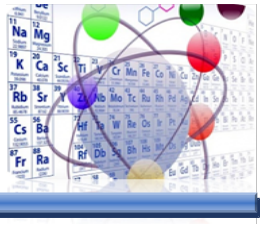
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Kinetics of extraction of essential oils from ginger variations (*Zingiber officinale Rosc.*)

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ABSTRACT

Ginger as one of the root plants can produce essential oils. Meanwhile, essential oils can be produced from plants. Essential oils are extracted from Emprit ginger, Red ginger and Gajah ginger using ethanol solvent to temperatures below 40°C. This research includes one-component equilibrium which includes the process of changing the molecules of substances which are influenced by changes in concentration, pressure or volume and most importantly changes in temperature. Emprit ginger tends to show order 1. Gajah ginger tends to follow order 1, while Red ginger tends to follow both orders so it is difficult to determine the right order, therefore requiring more time variations. Then the most essential oil lumps were obtained in Red ginger at 6.89 grams, Gajah ginger at 2.87 grams and Emprit ginger at 0.65 grams.

Keywords: ginger, essential oils, equilibrium phase, kinetics

1. INTRODUCTION

There are many types of live root plants, one of which is ginger (*Zingiber officinale Rosc*.) which has many benefits for various diseases, where ginger is one of the many types of live root plants which is very popular in Indonesia because of its many benefits, according to research results from several experts that ginger produces 2.39-8.87% oleoresin compounds, 0.78-4.80% essential oil, 0.49-1.37% gingerol, shogaol, zingeron, starch 39-45%, fiber 5.60-8.60% vitamins and minerals.[1,2] There are many uses that can be taken from ginger, for example as a kitchen spice so that the taste of food tastes better and also other benefits of the ginger plant can be used as medicine to cure various diseases, one of which is essential oil.[3]

Essential oils (ethereal oil, volatile oil) are usually produced from plants. This essential oil has several properties such as easily evaporating at room temperature without decomposition, having a bitter taste,

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having a fragrance that matches the odor of the plant that produces it and generally soluble in organic solvents and insoluble in water.[4] From the results of extracting essential oils from ginger plants, further research can be carried out regarding one-component equilibrium systems.

Component balance is one of the chemical materials that studies complex concepts that involve understanding reversible reactions, the law of mass action, as well as changes in the concentration of substances in a reaction and also chemical reaction simulations that can show changes in the concentration of substances over time.5 Apart from that, equilibrium also describes a situation where the rates of the forward and reverse reactions of a substance are the same and the concentrations of reactants and products remain unchanged over time. Component balance also includes an explanation of the process of changes in the molecules of substances which are influenced by changes in concentration, pressure or volume of molecules and changes in temperature.[6]

2. EXPERIMENTAL

2.1 Chemicals, Equipment and Instrumentation

The materials used in this research were three types of ginger consisting of emprit ginger, red ginger and gajah ginger, distilled water and using ethanol (C_2H_6O) as a solvent. The equipment used is a beaker, analytical scale, three gauze legs along with a spirit burner, stand, aluminum foil and thermometer.

2.2 Research Procedure

2.3 Preparation of Tools and Materials

Prepare an analytical balance and empty beaker. Then samples were prepared in the form of ginger, ethanol solvent and distilled water. Each ginger sample was weighed 100 grams and 150 mL of ethanol solvent.

2.4 Reactor *Preparation*

Emprit ginger, Merah ginger and Gajah ginger were each weighed 100 grams using analytical scales. Then each third sample was put into each beaker and then added to each sample 150 mL of ethanol solvent. Then weigh each beaker along with the sample and solvent. The beaker was immediately covered with aluminum foil to prevent ethanol evaporation. Then put the sample beaker into a larger beaker containing distilled water then heat it with a spirit burner then hang the thermometer on a stand to measure the temperature of the sample by making a small hole in the middle of the aluminum foil then inserting it with the thermometer.

2.5 Extraction Process

Heat each ginger sample with ethanol solvent to no more than 40°C. Every 15 minutes weigh the beaker as quickly as possible to analyze the increase in oil that was successfully extracted. Observe every 15 minutes until the ethanol can no longer dissolve the oil as indicated by the formation of two phases in the mixture or until there is no further increase in the mass of the beaker. Then evaporate all the ethanol to get the essential oil and the final procedure is to measure the volume of essential oil that has been

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successfully extracted.

3. RESULTS AND DISCUSSION

To calculate the kinetics of essential oil extraction in ginger, first-order and second-order equations are used. The order one is formulated as:

$Ln[A] = -kt + \ln [A]_0$ (1)

Note:

[A] = initial concentration (%w/w)

$[A]_0$ = Final concentration at a given time (%w/w) k = Constant

t = time (min)

While the second order is formulated as:

$$\frac{1}{[A]} = \frac{1}{[A]_0} + kt \quad (2)$$

An increase in extraction was observed based on the 10-minute, 20-minute, and 30-minute time variations in each ginger. In emprit ginger, the increase in essential oil extraction for 10 minutes, 20 minutes, and 30 minutes respectively was 0.236%, 1.012%, 1.013%. In elephant ginger, the extraction increased for 10 minutes, 20 minutes, and 30 minutes in a row by 0.1181%, 0.118%, 0.11833%. And in red ginger the extraction increase for 10 minutes, 20 minutes, 30 minutes in a row was 0.0675%, 1.03687%, 1.03687%.

After all the ethanol was evaporated, the mass of essential oil that was successfully extracted from the three ginger samples was weighed. The results showed that what was left in the beaker glass was not in the form of oil but in the form of lumps. This can happen due to the presence of starch that can clump during warming. In addition, proteins can also clump as a result of heating.[7,8] Oil that appears to clump is caused by the mixing of oil with the clump. The mass of clumps formed for emprit ginger, elephant ginger, and red ginger was 0.65 g, 2.78 g, and 6.89 g, respectively. Determination of the order of extraction of essential oils from emprit ginger.

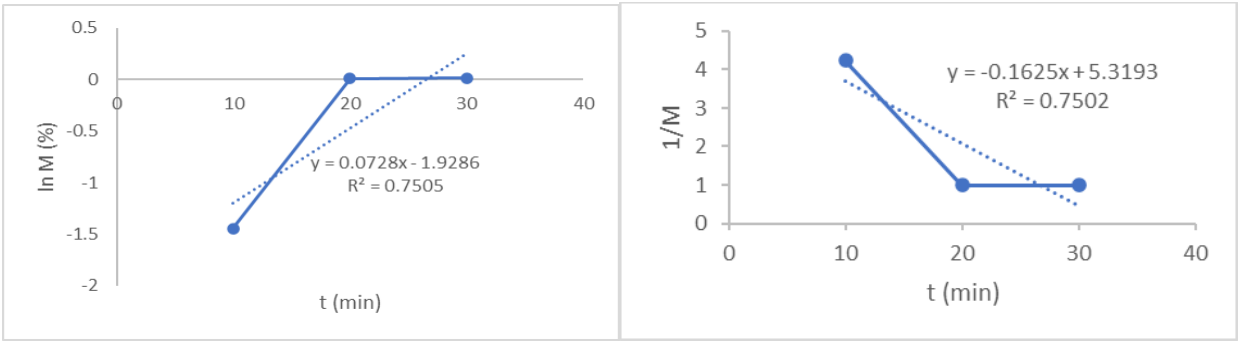


Figure 1. Order 1 extraction rate of emprit ginger (left) Order 2 extraction rate of emprit ginger (right)

To determine the order of extraction of emprit ginger, it can be determined based on the analysis of the R^2 value where the 1st order reaction has an R^2 value of 0.7505 and the 2nd order reaction has an R^2 value of 0.7502. However, the interesting thing is that the 1st order graph and the 2nd order graph are actually opposite

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to each other. A reaction is said to be order 1 when the graph ln M vs t tends to decrease linearly while the reaction is said to be order 2 when the graph 1/M vs t tends to increase linearly but the graph data shows that the order 1 and order 2 graphs are opposite to each other. This can occur due to the lack of variation in extraction time so that the resulting graph does not show a linear change. In addition, at the 30th minute, the increase in the extraction of essential oils slows down further which predictably at the 40th minute the extraction process stops indicating if the essential oils have been fully extracted. However, based on the R^2 value, essential oil extraction tends to follow the 1st order.

2.1. Determination of the order of extraction of essential oils from gajah ginger

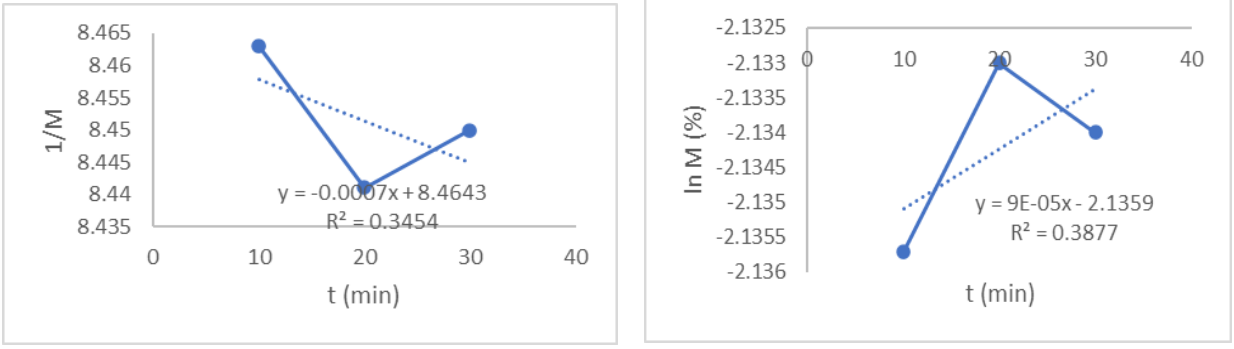


Figure 2. Order 2 extraction rate of gajah ginger (left) Order 1 extraction rate of gajah ginger (right).

In the extraction of essential oils from gajah ginger, the same is true. Where the first order and the second order are opposite. In addition, based on the R^2 value, there is no significant difference between the 1st order and 2nd order graphs. Where the R^2 value in the first order is 0.3877 and the second order is 0.3454 with the R^2 value of the first order slightly greater than the 2nd order. This means that the extraction of essential oils from gajah ginger can follow the 1st and 2nd orders. However, there is a potential that the extraction of essential oils from elephant ginger follows the 1st order where this is related to its R^2 value which is slightly greater than the 2nd order.

2.3. Determination of the order of extraction of essential oils from Red ginger

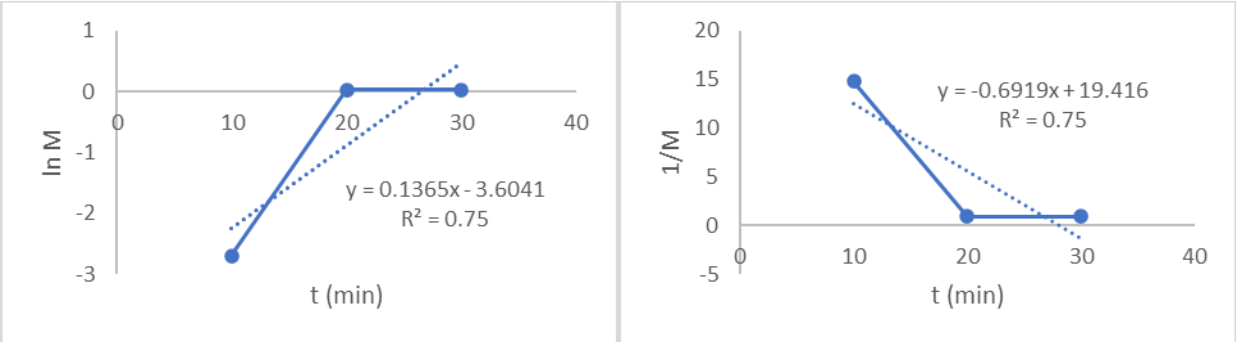


Figure 3. Order 1 extraction rate of red ginger (left) Order 2 extraction rate of red ginger (right).

That appears in the graph ln M vs t shows a linear decrease with $R^2 = 0.75$. Then the 1/M vs t graph also shows a linear increase with $R^2 = 0.75$. Because the 2nd orders have the same compatibility, further

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consideration is needed regarding the extraction of essential oils from red ginger, namely by increasing the variation in extraction time. But the mass of red ginger clumps is larger than emprit ginger and gajah ginger. This can lead to a new conclusion that the content of essential oils in red ginger is more than emprit ginger and elephant ginger. In addition, it can also be an indicator that red ginger contains higher starch than emprit ginger and gajah ginger considering the formation of clots due to the clumping of starch or protein at high temperatures.

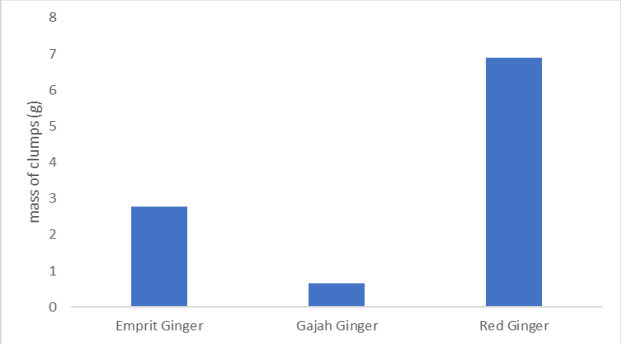


Figure 4. mass of clumps from various of ginger.

4. CONCLUSION

Emprit ginger tends to show the same order of things for gajah ginger which tends to follow the first order. As for red ginger, it needs further analysis with more time variations to observe the order of reactions. Then, red ginger contains a higher clump which is 6.89 grams. Followed by gajah ginger and emprit ginger at 2.78 grams, and 0.65 grams, respectively.

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