EXTRACTION OF OIL FROM RUBBER (*HEVEA BRASILENSIS*) SEED BY USING SOXHLET EXTRACTION

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Running title: Effect of seed size, type of solvent and mass to solvent ratio to the production of oil
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Abstract: The extraction of oil from rubber *(Hevea brasillensis)* seed by using solvent extraction Soxhlet extraction techniques. Soxhlet technique is extraction method to produce high percentage of oil yield and practically easy to use. The size is 355, 500 and 700µm. It is found that rubber seed with 355µm produce percentage of oil yield 42.13% percentage of oil yield for 500 and 700µm rubber seed were 37.83% and 18.96% respectively. These studies n-hexane and methanol solvent. The results show that, the percentage of oil yield for the methanol is lower than n-hexane solvent the effect of mass to solvent ratio compared between 1:4, 1:5, 1:10 and 500µm rubber seed and n-hexane as the solvent 1:4 with 31.39%

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Key words: Rubber seed oil, Soxhlet technique, Size effect, Solvent effect, Mass to solvent ratio effect.

1 INTRODUCTION

For many years, rubber tree (*Hevea brasiliensis*) have been discovered and being well known for its latex production. Nowadays, Malaysia has been one of the top latex producer in the world including plantation, processing and manufacturing for local and foreign customers. Statistically, total of the natural rubber production in 2016 is about 673,513 tones while 930,335 and 1,017,623 tones were being import and exported respectively (Malaysian Rubber Board, 2016)This is clearly shows that the usage of rubber tree in producing latex is undeniably large. It seems like the rubber tree are fully utilized especially in latex production. Besides latex, rubber tree also producing rubber seed and it is usually wasted.

Many studies had been done on the usage of rubber seed since it is abundance and unused in the country. Interestingly, it is found that the rubber seed oil has the potential to be raw material for the biodiesel and replacing the other edible raw material source such as peanut, soybean, almond and walnut. Since the usage of edible raw materials in biodiesel production at the recent time has been a concern on food versus fuel dispute and sustainability (Chhetri, Tango, Budge, Watts, & Islam, 2008). Rubber seed oil can be a solution in replacing current edible raw material since it is cheap and high availability. Various methods like cold pressing, solvent, super-critical fluid and aqueous extractions are in practice for oilseed extraction. The most common method is solvent extraction and mechanical pressing because it is simple and effective.

Malaysian rubber tree is widely known in producing natural rubber for commercialization and the tree also has been found useful in the industries nowadays. It seems Malaysian rubber tree had been completely utilized but there are not many studies are done on the rubber seed itself. Rubber seed are non-edible and it is considered as cheap raw materials because the rubber seed are found to be abundance and usually wasted. Lately, based on (Onoji, Iyuke, Igbafe, & Nkazi, 2016) research has shown that the seed is rich in oil which has been found to have potential application in many areas such as, biodiesel,

foaming agent, in paints and coatings and several other uses. According to (Eka, Tajul Aris, & Wan Nadiah, 2010) rubber seed has potential in the production of soap, paint, cosmetics and additive to diesel.

The research of extraction of rubber seed oil will be conducted using Soxhlet apparatus and will be tested using three different solvents, mass to solvent ratio and size of the grinded rubber seed. The solvent with the most yielded oil will be used to run on three different size of rubber seed. From the research we will found which is the best solvent with the best size to be grinded rubber seed to produce more oil that can be used as biodiesel raw material. Because of the potential of the rubber seed oil in various field, a study will be done in order to extract high yield of oil from rubber seed which is can be affected by size of the seed and mass/solvent ratio.

Soxhlet extraction is using Soxhlet apparatus which was invented in 1879 by Franz von Soxhlet. In this technique, based on (Derksen, Rodgers, Dolinowski, & Wrk, 1879) the sample will be grounded finely in order to increase the surface area and being placed inside a porous bag made from thick filter paper and being placed inside of the main chamber of the Soxhlet extractor. A selected solvent is going to be heat up inside of the bottom flask until reach certain temperature and the vapor travels upward into the distillation arm, and floods into the housing chamber into the thimble of solid. Then, the vapor will condense in the condenser to become a liquid form and drips down into the chamber housing the solid material. Then, warm solvent slowly fills the chamber containing the solid material and the desired compound will dissolve in the warm solvent. When the chamber is almost full, it will be automatically emptied by a siphon side arm and the solvent will flow down into the bottom flask. This cycle can be repeated many times. During each cycle, some portion of non-volatile compound dissolves with the solvent. The desired compound will be concentrated in this distillation flask after many cycles. One of the advantages is just one batch of solvent is recycled instead of many portions of warm solvent that passed through the sample. After extraction complete, the solvent needed to be removed using rotary evaporator, yielding the extracted compound.

Soxhlet extraction method using petroleum ether and n-hexane as a solvent will yields more oil compared to ethanol: water due to its high solubility and polarity. High efficiency of extraction process will result from a longer extraction time with the size of 0.55microns with optimum time of 6 hours. The moisture content of rubber seed oil was 7% which still in the range of oil seed processing (Lee, Sharif, Ahmad, & Khatoon, 2013). Others finding also said that the effect of solvent to mass ratio, temperature, seeds size to the oil yield has a great influence to the oil yield. It is found that the highest oil yields at 40% at 1:6 mass ratio, temperature at 65°C and 150 microns size of seed. (Abdulkadir et al., 2015).

2 EXPERIMENTAL PROCEDURES

2.1 Materials

The solvent used in this study are n-hexane and methanol. These two solvents will be used to compare which is the best solvent to produce more oil. The apparatus used to run the solvent extraction is Soxhlet chamber, tube, condenser, round bottom flask and heating mantle. After that, for the oil recovery part was done using rotary vacuum evaporator with water bath. The analysis for oil density and viscosity was done using hydrometer and viscometer. Other equipment used include blender, oven and sieve trays of size 355, 500 and 700 μm.

2.3 Sampling procedure

The capsules of the seeds are spread over the ground in plantation. The seeds were collected from a plantation and dried under the sun about 3 hours to remove the remaining moisture. Then, the shell and kernels were separated by breaking the capsule. The kernels were dried in the oven for about 24 hours to remove the remaining moisture. The kernel was immediately ground using food processing machine (blender) in order to weaken and rupture the cell, subsequently, the ground rubber seed was taken into the oven overnight at 104ºC in order to deactivate the remaining enzyme as well to remove the moisture and then sieved using 355, 500, and 700μm opening screens. Finally, three different size fractions were obtained 177.5 μm (0-355 μm), 427.5μm (355-500 μm), and 600 μm (500-700 μm). from the seeds. Oil content of the kernels was determined through soxhlet extraction using hexane as a solvent for 6 hours.

Figure 1: The dehulled rubber seed

2.4 Solvent Extraction Process

Solvents used are methanol and n-hexane. 10 gram of grinded rubber seed will be placed inside of the thimble and 50ml of solvent will be placed in the bottom flask and attached to the Soxhlet extractor. The temperature will be set at 80 and the overall extraction time is about 5-6 hours. After the extraction finish, the flask will be placed on the rotary evaporator in order to remove all of the solvent from the extracted oil. The mass of the oil will be weighed to calculate the percentage of oil yield. The experiment will be repeated using the solvent with the most extracted oil percentage, different size of grinded rubber seed and different solvent to mass ratio.

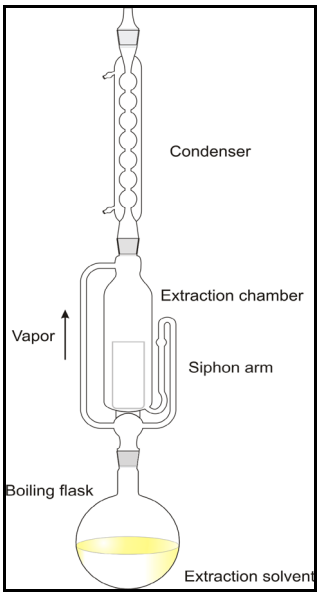

Figure 2: Soxhlet Extractor (Generalic, 2017)

2.5 Oil Recovery from rotary evaporator

The mixture of oil and solvent and the mixture will be rotary evaporator and another round-bottomed flask is placed at the bottom of evaporator for the solvent residue and the rotary is slowly rotate in order to prevent the mixture to evaporated out of the equipment. After all of the solvent being evaporated, switch of the main supply and let the sample to cooled. Finally, the oil weighted and recorded.

3 RESULTS

3.1 Effect of Rubber Seed Size to The Percentage of Oil Yield

The figure below show that the percentage of oil yield based on the rubber seed size of 355 µm, 500 µm, 700 µm with hexane solvent and 1:4 mass to solvent ratio with the Soxhlet extraction technique for 6 hours.

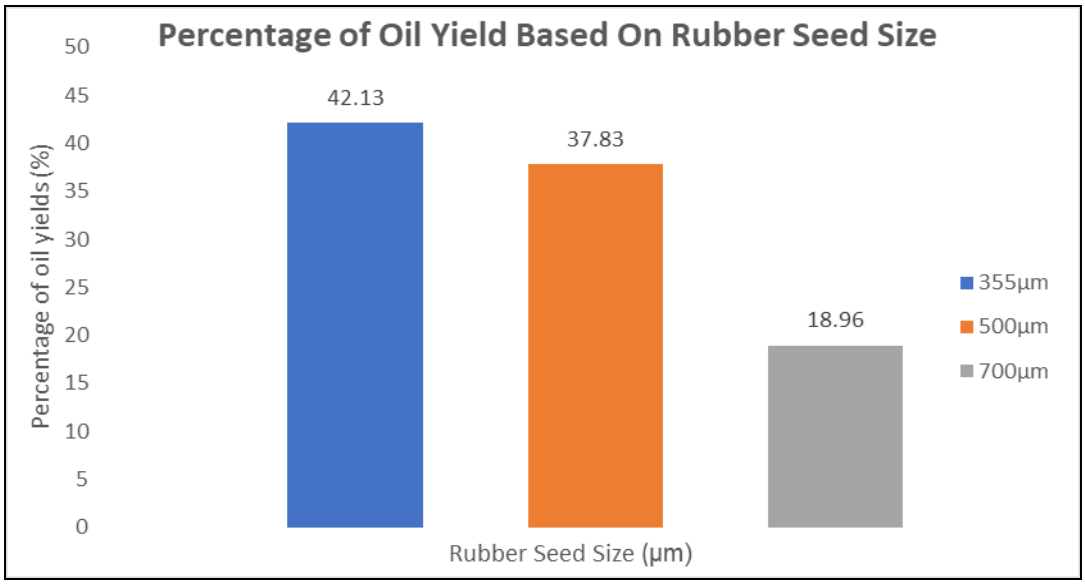

Figure 4.1: Comparison of Rubber Seed Size to The Percentage of Oil Yields

The results above show that the effect of rubber seed size to the production of oil yields. It is shows that the rubber seed size of 300µm is the highest percentage of oil yields with 42.13% compared to the rubber seed size of 500µm and 700µm with the percentage of 37.83% and 18.96% respectively. In each of the experiment it is clearly shows that the production of oil is increase with decrease in rubber seed size. Based on the result obtain from (Journal et al., 2017) they also found that the oil recovery was increased as the size of rubber seed is decreased. It also stated in (Reshad, Tiwari, & Goud, 2015) where they found out that the size of rubber seed influence the production of oil yields. They also discuss on the extraction time with the rubber seed size to the production of oil. Smaller size rubber seed is giving high percentage of oil yield compared to the bigger size with long time extraction. Based on (Journal et al., 2017) this is because of the fact that smaller particle have larger amount of surface area and lead to increasing number of broken cell and caused the high concentration of oil at the surface of the particle. It can be concluded that the amount of oil available is directly proportional to the surface area. The smaller the particle size, the larger the surface area being contacted with solvent and will produce more oil compared to the particle with bigger size.

3.2 Effect of Solvent

Figure 4.2 shows that the percentage of oil yield from two different solvent which is from n-hexane and methanol. The boiling point for both solvent is 68°C and 64.7°C respectively.

Based on the Figure 4.2, it is clearly shows that the percentage of oil production by using n-hexane as a solvent is greater than using methanol as a solvent. This might show the effect of polarity between the solvent. According to (Lee et al., 2013) the polarity theory of solvent and oil seeds in extraction. They also said that the polar lipid is dissolve and soluble in polar solvent, thus make the rubber seed oil is non-polar lipid.

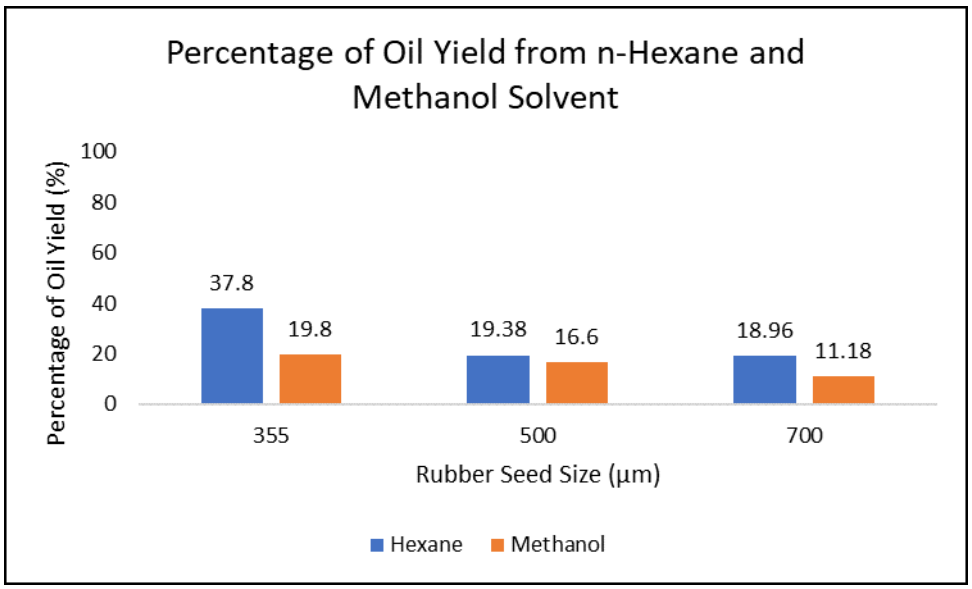

Figure 4.2: Comparison between solvent n-Hexane and Methanol to The Production of Oil Yields

Based on the (Reshad et al., 2015) the oil yield obtained is depend on the polar and non-polar solvent. Where, non-polar solvent n-hexane is producing more oil compared to polar solvent methanol. Other finding, from (Reshad et al., 2015) found that non-polar solvent hexane is producing more oil compared to high polarity solvent methanol at 46.01% and 32.67% respectively. Based on the previous research all of the results show the non-polar solvent yield more oil compared to polar solvent. The most non-polar solvent used is hexane, petroleum ether and pentane. This is because the polarity theory of solvent and oil from seed extraction. Based on (Lee et al., 2013) the rubber seed oil is non-polar lipid because of polar lipid is soluble inside polar solvent. Referring to Figure 4.2, this is also proved by the lower percentage of oil yield with polar solvent methanol.

3.2 Effect Mass Rubber Seed to Solvent Ratio

The Figure 4.3 described the percentage of oil yield based on mass of rubber seed to solvent ratio. The experiment was done using n-hexane as a solvent for 6 hours with rubber seed size of 700µm for 1:04 ratio, 500µm for 1:05 ratio and 355µm for 1:10 ratio.

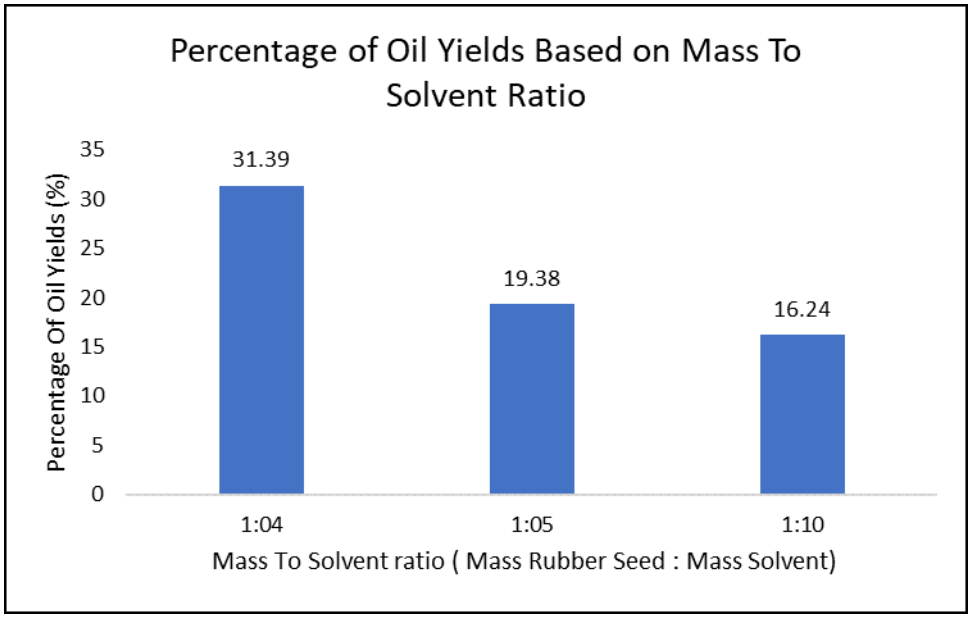

Figure 4.3: Percentage of Oil Based on Mass of Rubber Seed to Solvent Ratio.

Based on Figure 4.3, the highest oil yield is at 1:04 mass rubber seed to solvent ratio and the lowest is at 1:10 mass rubber seed to solvent ratio. This result is different with (Lee et al., 2013) where they found that when the ration of rubber seed to solvent is increasing, the percentage of oil yield will increase. Same with (Reshad et al., 2015), the result obtained is at the highest ratio of mass rubber seed to solvent. It is found that (Abdulkadir et al., 2015) get the high yield of oil with 1:5 ratio, but further the increases the ratio, the percentage of oil yield is decreases. Based on the previous results obtained, it can be concluded that higher the mass rubber seed to solvent ratio, the higher the percentage of oil yield. This is because the good mass transfer happens when the concentration gradient between the liquid and solid become greater.

4 CONCLUSIONS

Soxhlet extraction technique with the solvent n-hexane give you high percentage of oil yield compared to methanol solvent because of its non-polar characteristic. The smaller particle size, the higher the oil yields percentage. This is because the effect of surface area. The smaller the particle size, the larger the surface area and thus more oil yield. Furthermore, the mass to solvent ratio of 1:4 is producing more oil compared to 1:5 and 1:10.

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