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Impact of Different Storage Conditions on Composition of Lemongrass (*Cymbopogon citratus* L.) Essential Oil of Tien Giang Province, Vietnam

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Essential oils are known to be susceptible to changes and degradation that can lead to loss of quality and pharmacological properties. In this work, lemongrass essential oil is stored under different storage conditions under the influence of light and temperature, assessing the physical and chemical properties as well as the chemical composition of the citronella essential oil respectively. The change in the chemical composition of citronella oil is determined based on the storage time of 4 months under different conditions *i.e.* light (45 ºC) and in dark (4 ºC). To determine the change in the composition of the essential oil, based on the results of GC-MS analysis methods to monitor the chemical changes of the essential oil. The content of main components of citral and β-myrcene increases significantly after storage time under the influence of light and temperature. Some low content components (β-citronello, β-caryophyllen, *p*-cymen-8-ol, *etc.*) are likely to be oxidized and lost under light conditions, even in the dark. Therefore, the importance of external storage factors for the chemical and physical stability of essential oils is a matter of concern to control the quality of scientific evaluation.

Keywords: Lemongrass (*Cymbopogon citratus* L.), Essential oil, Tien Giang province, Storage, Temperature, Light.

INTRODUCTION

In recent years, people have tended to favour natural, non-toxic food, pharmaceutical and cosmetic products and can minimize the introduction of chemicals into the body and protect consumers' health. As an outstanding phenomenon, extracts from herbs and plants, especially essential oils are being paid attention in Vietnam as well as in the world, which are applied to create natural flavour in products [1]. There are many studies showing the attractiveness of essential oils to life, how to extract and preserve, determine chemical composition or biological activity and how to apply essential oils to bring high efficiency [2-6]. Through this, essential oil plants are highly applicable in many areas of production and life and are scientists interested in researching, exploiting and processing them to enhance their use-value [7,8].

Cymbopogon (family: Poaceae) represents an important genus of about 120 species that grow in tropical and subtropical regions of the world. Citronella is grown on a large scale, especially in the tropics and subtropics [9]. Lemongrass (*Cymbopogon citratus*) of the Rice family is native to the tropics, it is widely grown in Vietnam. The tree grows about 1.5 m tall, grows perennial into bushes and branches. Lemongrass is not only used as a spice in food processing but also as a traditional herb in tropical regions of the world [10]. Several studies have reported the composition of citronella essential oil (*Cymbopogon citratus*) showing its main constituents include geranial (α-citral), neral (β-citral) and myrcene [11,12]. Lemongrass essential oil has many attractive aromatic compounds (myrcene and limonene) and some compounds capable of deodorizing, strong antibacterial (citral and geraniol) should be used as medicinal herbs, food, protective drugs plant and cosmetic production, *etc*. However, the component that accounts for the highest content of citronella oil is citral (accounting for more than 80% of citronella oil content), which is very unstable, easily oxidized and denatured by external conditions such as light, temperature, pH, *etc*. alter the quality as well as the loss of high-value bioactive substances [13-15]. Essential oils are a mixture of volatile compounds and consist primarily of hydro-carbon monoterpene which are highly unsaturated and often unstable due to many factors such as light, heat, oxidation and hydration [16]. Maswal and Dar [17] reported the method about the citral content preservation in food, thereby improving the quality of food. The results show that citral is one of the most important natural flavours with a strong and characteristic aroma, widely used as an additive in food, beverages and cosmetics with the utmost care. However, citral is chemically unstable and reduces the time in aqueous solutions due to the acid and oxidative catalytic reaction leading to loss of flavour and an undesirable flavour. Therefore, an appropriate technology is required to preserve them to improve the effectiveness of the product. This disadvantage in lemongrass essential oil is quite difficult because when the citral component is denatured, it will create another structure that leads to changes in the smell or loss of the characteristic odour of citronella oil. Therefore, in this work, the determination of volatile compound composition and the durability of essential oils when stored under different storage conditions is assessed, in order to improve their potential and applicability of citronella essential oil into the product. In this regard, the essential oil components of *Cymbopogon citratus* were analyzed under different storage conditions including normal conditions, dark conditions, refrigerators (4 °C) and ovens (45 °C) during storage period of 4 months.

EXPERIMENTAL

Lemongrass essential oil is extracted by the process of steam distillation. Citronella leaves used in the extract were collected in February from Tan Phu Dong area, Tien Giang province, Vietnam (coordinates 10°15′N 106°39′E). Lemongrass leaves after harvest are preserved In normal conditions, a cool place to conduct production in a few days. 710 kg of citronella leaves are fed into an industrial plant's distillation plant, extracted until the essential oils are removed from the system. The resulting oil is filtered through a funnel to remove any water, anhydrous with sodium sulfate and stored in a dark bottle.

Storage condition: The essential oil collected from the above extraction process will be divided evenly and stored in a sealed glass jar. Each set of samples is stored at four different temperature and light conditions: kept under daylight indirectly at room temperature (25 °C), in dark bottles at room temperature, refrigerators (4 °C) and drying oven (45 °C) for 4 consecutive months. GC-MS analysis methods are used to assess the change of volatile compounds in essential oils. However, in order to determine the effects of accurate storage conditions on the composition of essential oils during storage, essential oils are analyzed immediately after extraction to compare with changes from month to month.

Gas chromatography-mass spectrometry analysis: Chemical composition of the pomelo fruit oil was determined by GC-MS analysis using GC Agilent 6890 N instrument coupled with HP5-MS column and MS 5973 inert. The pressure of the head column was 9.3 psi. 25 µL of essential oil was added with 1.0 mL *n*-hexane and dehydrated with Na_2SO_4. The flow rate was constant at 1 mL/min. Injector temperature is 250 °C and the rate of division is 30. Thermal program for samples: 50 °C kept for 2 min increased by 2 °C/min to 80 °C, continued to increase by 5 °C/min to 150 °C, continued to increase by 10 °C/min to 200 °C, increase 20 °C/min to 300 °C hold for 5 min. The compounds were determined by comparing retention indices with the Wiley library or with published mass spectra.

RESULTS AND DISCUSSION

The study on the storage of essential oil samples because the oil is highly volatile and is likely to be changed differently by different storage situations. There is very little research on secondary storage of plants especially essential oil because these metabolites are very volatile and are likely to be varied by storage situations. In this study, samples of essential oil extracted from *Cymbopogon citratus* were deter-mined at different temperatures and storage times. Thirteen components were identified and measured in *Cymbopogon citratus* essential oil samples, comprising more than 93-97% of the total essential oil. As a result of previous reports, the major components of citronella essential oil from different regions and growth stages are greatly influenced by genetic, environmental and geographical conditions [18]. However, this result has shown that the concentration of the ingredients varies greatly by the impact of different conditions. The results of the study indicate that the concentration of some of the essential components in essential oils has varied differently over time preserved by the effects of light and temperature.

Influence of light conditions on the quality of lemongrass essential oil: The findings of this analysis indicate that at room temperature under the influence of light in Fig. 1a, β-myrcene immediately after extraction is 16.654%, then decreases continuously for the next 2 months to 2.373 and 0.836% and tend to increase again at the end of storage time 4.578%. On the other hand, the citral compound (α-citral and β-citral) increased during the 4 month storage period with 46.651% and 32.363% compared to 40.838% and 28.494% at the time of extraction. GC-MS analysis of essential oils when stored under light dark conditions at room temperature are shown in Fig. 2. While citral (α-citral and β-citral) compounds showed the greatest increase in the first 2 months of storage (45.265 and 33.117%), α-citral content tended to decrease by 32.544% and α-citral continues to increase to 47.959% at the end of the storage period. Storing essential oils in a dark bottle away from light cannot avoid changing the composition of the essential oil, due to the chemical changes of terpenoids. In significant changes in the content of substances in the dark, it may depend on their structure and reactivity. In particular, the monoterpene compound has been shown to decline rapidly under the action of light [19]. β-Myrcene plummeted after the first month of storage by 2.365%, with an increase in returns in the following months with a concentration of 10.401% at the end of storage time compared to 16.654% after just extracting essential oil. Light is considered a factor that enhances self-oxidation by activating hydrogenation leading to the formation of alkyl radicals. However, component changes have been oxidized

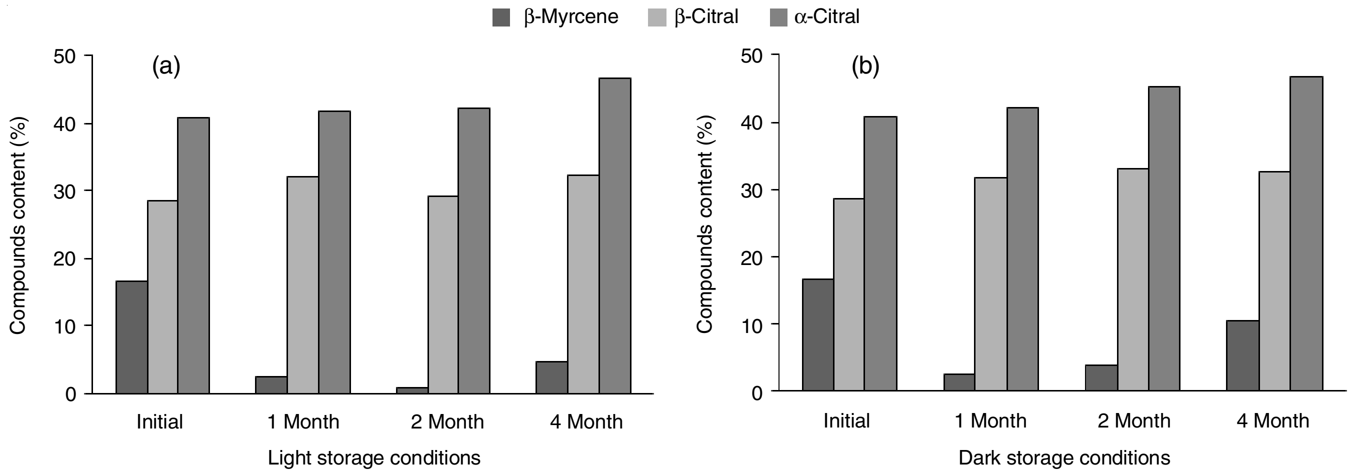

Fig. 1. Conditions for storing lemongrass essential oils: (a) lighting, (b) dark in room temperature

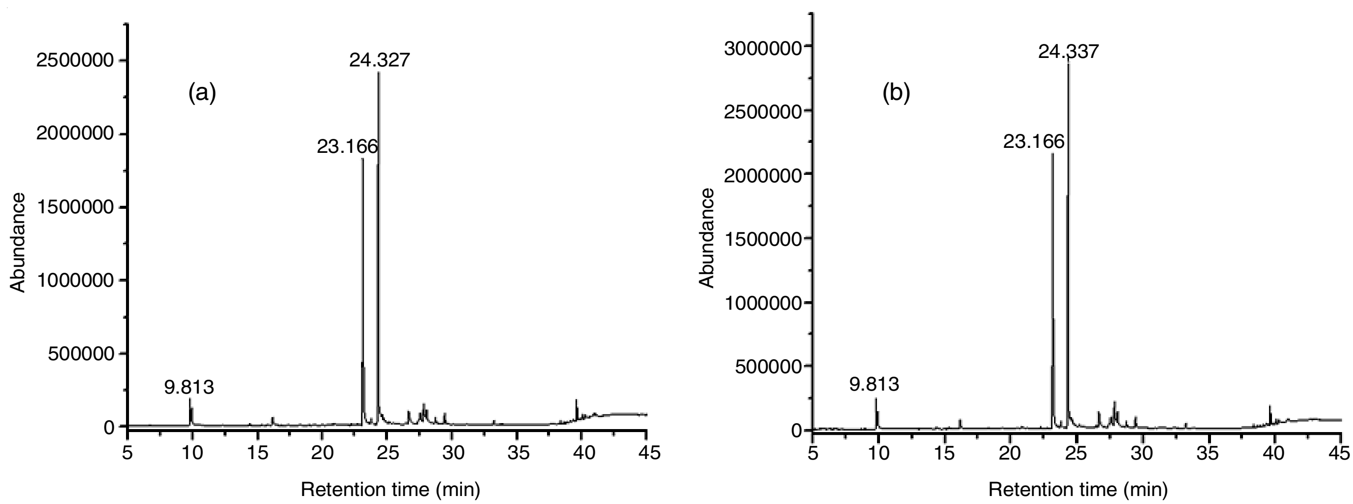

Fig. 2. Chromatogram of lemongrass essential oil under conditions: (a) light, (b) dark

significantly faster when illuminated [20]. In addition, some compounds with small amounts in essential oils are determined to decompose when exposed to light causing an increase in polar compounds, leading to a number of other indeterminate substances that are initially formed into the first month of storage but decrease content when stored in the next month [21]. Sköld *et al.* [22] provide an explanation that shows that a large number of allylic hydrogen atoms are available in unsaturated terpenes, thus creating free angles so unstable essential oils are easily degraded. The increase in content and formation of compounds that have been reported frequently in the oxidation of essential oils or essential oil volatilizers represents the characteristic signs of essential oil aging [14,19,21].

Influence of temperature conditions on the quality of lemongrass essential oil: Temperature is the main factor affecting the stability of pure essential oils in some respects. This variation may be due to volatilization, oxidation and other undesirable changes in essential oil component during storage [23,24]. A comparison of the essential oil components of different temperatures and storage times indicates that the amount of the main compound is subject to drastic changes during storage at temperatures under corresponding conditions (Table-1). The content of β-myrcene was 16.654% after extraction, then it tended to be unstable about 11.043% after the first month and increased again to 15.93% after 2 months, but dropped sharply at the end of storage time 4.912%. Meanwhile, the content of α-citral and β-citral is the decisive ingredient to the quality of citronella oil after 1, 2 and 4 months after storing essential oils (29.976 and 42.84%), (30.927 and 44.162%) and (27.645 and 37.387%), respectively. Therefore, when stored at low temperatures it is beneficial for the ability to dissolve oxygen into liquids and negatively affect the stability of essential oils [25]. Self-oxidation as well as hydrogen peroxide decomposition both increase with increasing temperature, even more because heat can contribute to the initial formation of free radicals [20]. Especially under light boosting and rising temperatures, a marked decrease in the number of unsaturated terpenes as β-myrcene is often revealed [26]. Fig. 3a showed that β-myrcene content tended to decrease continuously after 2 months of storage of 9.077%, then increased again during the end of the 9.25% storage process, which showed a 45% reduction with immediate at the time of extraction. In contrast, the citral compound (α-citral and β-citral) increased continuously by 18% over the first 2 months and decreased

TABLE-1
CHEMICAL COMPOSITION OF THE LEMONGRASS ESSENTIAL OIL BY GC-MS ANALYSIS METHOD

Name	Initial	1 Month				2 Month				4 Month			
		Light	Dark	4 °C	45 °C	Light	Dark	4 °C	45 °C	Light	Dark	4 °C	45 °C
2,3-Dehydro-1,8-cineole	2.264	2.562	2.777	2.597	1.873	2.1	2.17	1.654	1.857	2.488	2.195	0.175	1.82
β-Myrcene	16.654	2.373	2.365	11.043	13.07	0.836	3.848	15.93	9.077	4.578	10.401	4.912	9.225
Linalol	1.519	1.411	1.546	1.623	1.315	1.303	1.322	1.129	1.334	1.61	1.555	1.9	1.398
β-Citronellol	0.281	–	–	–	–	–	–	–	0.278	–	–	–	–
p-Cymen-8-ol	–	–	–	0.423	0.77	–	–	–	–	–	–	–	–
β-Citral	28.494	32.051	31.666	29.976	32.324	29.199	33.117	30.927	33.713	32.363	32.544	27.645	33.279
Nerol	2.388	1.157	1.163	1.762	2.389		1.393	2.322	2.489	1.449	2.174	0.797	2.447
α-Citral	40.838	41.81	42.11	42.84	45.5	42.145	45.265	44.162	48.11	46.651	46.827	37.387	47.959
Geranic acid	–	3.12	2.965	1.723	–	3.147	2.085	–	–	–	–	–	–
Geranyl acetate	0.722	3.001	2.769	1.651	–	2.44	0.519	–	0.531	1.471	0.892	2.45	0.577
β-Caryophyllen	0.213	–	–	–	0.229	–	–	–	0.215	0.275	0.246	0.236	0.234
α-Bergamotene	0.21	–	–	–	0.23	–	–	–	0.251	–	–	–	–
Caryophylene oxide	–	–	0.396	0.252	–	0.401	0.332	–	–	0.248	–	0.502	–

again by the end of the storage period, but overall the citral content was still higher than initially 16.8 and 17.5% respectively. On the other hand, when stored at 45 °C, essential oils have a state of light yellow to dark yellow and a higher viscosity than the other storage conditions (Fig. 3b). GC-MS analysis of essential oils when stored under light dark conditions at 4 and 45 °C are shown in Fig. 4. Previous reports indicated that a number of factors such as different harvest times, storage conditions, storage temperatures at different temperatures, light and oxygen content may affect quality and composition essential oils [14,21,24,27]. This can lead to colour changes, increased viscosity or unpleasant aroma formation, often sharpened by changes in composition and increased oxidative compounds.

Conclusion

The change in the chemical profile depends on the different levels on the corresponding storage mode of lemongrass essential oil. While lemongrass essential oil only undergoes a slight change according to different storage regimes, has manifested marked changes under the action of light and temperature leading to the oils susceptible to oxidation. It is found that low boiling point compounds such as β-myrcene significantly decreased under storage conditions 4 °C and room temperature was affected by light after 4 months. Compounds with a high boiling point such as α-citral and β-citral increase markedly at 45 °C after 4 months. In general, storing lemongrass essential oil in dark and low temperature conditions prevents an increase or decrease in the concentration of the essential oil components and helps keep the essential quality of the essential oil with minimal changes, but there is also the number of important index components such as citral compound significantly increased not only did it not lose the quality of essential oil.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

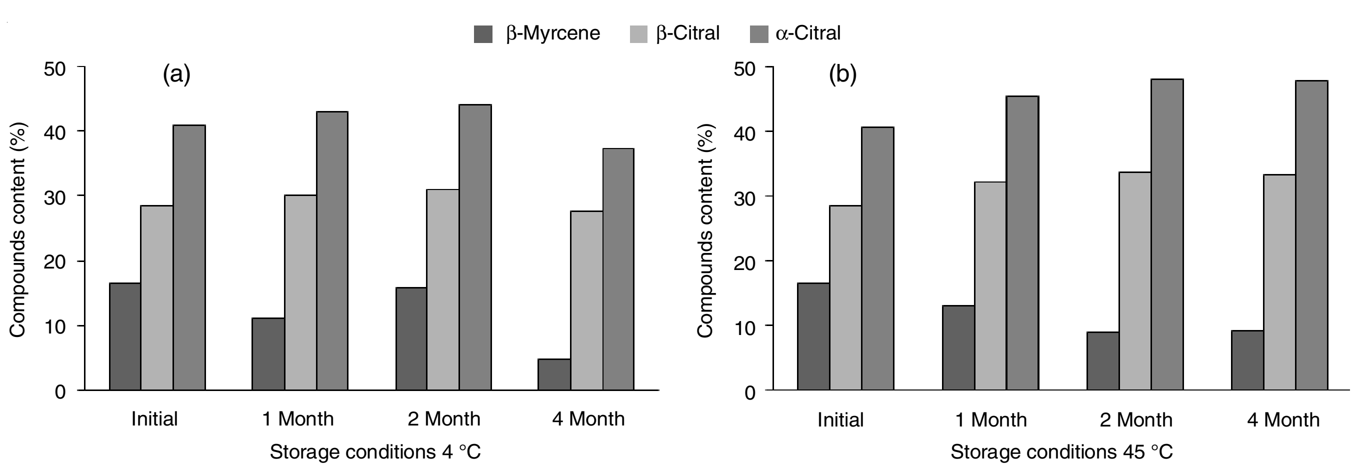

Fig. 3. Conditions for storing citronella essential oil at a temperature: (c) 4 °C, (d) 45 °C

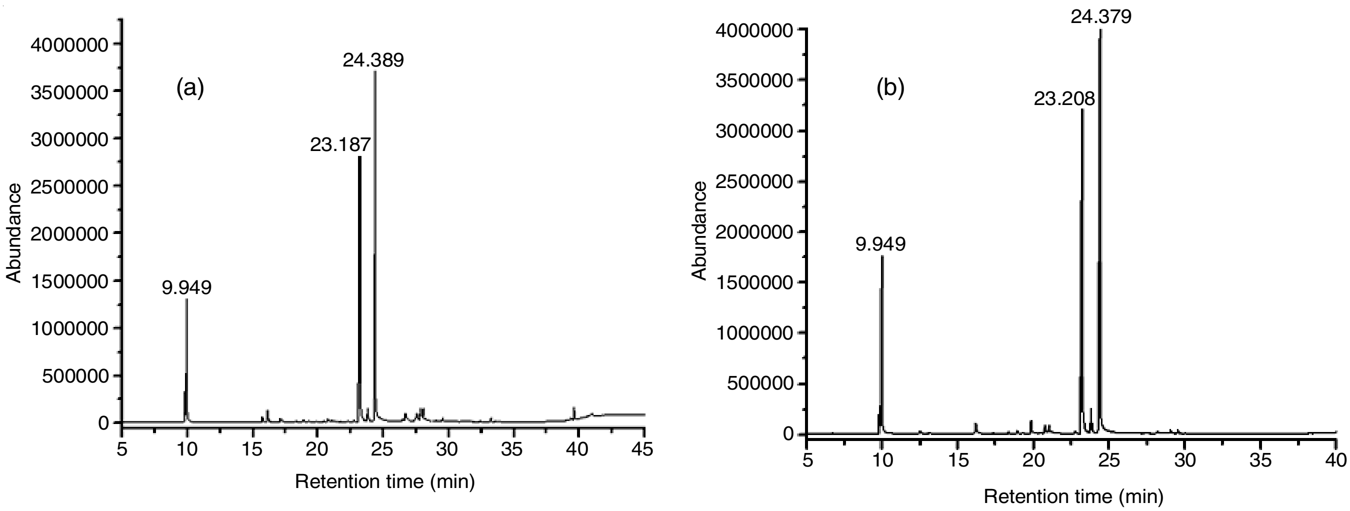

Fig. 4. Chromatogram of lemongrass essential oil under conditions: (c) 4 °C, (d) 45 °C

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