91	0,55631
24	18,591	Alpha-Caryophyllene	6753-98-6	1579	204	93,80,41,121	0,72394
25	18,694	(+)-Epi-bicyclosesquiphellamdrene	54324-03-7	1435	204	161.105.119.204	0,82066
26	19,142	Gama-Cadinene	55963-79-6	1718	288	181.183.109.219	0,04297
27	19,545	Diethyl pthalathe	1609-47-8	1028	162	29,49,63,91	0,11211
28	20,023	Sigma-Cadinene	50-03-3	2952	404	43,123,124,91	0,05704
29	20,161	Alpha-Muurolene	10208-80-7	1440	204	105,161,94,93	0,11072
30	20,300	Elemol	639-99-6	1522	222	59,93,81,41	0,20524
31	20,877	Alpha-selinene	473-13-2	1474	204	189,204,93,81	0,00000

The results of the analysis of citronella essential oil from Riau district were then compared with the results of the analysis from West Java. The results of the analysis of citronella oil from West Java can be seen in Figure 2 and Table 4.

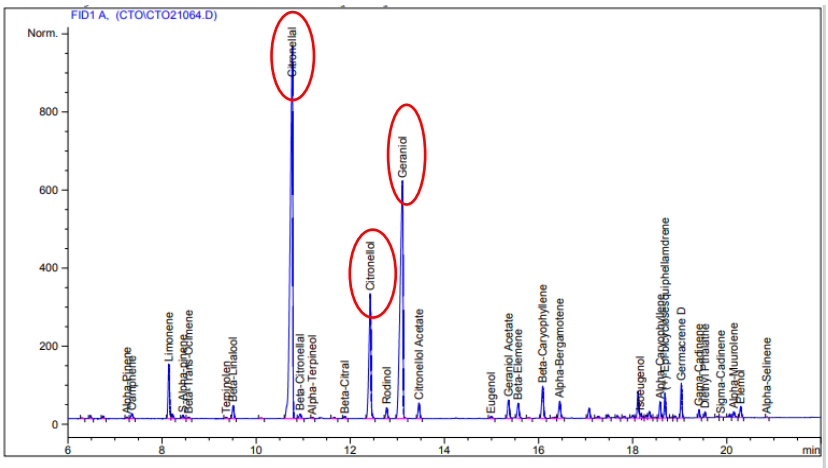

Figure 2. Chromatotographic Pattern of GC-MS Analysis Results from Citronella Oil from West Java Province

Table 4. Compound Components of GC-MS Analysis of West Java Citronella Oil

No	Ret Time	Name of Compound	CAS	RI NIST	Mr	4 Main Ions	% Area
1	7,256	Alpha-Pinene	80-56-8	948	136	93,92,91,77	0,08938
2	7,361	Camphene	79-92-5	943	136	93,121,79,91	0,35431
3	8,148	Limonene	138-86-3	1018	136	68,93,39,67	3,22846
4	8,445	S-Alpha-Phinene	51-64-9	1855	135	44,91,65,42	0,24393
5	8,564	Beta-Trans-Ocimene	3779-61-1	976	136	93,41,79,91	0,08597
6	9,362	Terpinolen	586-62-9	1052	136	93,21,91,136	0,09327
7	9,511	Beta-Linalool	78-70-6	1082	154	71,93,55,43	0,84930
8	10,766	Citronellal	106-23-0	1125	154	41,69,55,95	37,89740
9	10,936	Beta-Citronellal	106-23-0	1125	154	41,69,55,95	0,37192
10	11,196	Alpha-Terpineol	586-62-9	1052	136	93,121,91,136	0,07149
11	11,883	Beta-Citral	106-26-3	1174	152	41,69,27,39	0,14037
12	12,424	Citronellol	106-22-9	1179	156	69,41,67,81	10,21944
13	12,773	Rodinol	106-22-9	1179	156	69,41,67,81	0,74734
14	13,108	Geraniol	106-24-1	1228	154	69,41,68,67	26,84486
15	13,458	Citronellol Acetate	150-84-5	1302	198	43,69,81,95	1,06874
16	14,993	Eugenol	97-53-0	1392	164	164,103,77,149	0,15606
17	15,362	Geraniol Acetate	16409-44-2	1352	196	96,43,91,68	1,36561
18	15,567	Beta-Elemene	515-13-9	1398	204	81,93,68,41	1,09205
19	16,087	Beta-Caryophyllene	87-44-5	1494	204	93,133,91,41	2,3691
20	16,449	Alpha-Bergamotene	17699-05-7	1430	204	93,41,119,91	1,28457
21	18,162	Isoeugenol	97-54-1	1410	164	164,77,149,91	0,21262
22	18,582	Alpha-Caryophyllene	6753-98-6	1579	204	93,80,41,121	0,94068
23	18,686	(+)-Epi-bicyclosesquiphellamdrene	54324-03-7	1435	204	161.105.119.204	1,32668
24	19,033	Germacrene D	23986-74-5	1515	204	161,105,91,41	1,81552
25	19,409	Gama-Cadinene	55963-79-6	1718	288	181.183.109.219	0,42559
26	19,536	Diethyl Pthalathe	1609-47-8	1028	162	29,49,63,91	0,27753
27	19,875	Sigma-Cadinene	50-03-3	2952	404	43,123,124,91	0,02038
28	20,149	Alpha-Muurolene	10208-80-7	1440	204	105,161,94,93	0,40398
29	20,294	Elemol	639-99-6	1522	222	59,93,81,41	0,67076
30	20,851	Alpha-Selinene	473-13-2	1474	204	189,204,93,81	0,03497

Before characterizing the citronella essential oil compound, the sample was first prepared by pipetting 10 µL then adding 1 mL of methylene chloride so that it evaporates quickly and does not interfere with the chromatogram of the original compound, then homogenized until the oil and methylene chloride are evenly mixed, before the sample is injected. the syringe was rinsed using methylene chloride solution 3 times so that the syringe was not contaminated with the previous sample, then the syringe was rinsed again using the sample in the vial 3 times. Then 1 µL of the sample is taken from the vial using a syringe, then injected through an injector at a temperature of 250°C, then evaporated until the sample turns into steam or gas. The gaseous sample is carried by Helium at a constant flow rate into the capillary column at a maximum temperature of 325°C. The sample components will separate when passing through the column due to differences adsorption power of the stationary phase on components of sample. The separated components will be pushed by the mobile phase to exit the column.

After the sample is separated into its components, each component will come out of the column with the mobile phase. This concentration can be measured with a detector with a programmed temperature of 300°C, with a hydrogen flow of 35 ml/minute and an air flow of 350 ml/minute in a FID detector (Flame Ionization Detector) which will produce a signal, level and then be sent to the reader. In Table 3, the condition of the GC-MS equipment when used.

The results of the analysis of lemongrass essential oil compounds showed that there were 3 highest peak points, namely Geraniol 39.47%, Citronellal 13.76% and Beta-Caryophyllena 14.11%. The results of the analysis of the compounds that make up citronella essential oil from this research were then compared with the results of compounds from West Java, where the results of the analysis of West Java citronella contained 30 compounds with different peak points and there were 3 highest peaks, namely Citronellal 37.89% , Geraniol 26.84% and Citronellol 10.21%. In citronella oil, Riau district, the presence of the Methyl Ieugenol compound was detected at a retention time of 17.283, but in citronella oil from West Java, those compounds are not detected (Table 3).

The comparison can be seen from the number of compounds, retention time and levels of each identified from each citronella essential oil. The levels obtained in the two samples were different, this was due to differences in location or place of planting of the citronella samples which influenced their composition and factors during steam distillation.

The results of these levels when calculated using a manual formula can be seen below:

$$\% \text{ area} = (\text{Area citronellal})/(\text{Total area}) \times 100\% \quad (4)$$

Data :
Area citronellal = 1124,71814
Total area = 8172,02708

Then :
% area = (1124,71814/8172,02708) x 100%
=13,76303 %

Based on the results of observations made on both citronella essential oils from Riau and West Java districts, there are twelve compounds contained in ISO-3848:2016, namely: Alpha-Pinene, Limonene, Beta-Linalool, Citronellal, Citronellol, Geraniol, Citronellol Acetate, Eugenol, Beta-Elemene, Germacrene D, Gama-Cadinene, Elemol. With different retention times, it can be seen in Tables 6 and 7.

Table 5. GC-MS Instrument Condition

Oven Conditions	
Initial Temperature	50°C
Initial Time	0,00 minute
Maximum Temperature	325°C
Post Temperature	50°C
Post Time	0,00 minute
Running Time	22,67 minute
Front Inlet Injector Conditions	
Mode	Split
Initial Temperature	250°C
(Pressure)	4,95 Psi
Gas Type	Helium
Column Conditions	
Capillary Columns	
No. Model	Agilent 19091J-113 HP-5 5%
Maximum Temperature	325°C
Mode	Constant Flows
Initial Flows	1,0 mL/minute
Average Speed	19 cm/second
Detector Conditions	
Temperature	300°C
Hydrogen Flows	35,0 mL/minute
Air Flows	350,0 mL/minute
Mode	Constant Makeup Flows
Aliran makeup	5,0 ml/minute
Makeup gas type	Helium
Flame	on

In the Table 6 and Table 7 with the results of different retention times. This is due to the difference in boiling point. Where compounds that have a lower boiling point will be separated first into the detector. Compounds with low boiling points will easily evaporate and this will affect the retention time. The shortest retention time in the two samples was the alpha-pinene compound and the compound that had the longest retention time in the two samples was elemol. This shows that the alpha-pinene compound has the lowest boiling point, while the elemol compound has the highest boiling point. Comparison of the retention times of the two samples with the same compounds, namely eugenol and germacrene D, the retention time for citronella essential oil in Riau District was (15,008 and 17,089) while the retention time for citronella essential oil in West Java was (14,993 and 19,033), at

Riau district samples, the germacrene D compound had a slower retention time and conversely for the West Java essential oil sample the eugenol compound had a slower retention time. Comparison of retention times in both samples because The results of compound characterization from two samples of citronella essential oil from different regions contained 12 compounds, showing that the levels of these compounds were not all included in ISO-3848:2016, only a few levels were included in ISO.

Table 6. Active Components that are in Accord with ISO-3848:2016 Standards from GC-MS Results from Citronella from Riau District

No	Ret Time	Name of Compound	CAS	RI NIST	Mr	4 Main Ions	% Area
1	7,262	Alpha-pinene	80-56-8	948	136	93,92,91,77	0,18699
2	8,155	Limonene	138-86-3	1018	136	68,93,39,67	0,88315
3	9,519	Beta-Linalool	78-70-6	1082	154	71,93,55,43	1,30111
4	10,732	Citronellal	106-23-0	1125	154	41,69,55,95	13,76303
5	12,420	Citronellol	106-22-9	1179	156	69,41,67,81	6,22659
6	13,133	Geraniol	106-24-1	1228	154	69,41,68,67	39,47457
7	13,475	Citronellol Acetat	150-84-5	1302	198	43,69,81,95	2,14379
8	15,008	Eugenol	97-53-0	1392	164	164,103,77,149	0,10188
9	15,580	Beta-Elemene	515-13-9	1398	204	81,93,68,41	0,40841
10	17,089	Germacrene D	23986-74-5	1515	204	161,105,91,41	2,29395
11	19,142	Gama-Cadinene	55963-79-6	1718	288	181.183.109.219	0,04297
12	20,300	Elemol	639-99-6	1522	222	59,93,81,41	0,20524

Table 7. Active Components that are in Accord with ISO-3848:2016 Standards from GC-MS Results from Citronella from West Java Province

No	Ret Time	Name of Compound	CAS	RI NIST	Mr	4 Main Ions	% Area
1	7,256	Alpha-Pinene	80-56-8	948	136	93,92,91,77	0,08938
2	8,148	Limonene	138-86-3	1018	136	68,93,39,67	3,22846
3	9,511	Beta-Linalool	78-70-6	1082	154	71,93,55,43	0,84930
4	10,766	Citronellal	106-23-0	1125	154	41,69,55,95	37,89740
5	12,424	Citronellol	106-22-9	1179	156	69,41,67,81	10,21944
6	13,108	Geraniol	106-24-1	1228	154	69,41,68,67	26,84486
7	13,458	Citronellol Acetate	150-84-5	1302	198	43,69,81,95	1,06874
8	14,993	Eugenol	97-53-0	1392	164	164,103,77,149	0,15606
9	15,567	Beta-Elemene	515-13-9	1398	204	81,93,68,41	1,09205
10	19,033	Germacrene D	23986-74-5	1515	204	161,105,91,41	1,81552
11	19,409	Gama-Cadinene	55963-79-6	1718	288	181.183.109.219	0,42559
12	20,294	Elemol	639-99-6	1522	222	59,93,81,41	0,67076

From Riau district there are 4 compounds whose concentration values meet standards and 8 compounds whose concentration values do not meet ISO 3848-2016 standards, compounds whose concentration values meet ISO standards are: Alpha-Pinene, Beta-Linalool, Citronellol Acetate and Germacrene D. Meanwhile the compounds whose content values are not included in ISO, namely, Limonene, Citronellal, Citronellol, Geraniol, Eugenol, Beta-Elemene, Gama-Cadinene and Elemol. Meanwhile, from West Java, the concentration values met the standards, there were 6 compounds and there were 6 compounds that did not meet the ISO 3848-2016 standard.

The results of the differences in the main components of the citronella essential oil, citronellal and citronellol contained in the Riau sample had lower levels (13.76% and 6.22%) compared to the West Java essential oil content of citronellal and citronellol (37.89% and 10.21%). However, the geraniol content in the Riau sample was higher, namely 39.47%, compared to the level from West Java, namely 26.84%.

The difference in levels of these compounds is thought to be due to climate and altitude above sea level. These elements greatly influence the plant growth process. The higher a place, the lower the average air temperature, and conversely, the lower a place is, the higher the temperature at that location. From the results observed above, it can be concluded that within the same plant species, but at different growing locations, the levels of chemical

compounds produced vary quite a lot. This is due to the chemical relationship between the chemical components of essential oils and the secondary metabolic processes that occur in plants. This process is influenced by the ecosystem and natural challenges such as weather and soil conditions.

Table 8. Comparison of Compounds in Citronella Grass from Riau District and West Java

Name of Compound	Riau District (%)	West Java (%)	ISO-3848:2016	Riau District	West Java
Alpha-Pinene	0,18699	0,08938	≥ 1,5	✓	✓
Limonene	0,88315	3,22846	2-5	-	-
Beta-Linalool	1,30111	0,84930	0.5-1.5	✓	✓
Citronellal	13,76303	37,89740	31.0-40.0	-	✓
Citronellol	6,22659	10,21944	8.5-14	-	✓
Geraniol	39,47457	26,84486	0.3-1	-	-
Citronellol Acetate	2,14379	1,06874	2-4	✓	-
Eugenol	0,10188	0,15606	0.5-1	-	-
Beta-Elemene	0,40841	1,09205	0.7-2.5	-	✓
Germacrene D	2,29395	1,81552	1.5-3	✓	✓
Gama-Cadinene	0,04297	0,42559	1.5-2.5	-	-
Elemol	0,20524	0,67076	1.3-4.8	-	-

✓ in accord to standard
- not in accord to standard

CONCLUSIONS

In Riau citronella essential oil, 31 compounds were found, but in this sample only 12 chemical compounds met ISO 3848-2016 standards, namely: Alpha-Pinene, Limonene, Beta-Linalool, Citronellal, Citronellol, Geraniol, Citronellol Acetate, Eugenol , Beta-Elemene, Germacrene D, Gama-Cadinene. From the two different samples, the same 3 main components were obtained, namely citronellal, citronellol and geraniol. Comparison of the main components, namely: citronellal and citronellol found in Riau district have lower levels (13.76% and 6.22%) compared to West Java essential oil levels of citronellal and citronellol (37.89% and 10.21%). However, the geraniol levels found in Riau Regency are higher, namely 39.47%, compared to the levels in West Java, namely 26.84%.

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