

# Biodiesel Production from a Mixture of Rubber Seed Oil and Waste Oil Through the Alcoholysis Process with Catalysts Based on Vegetable Waste

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## Abstract

The increasing types of people needs along with the times have resulted in the need for energy increasing so that the supply of energy, especially energy that cannot be renewed (unrenewable energy) is decreasing. Currently, almost 80% of the world's energy needs are met by fossil fuels. In fact, the use of fossil fuels can cause global warming. To reduce dependence on fossil fuels as an energy source, it is necessary to search for energy sources that can be used as alternative fuels that are environmentally friendly. Indonesia is an agricultural country that is overgrown with plantation crops that produce various kinds of waste such as rubber seeds which contain oil. This plant produces a lot of wasted seeds that are not useful. Therefore, researchers want to research the oil from rubber seeds to be a biodiesel product and in order to get high quality results. This study regulates several independent variables, namely the alcoholysis temperatures: 650C, 700C and 750C and the alcohol volume: 200 ml, 250 ml and 300 ml. The process is carried out by extraction using the alkalysis method. The best yield yielded 60.5%, with the best yield of biodiesel from alcoholysis obtained at a volume of 250 ml of ethanol and a temperature of 750C with a density of 09 kg/m3 and a viscosity of 3,285 mm2/s (cSt), fulfilling the requirements of SNI 7182:2015. Based on the results of GC analysis, the main fatty acid components in the sample were at peak 1, namely saturated fatty acids in the form of palmitic acid at 44,28% and peak 4, namely unsaturated fatty acids in the form of oleic acid at 31.99%.

**Keywords:** Biodiesel, Rubber Seed Oil, Alcoholysis, Bio-catalyst

## 1. Introduction

Biodiesel compounds are one of the alternative fuels that are environmentally friendly because biodiesel can reduce carbon monoxide (CO) gas emissions by about 50%, carbon dioxide gas (CO2) by about 78.45% and free sulfur content [1] [2]. Biodiesel compounds can be obtained from plant oils derived from renewable resources such as vegetable oil from rubber seeds and used cooking oil (cooking oil) through esterification and/or transesterification with alcohol and the help of a catalyst. Biodiesel compounds are known as renewable resources because they can generally be extracted from various agricultural and plantation products. Vegetable oils commonly used for biodiesel production include castor seed oil, palm oil, rubber seed oil and so on. One alternative raw material that deserves to be studied is rubber seed oil [3] [4].

Raw materials that have the potential as raw materials for making biodiesel compounds include palm oil, soybeans, jatropha, kapok and several other plant species. The manufacture of biodiesel compounds is generally carried out using homogeneous base catalysts such as NaOH and KOH because they have a higher catalytic ability than other catalysts [5]. This research is limited to the alcoholysis reaction which involves several variables and then analyzes the resulting biodiesel compounds such as density, viscosity, yield and analysis of the composition of hydrocarbon compounds using GC (Gas Chromatography) [6] [7].

## 2. Literature Review

### 2.1. Rubber seed (Hevea Brasiliensis)

Seeds that have been processed by the community are usually for oil. Rubber seed oil can be used as a lubricant, but it can also be used as a mixture to make paint. Processing rubber seeds into oil inevitably produces waste. The waste is usually used for plant fertilizer, but it can also be used as animal feed. According to Swern, 1964 in the journal Novia fresh rubber seeds consisted of 34.1% skin, 41.2% content and 24.4% water, while rubber seeds that had been dried for two days consisted of 41.6% skin, 8% water, 15.3% oil and 35.1%



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dry matter [8]. Rubber seeds contain 40% to 50% oil consisting of 17% to 22% saturated fatty acids and 77% to 82% unsaturated fatty acids [9]. For the nutritional content contained in rubber seeds and needed by the body, based on test results at the Pontianak Research and Industrial Standardization Center (Baristand), rubber seeds contain 40.9% fat, 15.6% protein, and 31.6% carbohydrates. For the nutritional content contained in rubber seeds and needed by the body, based on test results at the Pontianak Research and Industrial Standardization Center (Baristand), rubber seeds contain 40.9% fat, 15.6% protein, and 31.6% carbohydrates [10] [11].

The rubber seed waste oil used in this study contains high free fatty acids, namely 97.77% and has a high acid number which is equivalent to 6.2 mg KOH g of oil, so esterification is necessary to reduce the free fatty acid content to ester. Methanol (20% oil volume) was reacted with rubber seed waste oil with 98% sulfuric acid catalyst (0.5% oil volume) to become ester.

## 2.2. Biodiesel Compound

Biodiesel compounds are monobiodiesel from long-chain fatty acids contained in vegetable oils or animal fats to be used as fuel for diesel engines. Biodiesel compounds can be obtained through a triglyceride transesterification reaction or a free fatty acid esterification reaction depending on the quality of the vegetable oil used as raw material. Biodiesel compounds are the most appropriate solution to replace fossil fuels as the world's main transportation energy source, because biodiesel compounds are renewable fuels that can replace petrol diesel in engines and can be transported and sold using current infrastructure. Biodiesel compounds are biodegradable, contain almost no sulfur and are renewable fuels. Alternative fuels consist of methyl or ethyl esters, either transesterified from triglycerides (TG) or esterified from free fatty acids (FFA) [12] [13].

Biodiesel compound fuels are becoming more attractive because of their environmental benefits. Plants and vegetable oils and animal fats are renewable sources of biomass [14]. Currently, most biodiesel compounds arise from the transesterification of edible resources, such as animal fats, vegetable oils and even waste cooking oil, by alkaline catalyzed processes. However, high consumption of catalyst causes soap formation and low conversion of biodiesel compounds [15] [16].

Transesterification is a process that reacts triglycerides in vegetable oils or animal fats with short chain alcohols such as methanol or ethanol (currently most of the biodiesel production uses methanol) to produce fatty acid methyl esters (FAME) or biodiesel and glycerol compounds (glycerin) as a by-product. The catalyst used in the transesterification process is a base/alkali, usually sodium hydroxide (NaOH) or potassium hydroxide (KOH) [17].

## 2.3. Alcoholic Reaction

The alcoholysis process is a method in which the extraction process is carried out separately. In the alcoholysis reaction, the oil extraction process and the transesterification reaction of oil into biodiesel compounds occur simultaneously in one process. Alcoholysis is a method developed to produce mono esters from oils containing high free fatty acids. In alcoholysis, the oil extraction process and the esterification reaction are carried out simultaneously. Alcohol in this method functions as a solvent, oil components and as a reagent in the esterification reaction. The use of this method in the production of biodiesel compounds can reduce costs because the conventional oil esterification step is removed [18] [19].

Alcoholysis is a simpler step in producing biodiesel compounds by eliminating the oil extraction and refining process so as to reduce the cost of producing biodiesel compounds [20]. The alcoholysis method is a method where the extraction and transesterification processes are not carried out separately, the oil extraction process and the transesterification reaction of oil into biodiesel compounds occur simultaneously in one process. This method utilizes triglycerides derived from oil source raw materials without the need to extract and purify them first [21] [22].

## 2.4. Catalyst Based on Waste Vegetable

Esterification and transesterification processes in the formation of biodiesel are very necessary catalysts. The function of the catalyst is to speed up the process, it turns out that natural ingredients from vegetable ingredients that contain organic compounds provide benefits to be used as catalysts. One of these vegetable ingredients is banana weevil. Banana weevil is mostly obtained as agricultural waste which is organic material left over from banana plants that is not utilized. Banana bole can be used as the main ingredient in composting because it contains complete macro and micro nutrients [23] [4]. The nutrient content of banana weevil includes nitrate, ammonium, zinc, manganese, cuprum, phosphate, potassium, calcium, iron, and carbon [7] [22].

## 3. Methods

Research tools and materials used in research extraction, distillation, and other supporting equipment. As for the materials used in rubber seed research, alcohol, catalysts, n-hexane, etc. The variables in this study were varying the alcoholation temperature, namely 65, 70, and 750C and the alcohol volume was 200, 250 and 300 ml [24].

In this study, the working procedure for the manufacture of biodiesel from rubber seed oil and waste oil with alcoholysis is divided into several stages including raw material preparation, alcoholysis process, separation process, density analysis, viscosity analysis, yield analysis, and analysis of the composition of hydrocarbon compounds using gas chromatography. For other variables, it will be carried out with the same steps but by changing the temperature and solvent volume variables according to what has been determined. Furthermore, analysis of yield, density, viscosity, and analysis of biodiesel compounds was carried out [25].

## 4. Results and Discussion

### 4.1. Rubber Seed Oil Yield

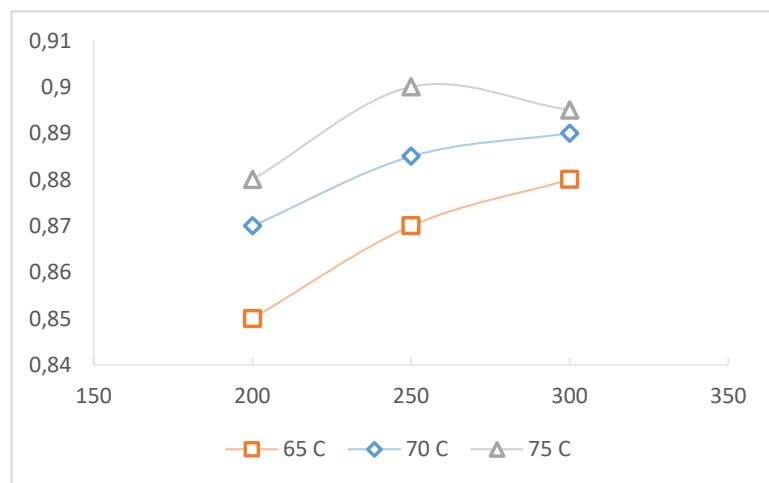
After the process of extracting rubber seed oil from the seeds, it was carried out using n-hexane solvent at constant conditions and solvents. Then a series of separation processes were carried out to obtain the yield as at 60.5%.

**Table 1.** Data from Research on Density and Viscosity Measurement

Temperature (°C)	Volume (ml)	Density (kg/m <sup>3</sup> )	Viscositas (cP)	Yield (%)
65	200	0,850	4,466	59.07
	250	0,870	3,547	60.10
	300	0,880	3,029	59.88
70	200	0,870	4,355	60.00
	250	0,885	3,436	55.96
	300	0,890	2,328	59.09
75	200	0,880	3,742	57.03
	250	0,900	3,285	60.50
	300	0,895	2,276	58.84

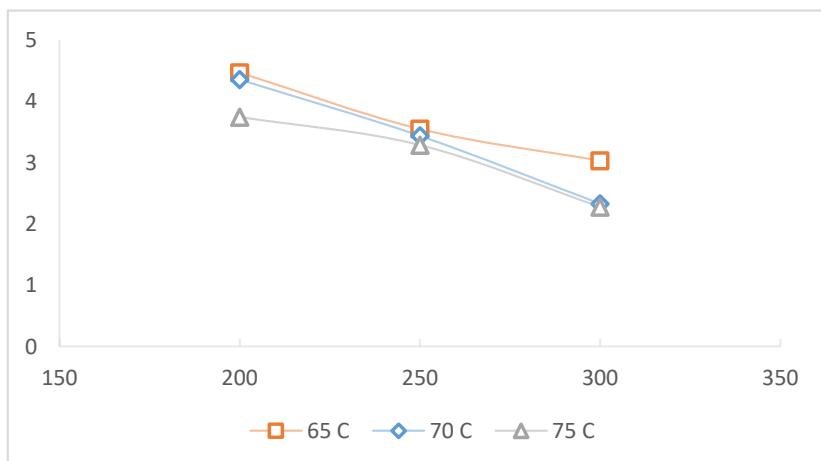
#### 4.2. Effect of Alcohol Volume and Operating Temperature on

According to the procedure for carrying out the alcoholysis process, the results are presented in Table 1. If we look at Figure 1 of the results of the density test on the effect of alcohol volume and temperature, it shows that the volume and temperature increase and density increases, only at a volume of 300 ml and a temperature of 75°C it slightly decreases. These results indicate that all results are within the standard range of SNI 7182:2015 for biodiesel. Based on the working procedure, it is shown that the alcoholysis process is going well, it is estimated that there is a transesterification reaction that takes place to form methyl esters which are the basic ingredients of biodiesel. In addition, in the previous extraction process there was a role for n-hexane which first took the rubber seed oil better than the seeds. The distillation process for the separation of alcohol as the final stage also plays a perfect role.

**Fig 1.** Effect of Alcohol Volume and Temperature on Density

#### 4.3. Effect of Alcohol Volume and Operating Temperature on Viscosity

According to the test results obtained indicate that the increase in the volume of alcohol in the alcoholysis process causes a decrease in viscosity. Furthermore, the increase in process temperature causes a decrease in viscosity as illustrated in Figure 2. This occurs because the increase in the volume of alcohol provides a greater chance of contact between oil and alcohol in the same operating time, while the increase in viscosity temperature decreases because the high temperature for the fluid can dilute it. solution. In addition, the alcoholysis process provides a good opportunity for the formation of esters under the operating conditions. If we look at table 1 shows.

**Fig 2.** Effect of Alcohol Volume and Temperature on Viscosity

#### 4.4. Analysis of Biodiesel Compound Composition

Methyl ester from rubber oil transesterification into biodiesel was analyzed using Gas Chromatography-Mass Spectroscopy (GC-MS). This analysis is a qualitative and quantitative analysis that can be used to determine the type of fatty acid content in biodiesel and its quantity. Methyl ester biodiesel which has been analyzed by GC-MS shows five dominant peaks as presented in Figure 3. Figure 3 is a chromatogram of biodiesel composition analysis using GC-MS. The chromatogram shows that the biodiesel in this study contains methyl esters which match the fatty acids contained in used cooking oil. However, methyl laurate does not appear in biodiesel, such as lauric acid in used cooking oil. It is possible that methyl laurate was also formed, but the instrument could not read it because there were too high content of compounds such as methyl oleate, linoleate and palmitate, so that methyl laurate was not observed because the content was too small. Based on the results of GC analysis, the main fatty acid component in the sample was at peak 1, namely saturated fatty acids in the form of palmitic acid at 44,28% and peak 4, namely unsaturated fatty acids in the form of oleic acid, at 31.99%.

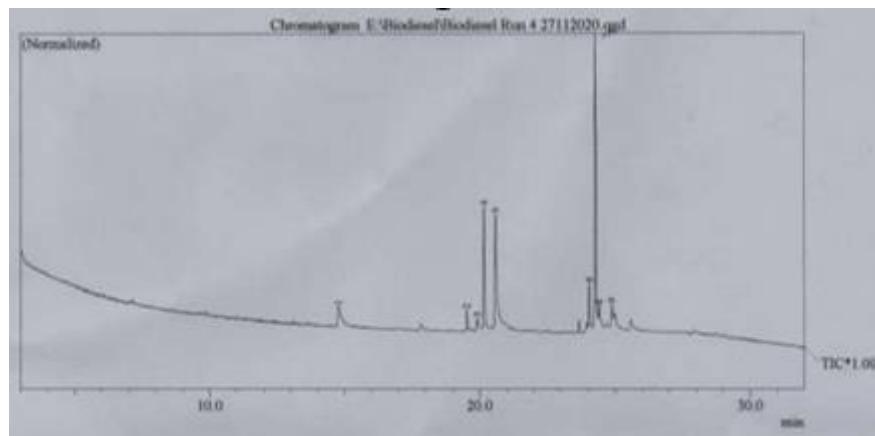


Fig 3. Product Test Results with GC-MS

#### 5. Conclusion

Based on the results of the study, it can be concluded that crude rubber seed oil and waste oil using alcoholysis process with banana weevil catalyst to produce biodiesel. The best results were at 60.5% pen, with the best yields of biodiesel from alcoholysis obtained at a volume of 250 ml of ethanol and a temperature of 75°C, namely a density of 0.9 kg/m<sup>3</sup> and a viscosity of 3,285 mm<sup>2</sup>/s (cSt), fulfilling the requirements of SNI 7182:2015. Based on the results of GC analysis, the main fatty acid component in the sample was at peak 1, namely saturated fatty acids in the form of palmitic acid at 44,28% and peak 4, namely unsaturated fatty acids in the form of oleic acid, at 31.99%.

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