The making of red ginger (*zingiber officinale rovb. var. rubra*) natural essential oil

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Abstract. This study aims to 1) learn the production process of red ginger natural essential oil, 2) learn the characteristics of red ginger natural essential oil, and 3) learn the content of red ginger natural essential oil. The research method used was the Research and Development (R&D) model. Distillation was used as the technique of making the essential oil. This study results in the product of good quality red ginger essential oil with high level of purity, as revealed by the result of the rendement test (1022 gram of red ginger for 23 ml, 1000 gram red ginger for 21 ml and 1028 gram red ginger for 23 ml). The result of organoleptic test shows the color of essential oil to be clear yellow with a strong/pungent smell and a little hot and bitter taste. Red ginger essential oil dissolves perfectly in alcohol, with specific gravity values of 0.886, 0.887 and 0.887 and refractive index values as much as 1.480, 1.485 and 1.482. This shows that the produced essential oil has a good quality and high level of purity. The main components of essential oil include E-Cital, Chempene, Cineole and Zingiberene. The results allows for the opportunities to develop red ginger essential oil as aromatherapy for medication and beauty treatment products.

1. Introduction

There is a notable trend of using natural cosmetics, *jamu* (javanese traditional herbal medicine), and other herbal medicines among Indonesian people. This is supported by the great potentials of more than thirty thousand kinds of medicinal plants, cosmetics plants, and aromatic plants which grow in the country. From the number, there are about 9,600 known species with medicinal values. However, only 100 species are being utilized as the raw ingredients for the traditional medicine and cosmetic industry. According to Indonesian Essential Oil: The Scents of Natural Life, there are currently around 40 kinds of Indonesian plants potential for the source of aromatherapy and about 12 essential oil producing which are in development in the industrial scale.¹ Essential oils have been widely used since a long time ago until now. They are a powerful healing agent, and have been the subject of many studies to develop the oils into aromatherapy. Aromatherapy has an important role in the health and beauty world, as the trends in lifestyle, health, and beauty have holistically shifted to the use of natural products. Aromatherapy is popular due to the worrying side effects of using synthetic chemical ingredients in medicines and beauty products. In aromatherapy, essential oils are used as probiotic, and not antibiotics, meaning that it has the ability to selectively kill a particular type of bacteria, which is the pathogen bacteria, and not kill all the bacteria in the body, as antibiotics do. For this reason, aromatherapy requires the use of the safer essential oils than synthetic chemicals.
The use of essential oils in aromatherapy makes the development of essential oil industry to improve, both in number, and in quality. One of the widely used aromatic plants which can produce essential oil is ginger (*Zingiber officinale Rosc.*). Ginger is a native herb of Indonesia and important in the daily use of Indonesian people, especially for health and beauty purposes. It can be classified as perennial herb, and belongs to the Zingiberaceae family that thrives the most in tropical regions. As an aromatic herbal plant, ginger produce secondary essential oil, which has a synergy effect based on the desired result with various uses and advantages. The distinctive sharp aroma and the strong pungent taste of ginger are the indicators of the many substances good for human body.

Ginger essential oil is good for relieving pain, improving the breathing circulation, improving the digestive system. Moreover, as an astringent, it can be used for beauty purposes such as to treat oil skin, acne, and removing dandruffs, and as analgesic, it is useful for relieving pain and relaxation, as well as a deodorant to treat body odor. However, despite its many advantages, the use of ginger essential oil in both medical and beauty fields is still limited. This may be caused by the interest of manufacturers which much prefer other major safe-to-use essential oils with numerous uses such as lavender, chamomile, ylang-ylang (*Cananga odorata*), cajuput, and others.

Ginger essential oils are in fact available in the market, and can be purchased online and offline. Its relatively expensive price unfortunately does not guarantee that the oil is made naturally. The development of technology, the increased needs, trends and lifestyle are all affecting the existence of trusted essential oil products. There are many products marketed as ginger essential oil and other types of essential oils that in fact use chemical compounds without even a slight of natural ingredient inside. Other manufacturers would mix the pure natural essential oil with other solvent such as alcohol in order to keep the price low.

The cosmetics industry develops the brand and products based on the trend development of cosmetics, and produce their beauty products by incorporating essential oil content such as aromatherapy. This is because there is generally a favorable response from the public, as essential oils are assumed to work as a holistic and safe aromatherapeutic agent. In addition to help balancing the body and the mind, the use of essential oils in aromatherapy can also improve the quality of human body by maintaining the health in general, and in particular the health of the skin, the hair, and the body of either man or woman, adult or child.

Ginger essential oil has many uses and benefits, whether for healthy or beauty treatment purposes. However, the incorporation of the essential oil for aromatherapy or cosmetics is still rare both in health or beauty industry. There are still very limited ginger oil-based products in the market. In the health products, ginger can be found in herbal medicines in liquid or tablet forms, as well as in massage oil. Nevertheless, there are still the opportunities for ginger-based beauty products such as soap, face mask, and other beauty treatment products that contain ginger essential oil.

Red ginger (*Zingiber Officinale Rovb. var. Rubra*) contains chemical compounds such as volatile oil, nonvolatile oil, and starch. Essential oil is ultimately formed by the volatile oil compound in ginger. Volatile oil is typically yellow, a bit thick, and provides the distinctive feature in ginger. Based on the dry weight, the oil content is around 2.58 – 2.72%. On the other hand, the high oleoresin content in the nonvolatile oil acts as antiemetic agent and provides the bitter and strong pungent taste in red ginger.

According to the standards regulation of Food Chemical Codex, the quality of essential oil should be included in the label or the product’s packaging. If the label “pure plant essential oil” is found in the packaging, the quality of the oil is good. On the other hand, if the label states “aromatherapy grade” or “natural” there is a possibility that the oil’s pureness is compromised as it has been added with other chemical compound. If, however, “fragrance oil” or “perfume oil” is stated on the label, this means that the product is a synthetic essential oil.

There are various methods that can be used to obtain the essential oil from a plant, namely cold expression, effleurage, maceration, and distillation. The choice of method is highly crucial in determining the quality of the extracted essential oil.
2. Method

In the making of ginger essential oil product, this study employed the 4-D Research and Development model based on the scheme developed by S. Thiagarajan, D. S. Semmel, and M. I. Semmel (1974). The model consists of four main stages, namely the Define, Design, Develop, and Disseminate stages. The implementation of each stage does not merely follow the original version as the study makes appropriate adjustments according to the characteristics of the subject, as well as the needs of development in the field. The research design scheme is presented in Figure 1, 2 and 3 below.

The method used to extract the red ginger essential oil is the water vapor distillation due to its ability to extract more high quality essential oil which does not contain any water. The data analysis refers to the Indonesian National Standard on the red ginger essential oil (SNI 06-1312-1998), which consists of the results of rendement test, organoleptic test, chemical and physical test, and main component test.

3. Result and Discussion

3.1 The Define Stage
The quality and quantity of the ginger essential oils produced are highly determined with the raw ingredients of red ginger, and the production method. Thus, careful literature review and field analysis are needed in order to produce a high quality essential oil which contains all the useful contents of red ginger. Based on literature review and field analyses, this research attempts to obtain essential oil with particular characteristics such as having a strong scent, clear and colorless liquid, no unpleasant smell, and not leaving any stain when applied on paper and cloth, as well as not containing any acid.

3.1.1 Analysis on the Type of the Red Ginger as the Raw Ingredient and Extracting Technique
In order to produce a high quality essential oil, a bunch of fresh ripe red ginger roots, with evenly spread red color in its root, and has no dry, damaged, or rotten part. The ingredients can be obtained in traditional market and big supermarket. The best red ginger extracting technique which can produce the best quality product is as follows: 1) wash the roots with clean water in order to clean and remove any dirt or bacteria; once done, dry the roots in a tray or colander to rid of the excess water; 2) sort in order to separate the good quality red gingers from the dry, damaged, and rotten ones; 3) chop up the gingers without peeling off the skins. The reason for not peeling is because the unpeeled roots produce a higher rendement (2.4–3.6%) than the peeled ones (1.9–3.0% with water content 10–12%). Turning the ingredient into smaller pieces by chopping or cutting up the ingredients can extend the surface of the root and break down the cell walls that contain oil and resin, as it allows the hot vapor penetration and solvent to be more effective.

3.1.2 Analysis on the Method Used
Distillation method was the extracting technique used to produce essential oils in this study. It is particularly selected because the distillation method using the water vapor (by boiling) is the best at extracting good quality oils. In addition, the ginger needs to be cut up into smaller pieces. The oils produced from using this method are expected to have a strong/pungent scent, colorless liquid, and higher rendement than other methods. The distillation method is done by putting the cut up ginger roots on shelves or colander, with the lower part of the shelf being filled with water until the surface is close to the colander. The foundation of this method lies on the condition that the vapor should be maintained continuously with the right temperature, and that the distilled matter only comes in contact with the vapor, and not the water.

3.1.3 Analysis on the Result and Use of Essential Oil
Various studies note that the essential oil content in ginger root ranges around 0.4-3.1% (Burkill, 1935), 2-3% (Hegnauer, 1963), 1-3% (Purseglove, 1972), or 2% (Encyclopaedia Brittanica, 2000). The results of hidrodistillation reveal that the elephant ginger, red ginger, and regular ginger can produce as much as 2%, 2.5% and 2.5% of essential oil, respectively. Ginger essential oil contains n-nonylaldehyde, d—camphene, d-B phellandrene, methyl heptenone, cineol, d-borneol, geraniol, linalool, acetates and caprylate, citral, chavicol and zingiberene. Those compounds are imperative in as the main component of the products in the pharmacy or cosmetic industries. Ginger essential oil are widely used as perfuming agent in cosmetic products such as soap, detergent, cream, lotion, and perfume. Moreover, the oil is also often used in the manufacturing of soft drinks, frozen food, and sweets. In addition to having an antibacterial characteristic and been widely used in aromatherapy, ginger oil also has analgesic, antioxidant, antiseptic, and stimulant agents.
3.2 The Design Stage

3.2.1 Cosmetics Production Specification by Adding Red Ginger Essential Oil

Based on the analysis, it can be learned that there is a high potential use of red ginger essential oil for numerous industrial sectors, especially those related to perfumes, cosmetics, pharmacy, as well as food and beverage. Most of the products used in daily life requires essential oil, e.g. shampoo, toothpaste, soap, body lotion, massage oil, etc. In this study, the red ginger essential oil would be used as the ingredient for an acne treatment soap, as well as an aromatherapy massage oil that can provide a warming effect that increases the blood circulation and maximize the penetration of nutrition in the skin and body. This is similar with the statement “The defining stage was done by collecting information to make the instrument design”\textsuperscript{12}

3.2.2 Production Method of Red Ginger Essential Oil

In this study, the production of the red ginger essential oil is mainly done by the vapor distillation method. In the Define stage, this method was revealed to be the best method in producing a good quality rendement of essential oil with more volume. Information about distillation method is the correct method to produce red essential oil can got from researches output in laboratory. Sugiyono, et.al. (2018) emphasized that experts consisted of lecturers of practical subjects in the laboratory who had role as information giver in determining need assessment to design the instrument prototype\textsuperscript{12}

The distillation method has several advantages, i.e. 1) perfect extraction, in which none of the main ingredient be burnt as it only reacts with the vapor, and does not come in contact with water; 2) the chemical compound content will not be hydrolyzed and experience polymerization caused by boiling water, as essential oil with high boiling point will vaporize perfectly and the resulting oil will have complete components.

3.3 The Develop Stage

3.3.1 Rendement of Red Ginger Essential Oil

The extraction process of essential oil was done three times through the distillation method with 10 kilograms of ingredients which takes 8-10 hours for each process. The volume and rendement of the oil produced are presented in Table 1 below.

Table 1. Rendement of Red Ginger Essential Oil

| Distillation | Amount of ingredients (gr) | Essential Oil Volume | Percentage (%v/b) |
|--------------|---------------------------|----------------------|-------------------|
| 1            | 1022                      | 23 ml                | 2.25              |
| 2            | 1000                      | 21 ml                | 2.10              |
| 3            | 1018                      | 23 ml                | 2.26              |

3.3.2 Organoleptic Test on Ginger Essential Oil

The organoleptic test on the color, scent, taste and form was conducted to examine whether the quality of the essential oil product addresses the Indonesian National Standard on ginger essential oil (SNI 06-1312-1998). The result of the test can be seen in Table 2 below.

Table 2. The Result of the Organoleptic Test on Red Ginger Essential Oil

| Distillation Result | Characteristics | Form     | Color               | Scent   | Taste              |
|---------------------|-----------------|----------|---------------------|---------|--------------------|
| 1                   |                 | Liquid   | Clear yellow to     | Pungent | A little hot-bitter |
The colors of the oil made by three different distillation methods are generally clear yellow, although there is one that is brownish yellow. The difference in color may be influenced by the duration of the distillation which made it hard to control the temperature and caused the red color in the ginger to be a little burnt. Other factors for the change in color are due to the evaporation and damage of some parts of phenol compound. Generally, the colors are affected both enzymatic and non-enzymatic reactions.

Despite the color slight differences, the scents of the three essential oils are all very pungent. This is caused by the combination of preparing the ingredients by cutting them up into small pieces and the use of the distillation method. As a result, the final product is a perfect extraction of the essential oil from ginger, which has the natural pungent smell. The distinctive smell of the essential oil is a result of the reaction between zingeron, shogaol, as well as the natural essential oil (1-3%) inside fresh gingers. The main components, zingiberene and zingiberol, cause ginger to smell fragrant, while the distillation method affects how the oil easily evaporates.

### 3.3.3 Chemical Physical Test of Red Ginger Essential Oil

The quality of essential oil can also be measured by its physical and chemical attributes, such as the oil’s solubility in alcohol, the specific gravity, optical spin, and the refractive index. The benchmark for a good quality essential oil is the Indonesian National Standard’s chemical and physical requirements for essential oils. The essential oil product in this study has been proven to be perfectly soluble in alcohol. In addition to solubility, another factor that is equally important as a determinant for quality essential oil is the specific gravity, as it concerns with the purity of the extracted oil. The result of the oil’s specific gravity can be seen in Table 3 below.

Table 3. The Result of Red Ginger Essential Oil’s Specific Gravity

| Sample       | Specific Gravity | Indonesian National Standard Requirement |
|--------------|------------------|-------------------------------------------|
| Distillation 1 | 0.886            | 0.8720 – 0.8890                            |
| Distillation 2 | 0.887            |                                           |
| Distillation 3 | 0.887            |                                           |

The specific gravity of the essential oil sample resulted from the Distillation 1 is as much as 0.886, while those resulted from Distillation 2 and 3 are both 0.887. This suggests that all samples have addressed the Indonesian National Standard requirement which ranges from 0.8720 to 0.8890. On the other hand, the result of the refractive bias of the oil is presented in the following table.

Table 4. The Refractive Biases of Red Ginger Essential Oil

| Sample       | Refractive Index | Indonesian National Standard Requirement |
|--------------|------------------|-------------------------------------------|
| Distillation 1 | 1.480            |                                           |
| Distillation 2 | 1.485            | 1.4853 – 1.4920                            |
| Distillation 3 | 1.482            |                                           |
The specific gravity and refractive index values suggest that all three distillations have addressed the Indonesian National Standard. In conclusion, the chemical physical test has proven that the red ginger essential oils resulted from the three distillation process have good quality and high purity level.

3.3.4 Analysis on the Main Components of Red Ginger Essential Oil

The analysis of the main components is aimed at learning the percentage and the amount of the compound content in red ginger essential oil. The result of separating the oil’s components from the three distillation process by using the the gas chromatography-mass spectometry reveals 12 peaks. Each peak that appears on the chromatogram indicates the compound contained in the oil. The result shows that the main components in red ginger essential oil are E-citral (24.20%), Chempene (21.75%), Cineole (17.16%), and zingiberene (2.28%).

Zingiberene is the compound known to give the pungent smell in ginger, while gingerol, shogaol, and zingeron give the spicy, hot and bitter taste. Nevertheless, this study was unable to detect the three mentioned components due to a number of factors, such as overheating during the distillation process or during the application of chromatographic gas, which causes gingerol to immediately degrade. For this reason, there needs to a more extensive study on gas chromatography-mass spectrometry to reveal other undetected compound in ginger.

4. Conclusion

The process of making red ginger essential oil is conducted through carefully designed preparation technique and extracting method in order to produce the best quality product. The extraction method is vapor distillation. The organoleptic test shows that the characteristics of the red ginger essential oil are that it has a liquid form with a clear yellow color, pungent/strong smell, and a little hot and bitter taste. The characteristics of the product have addressed the Indonesian National Standard, according to the refractive index and specific gravity. Moreover, the oil contains E-citral, Chempene, Cineole, and Zingiberene compounds. Although it has a distinctive ginger scent, the essential oil does not taste too strong or hot, due to the absence of the three main components of ginger, namely gingerol, shogaol, and zingeron. Considering all the compounds contained in the essential oil, this study concludes that red ginger essential oil has the potential to be developed into other cosmetic products.

5. References

[1] The Ministry of Trade of the Republic of Indonesia 2011 Indonesian Essential Oils: The Scents of Natural Life in Indonesian Essential Oil: The Scents of Natural Life
[2] Setyawan, Ahmad, D 2002 Keragam varietas jahe berdasarkan kandungan minyak atsiri Jurnal BioSmart Volume 4 No. 2, pp. 48-54
[3] Guenther, E 1990 Minyak Atsiri Jilid IV A (Jakarta: Universitas Indonesia Press)
[4] Hanief, Sidqa 2013 Efektivitas ekstrak jahe terhadap pertumbuhan bakteri streptococcus viridans. Graduating Paper Medical Education Study Faculty of Medicine UIN Syarif Hidayatullah (Jakarta: Unpublished)
[5] Rahayu 2010 Formulasi sediaan chewable lozenges yang mengandung ekstrak jahe merah (Zingiber Officinale Rosc.Var.Rubrum) Graduating Paper Faculty of Pharmacy UMS (Surakarta: Unpublished)
[6] Ravindran, P.N., Babu, K. N 2005 Ginger the genus zingiber (New York: CRC Press)
[7] Primadiati, Rakhmi 2002 Aromaterapi, perawatan alami untuk sehat dan cantik (Jakarta: Gramedia)
[8] Yuliarto 2012 Pengaruh ukuran bahan dan metode destilasi (destilasi air dan destilasi uap-air) terhadap kualitas minyak atsiri kulit kayu manis (cinnamomum burmannii) Jurnal Teknosains Pangan Volume 4 No. 1 2012
[9] Dyah Ratna Sari 2008 Karakterisasi minyak atsiri jahe gajah (zingiber officinale var. officinale) yang diproses dengan variasi ukuran dan metode destilasi diakses dari: https://unej.academia.edu/Departments/Agricultural_Technology/Documents

[10] Koensoemardiyah 2010 A to Z minyak atsiri untuk industri makanan, kosmetik dan aromaterapi (Yogyakarta: Penerbit Andy)

[11] Muchtadi 1989 Teknologi proses pengolahan pangan Departement of Education and Culture General Directorate of Higher Education Center for Inter-College Food and Nutrition Bogor Agricultural Institute

[12] Sugiyono, et.al. 2018 Development of authentic assessment instruments for saintifical learning in tourism vocational high schools. Jurnal pendidikan teknologi dan kejuruan. Vol. 24, No. 1, May 2018, pp. 54-55