Development of an aromatic wax product containing natural Lemongrass (Cymbopogon Citratus) essential oil

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Abstract. Lemongrass oil contains many useful aromatic compounds, some of which have strong deodorizing and antibacterial properties (citral and geraniol). The ingredient with the highest content in citronella oil is Citral (accounting for more than 80% of citronella oil content), which plays a key role in functionalities of disinfectants, biocides, odorants and insecticides. This study aims to incorporate lemongrass essential oil into a wax product to extend the application of the oil. The effect of factors that affect the process of creating aromatic wax was investigated. The yield of essential oils obtained by steam distillation was 0.29%. The effect of factors that affects the process of creating aromatic wax was investigated. The formula of aromatic wax contains 4.5% Stearic acid, 2.7% NaOH, 88.6% Alcohol 20°, 2.4% PEG-40, 2% Lemongrass Essential oil. The results indicate that the lemongrass essential oil causes no significant detriment to the beneficial properties of the obtained aromatic wax.

1. Introduction
Nowadays, essential oils are increasingly applied to flavours, fragrances, cosmetics, detergents and pharmaceuticals due to the need to use natural compounds, gradually replacing chemicals [1–8]. They can increase not only the quality but also the shelf life of the natural product [9,10]. Moreover, they also play an essential role as vehicles for different naturally occurring compounds including vitamins, antimicrobial compounds, flavour compounds and so on [11–14]. Lemongrass has a scientific name, Cymbopogon citratus or synonymous with Andropogon citratus, which currently has about 55 species. The main product of citronella is the essential oil accumulated in the leaf stems, with the oil content varying from 0.4 to 2.0% depending on the variety, ecological conditions and the regime of care. The previous study reports that lemongrass essential oils play a crucial role in the treatment of different diseases such as oily skin, scabies, acne, antibacterial, antimicrobial [15], and cardioprotective. In Indian and Chinese medicine, the plant has been widely applied as a tranquilizer and anti-inflammatory drug [10]. Lemongrass tea is also usually consumed in Brazil, Cuba, and Argentina as a therapy for catarrh, rheumatism, and sore throat [9].
As society grows in Vietnam, the demand for essential oils in the beauty and food sector is increasing. However, the manufacturer of citronella extract is only focus on the method of distillation with solvents and distillation with water. However, most of the applications are utilizing lemongrass and leaf parts for food products, personal or family care products such as shower gel, soap, and handwashing water. Therefore, the implementation of citronella related research will expand knowledge and exploit its uses in various industrial application. Lemongrass oil is known for its abundant citral component, which is composed of geranial and neral. The content of citral in lemongrass essential oil varies from 40 to 82% and is very unstable, easily oxidized and denatured by external conditions such as light, heat, pH [16–19]. Therefore, increasing the durability of Citral is a problem. Moreover, Lemongrass is also rich in aromatic compounds, which have been demonstrated to exhibit anticancer activity (myrcene and limonene) and pain-relieving properties (myrcene and limonene).

Aromatic wax is a daily consumer product at restaurants, hotels, and families that placed in the living room, bedroom, kitchen to deodorize other odor-causing impurities. In particular, many substances in aromatic wax are toxic to the body as its ingredients contain toluene (C₆H₅CH₃), acetone (CH₃COCH₃), formaldehyde (CH₂O), derivatives of benzene, and methylene chloride (CH₂Cl₂). These substances have been shown to cause cancer, congenital disabilities, nervous system degeneration.

Therefore, the purpose of the study is to apply lemongrass essential oil in the formulation of aromatic wax, investigate the conditions affecting the substrate as well as the impact on the process upon creating fragrant wax.

2. Materials and methods

2.1. Plant material and extraction of essential oil
Lemongrass leaves were collected in January from Tien Giang Province, Vietnam, coordinates 10 ° 15′N 106 ° 39′E. Lemongrass leaves were partially wilted, stored in a cool, convenient place during production for several days. Essential oils were extracted by the steam distillation process. Distillation systems are industrial plants tested for the steam distillation process of citronella capable of holding 200 kg to 750 kg of material per batch. Lemongrass leaves (710 kg) were subjected to steam distillation for 3 hours to obtain the essential oil. The yield achieved after distilling 0.29%. The essential oils were dried over anhydrous sodium sulfate and stored in sealed vials.

The chemicals used: Acid Stearic, Sodium Hydroxide (NaOH), Synthetic polymer, paraffin, PEG-40, Cetyl alcohol are purchased at Nguyen Ba Trading Production Co., Ltd, Tan Binh District, Ho Chi Minh City.

2.2. The mixing process of aromatic wax
First, chemicals such as alcohol solvents, antioxidants, emulsifiers are dissolved together and gently stirred with citronella oil. Next, the colors and preferences were given to diversify the products. The foaming agent is dispersed in water and gently heated to expand and dissolve. Blended with the mixture and poured into the mold to cool it, we will get the product of scented citronella oil.

2.3. Testing and characterization
The sensory evaluation of the product was based on the consumer’s point of view and compare to another product on the market. Characteristics of products such as the settlement of the needle, evaporation of the substrate and the transparency of the dispersion system was characterized.

3. Results and Discussion

3.1. Building basic formula of aromatic wax
Table 1 illustrates the properties such as condense, hardness, colour, and evaporation between Gel and wax. The two products have a significant appearance and properties different including soft, flexible gel, high transparency, and eye-catching. The gel sticks to the hand and evaporates slowly due to the
content of too much oil-based liquid phase. On the contrary, the appearance of the wax is opaque, unattractive, hard and fragile when pressed forcefully. Moreover, wax contains alcohol and water, so it is volatile and easy to scent. Based on evaluation properties, we choose stearic acid wax to develop the experiment because they have necessary properties for aromatic wax.

Table 1. The table compares the properties of two basic wax bases.

| Properties   | Gel: Synthetic polymer + Wax Paraffin | Wax: Acid stearic + NaOH + alcohol |
|--------------|--------------------------------------|------------------------------------|
| Condense     | Good                                 | Good                               |
| Hardness     | Soft, flexible, high elasticity      | Hard, strong squeeze is fragile    |
| Color        | White, transparent                   | Opaque white                       |
| Evaporation  | Very low                             | High                               |

Figure 1. Two types of basic wax background (a) and (b)

3.2. Effect of sodium stearate content on the wax

All experiments were conducted under the same condition with changing the amount of the initial effect, and the contents of stearic acid and NaOH (Table 2). Figure 2 shows the effect of sodium stearate content on the formation of wax background. When the amount of wax stearate initially decreases, the hardness decreases, and the colour of the product changes from opalescent to clear white and uniform.

Table 2. Effect of sodium stearate on the basic properties of wax background

| Experiment | Stearic acid (gram) | NaOH 20% (ml) | Alcohol 30° (ml) | Condenses | Hardness |
|------------|---------------------|---------------|------------------|-----------|----------|
| 1          | 20                  | 12            | 40               | Good      | Very hard|
| 2          | 5                   | 3             | 40               | Good      | Hard     |
| 3          | 3                   | 1,8           | 40               | Good      | Hard     |
| 4          | 2                   | 1,2           | 40               | Good      | Hard     |
| 5          | 1,5                 | 0,9           | 40               | Good      | Soft     |
| 6          | 1                   | 0,6           | 40               | Medium    | Soft     |
| 7          | 0,5                 | 0,3           | 40               | Least     | Soft     |
Products in Experiment 1 and Experiment 2 do not clump well because of lack of solvent. Products in experiments 3, 4, 5, 6 give high homogeneity, moderate hardness, soft, and flexible structure. In experiment 7, the product is not fully cured, with a separation phenomenon. Through preliminary sensory evaluation, it was that the products in tests 3, 4, 5, 6 have high uniformity and stability that suitable for product development.

![Image of samples](image_url)

**Figure 2.** Effect of sodium stearate content on the formation of wax background

### 3.3. Effect of emulsifying content when using aromatherapy
The effect of alcohol concentration on wax background are shown in table 3. The wax background shows white, solidify, moderate hardness at 96% alcohol. The effect of emulsifying content using aromatherapy is illustrated in table 4. When the alcohol content changes, the hardness of the product changes in figure 3. When the alcohol content decreases from 96% to 10%, the hardness of the product increases. The alcohol content from 10% to 0%, the layer separation product does not solidify. The hardness of the gel substrate was assessed through needle settlement. When reducing the amount of wax used, the hardness decreases, indicating the increased settlement. Experiments 1 and 2 give the high hardness, fragile high porosity, which is not suitable for the development of products. Experimental samples 3, 4, and 5 have structural homogeneity, which is used to evaluate evaporation.
Table 3. The effect of alcohol concentration on the basic properties of wax background

| Alcohol (40ml) | Condenses | Hardness | Comment |
|---------------|-----------|----------|---------|
| 96°           | Good      | Moderate, slightly soft | The background is white, solidify, moderate hardness. |
| 50°           | Good      | Moderate, slightly soft | The background is white, solidify, moderate hardness. |
| 30°           | Good      | Moderate | The background is opaque white, solidify, moderate hardness. |
| 20°           | Good      | Hard     | The background is opaque white, solidify, high hardness. |
| 10°           | Good      | Hard     | The background is opaque white. |
| 5°            | Least     | Porous, fragile | The background is opaque white, the water part is separated, the hardness is low. |
| 0°            | Not solidify | Liquid  | Not solidify, liquid form only has white solid suspended in water. |

Table 4. Effect of emulsifying content on the basic properties of the solution when using essential oils

| Sample | 1  | 2  | 3  | 4  | 5  |
|--------|----|----|----|----|----|
| Lemongrass EOs (%) | 1  | 1.03 | 1.04 | 1.02 | 1  |
| Fragrance | Weak | Moderate | Moderate | Moderate | Strong |
| Result | Turbid, Uneven dispersion, drops of incense suspended in alcohol | Turbid, Uneven dispersion, drops of incense suspended in alcohol | Turbid, evenly dispersed | Transparent, evenly dispersed | Transparent, evenly dispersed |

Figure 3. The needle settlement of each sample on wax background
3.4. Effects of alcohol on volatility of the sample

Figure 4 illustrates the wax pattern before and after evaporation. Evaporation of aromatic wax base is depending mainly on time. As can be seen in figure 5, the wax background volume decreases with time. The volume of the wax fell sharply in the beginning, then dropped slightly and decreased to a constant. The wax layer weight decreases to a constant value after 4-5 days. The higher the alcohol content, the faster the evaporation process. The samples 1 and 2 had weight reduction over time within 24 hours and 48 hours due to the high alcohol content. From the survey, it was found that the appropriate alcohol content for the process of creating aromatic wax has physical characteristics and suitable evaporation from 10% to 30%.

![Figure 4](image1.png)

(a) The wax pattern before evaporation and (b) the wax pattern after evaporation

![Figure 5](image2.png)

Figure 5. Effect of alcohol concentration on evaporation of wax background

4. Conclusion

The study demonstrated that the addition of lemongrass essential oils was a necessary factor contributing to product quality. Recovering lemongrass essential oil is carried out by steam distillation method with 710 Kg of raw material, at the optimal condition of 110-130 L/h steam flow rate that yielding 2064 ml EOs. In this study, an investigation on the impact of lemongrass essential oils to aromatic wax products was carried out. An optimal formula for the wax production includes the components of 4.5 % Stearic acid, 2.7 % NaOH, 88.6 % Alcohol 20°, 2.4 % PEG-40, and 2 % Lemongrass EOs. Aromatic wax products are evaluated for quality criteria based on the parameters of needle settlement, evaporation time, aroma factor of the sample.
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References
[1] Dao T P, Nguyen D C, Nguyen D T, Tran T H, Nguyen P T N and Le T H N, Le X T, Nguyen D H, Nguyen D V and Bach L G 2019 *Asian J. Chem.* **31** 977–81
[2] Tran T H, Nguyen H H H, Nguyen D C, Nguyen T Q, Huynh T, Le T H N, Nguyen D H, Tran L D, Do T S and Nguyen D T 2018 *Processes* **6** 206
[3] Nguyen P T N, Tran T H, Le T H N, Phan N Q A, Le T H, Nguyen T C T, Nguyen D T and Bach L G 2018 *Solid State Phenom.* **279** 235–9
[4] Tran T H, Ha L K, Nguyen D C, Dao T P, Nhan L T H, Nguyen D H, Nguyen T D, Vo D-V N, Tran Q T and Bach L G 2019 *Processes* **7** 56
[5] Huynh C M, Nguyen T S V, Le T H N, Nguyen D C and Bach L G 2019 *Processes* **7** 90
[6] Huynh C M, Le T T T, Diep T T, Le T H N, Nguyen D T and Bach L G 2018 *Asian J. Chem.* **30** 293–7
[7] Tran T H, Nguyen P T N, Pham T N, Nguyen D C, Dao T P, Nguyen T D, Nguyen D H, Vo D V N, Le X T, Le N T H and Bach L G 2019 *IOP Conf. Ser. Mater. Sci. Eng.* **479** 012002
[8] Tran T H, Nguyen P T N, Ho V T T, Le T H N, Bach L G and Nguyen T D 2019 *IOP Conf. Ser. Mater. Sci. Eng.* **479** 012015
[9] Faridi Esfanjani A and Jafari S M 2016 *Colloids Surfaces B Biointerfaces* **146** 532–43
[10] Bashir A, Jabeen S, Gull N, Islam A, Sultan M, Ghaffar A, Khan S M, Iqbal S S and Jamil T 2018 *Int. J. Biol. Macromol.* **106** 351–9
[11] Cerqueira M A, Fabra M J, Castro-Mayorga J L, Bourbon A I, Pastrana L M, Vicente A A and Lagaron J M 2016 *Food Bioprocess Technol.* **9** 1874–84
[12] Castro-Rosas J, Ferreira-Grosso C R, Gómez-Aldapa C A, Rangel-Vargas E, Rodríguez-Marín M L, Guzmán-Ortiz F A and Falfan-Cortes R N 2017 *Food Res. Int.* **102** 575–87
[13] Aytac Z, Yildiz Z I, Kayaci-Senirmak F, San Keskin N O, Tekinay T and Uyar T 2016 *RSC Adv.* **6** 46089–99
[14] Fidelis J C F, Monteiro A R G, Scapim M R S, Monteiro C C F, Morais D R, Claus T, Visentainer J V and Yamashita F 2015 *Ital. J. Food Sci.* **27** 468–75
[15] Masuda T, Odaka Y, Ogawa N, Nakamoto K and Kuninaga H 2008 *J. Agric. Food Chem.* **56** 597–601
[16] Djordjevic D, Cercaci L, Alamed J, McClements D J and Decker E A 2007 *J. Agric. Food Chem.* **55** 3585–91
[17] Weerawatanakorn M, Wu J, Pan M and Ho C-T 2015 *J. Food Drug Anal.* **23** 176–90
[18] Nguyen H, Campi E M, Jackson W R and Patti A F 2009 *Food Chem.* **112** 388–93
[19] Choi S J, Alamed J, Henson L, Mei L, Popplewell M, Decker E A and McClements D J 2009 *J. Agric. Food Chem.* **58** 533–6