

# Analysis Production of Biodiesel from Nyamplung Seeds (*Calophyllum Inophyllum*) in West Java

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**Abstract**—The needs for diesel fuel in West Java is unavoidable because the large population is a challenge to finding substitutes for diesel fuel to guarantee its availability. One of the alternative energy is Biodiesel, in addition to being environmentally friendly and the supply of the raw materials available throughout the year using nyamplung (*Calophyllum inophyllum*) plants. This plant is one of forest plant that grows in West Java. Oil yield up to 75% and its manufacture able to be processed used simple technology with oil conversion nyamplung (*Calophyllum inophyllum*) seeds of 18 Kg per 100 Kg of raw material. The method of writing this paper uses secondary data from previous researches and other supporting data. The purpose of this study is to analyze that West Java is able to be a producer of biodiesel derived from the nyamplung (*Calophyllum inophyllum*) plants which is cultivated on an area of 244,926 hectares in people forest to meet the needs of 46,709,600 West Java people. The paper presents the potential of biodiesel by nyamplung seeds as alternative energy to reduce utilizing diesel fuel. This paper explains also about the production stage and biodiesel industry establishment of nyamplung biodiesel in West Java. The gains are decreasing greenhouse gas emissions, guarantee that fuel reserves are always there and help the community economically related to the biodiesel industry.

**Index Terms**—Biodiesel, energy, nyamplung, West Java.

## I. INTRODUCTION

Human concerns about the continuity of energy which are currently a basic human needs have decreased dramatically. The availability of depleted oil reserves encourages people to think and find solutions for human problems in terms of energy. Energy must be available continuously and the impact on the environment is a small risk. One solution that is being implemented by several countries including Indonesia is biofuel in the form of biodiesel. Petroleum production in Indonesia decreased by around three percent after 2004, Indonesia's petroleum production in 2014 decreased to 96% in 2013 with total oil production of 789,000 bpd in 2014 and 824,000 bpd in 2013 [1]. While specifically fuel consumption is dominated by diesel fuel/diesel [2] and the government subsidies for diesel fuel are 17.05 million KL with a subsidy of Rp. 1,000 / liter in 2015 [1], [2] with a number of facts that explain the costs that must be incurred are very large and the dependence on fossil fuels must be reduced and seek alternative energy such as biodiesel.

Biodiesel with the chemical named is fatty acid methyl

esters (FAME), C14-C24 methyl esters [3] the esters are called biodiesel [4]. Biodiesel has advantages compared to fuels such as diesel fuel, which able to be degraded by the environment, non-toxic, sulfur-free, can reduce carbon dioxide gas emissions by around 60% [5].

Biodiesel also has a high flash point greater than 160°C, making it easier to store and use it, and the conversion process is easy to use as gasoline and diesel [5].

Nyamplung is one of the forest plants that have a large potential of biodiesel as an environmentally friendly fuel for substituting fuel oil in West Java. The people called *Calophyllum inophyllum* as Tamanu for common name [6]. But in Indonesia called as Nyamplung (*Calophyllum inophyllum*) Linn. The native habitat of Tamanu is in tropical Asia includes Melanesia and Polynesia [6]. The advantage of nyamplung become biodiesel feedstock because the seeds have a large oil content of 75% with 100 kg of fruit produced and will get the oil of 18 kg [7].

West Java is one of the province that potential to use as land growing of nyamplung (*Calophyllum inophyllum*) as wide as 244,926 hectares in people forests (Fig. 3). This potential can be used as an opportunity in carrying out nyamplung biodiesel production because the raw materials are abundant availability [8].

## II. METHODOLOGY

### A. Material and Methods

The making of this paper was carried out in December 2018 to January 2019 using a laptop, stationery, research data from previous researchers and other supporting data. The method used was a literature study that uses secondary data and then analyzed according to needs.

## III. RESULT AND DISCUSSION

### A. Nyamplung Oil is Biodiesel in the Future

According to the previous statement, nyamplung suitable become biodiesel feedstock. This potential is beneficial for the development of biodiesel in West Java. Competition with food crops does not occur [8] because nyamplung seeds are not included in a food plant, so no problem about the availability of the raw materials for biodiesel production in West Java.

The use of biodiesel is widely known in the community as a solution to the problem of decreasing world oil reserves. Human discretion in using fuel can affect the energy crisis. The need energy for a large transportation sector [9] and burden the availability of fuel for industrial and household

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needs. The use of transportation is well-known for mixing biodiesel with diesel fuel, its use is environmentally friendly with the lowest greenhouse gas emissions [9] plays a role in climate action efforts locally in West Java.

The large oil content in nyamplung (*Calophyllum inophyllum*) makes nyamplung one of the potential plant species to produce biodiesel up to 75% higher than *Jatropha* (25-40%) [10].

The use of the biodiesel is widely used to mix with petroleum fuels with certain comparisons. Strengthened by government regulations by ministerial regulation ESDM No. 25/2014 which requires the use of biofuels in everyday life mixing biodiesel in 10% diesel fuel (B-10) starts on September 01, 2013 [11]. As a result, biodiesel use has increased by 56.62% from the 2012 achievement with the

amount of biodiesel utilized amounting to 1.05 million KL for Indonesian domestic needs [11].

### B. West Java Diesel Energy Needs

The demand for the biodiesel is very profitable every year, the market demand for the biodiesel is good, making it an appropriate opportunity in the development of the nyamplung (*Calophyllum inophyllum*) biodiesel industry in West Java.

West Java is the province with the largest population in Indonesia with a percentage of 18.28% of the total population of Indonesia, which is 46,709,600 people [12] have implications for the use of energy fuels. The use type of diesel fuel is 1,815 kiloliters in 2014 [13]. Being a serious challenge and problem if there is no alternative energy.

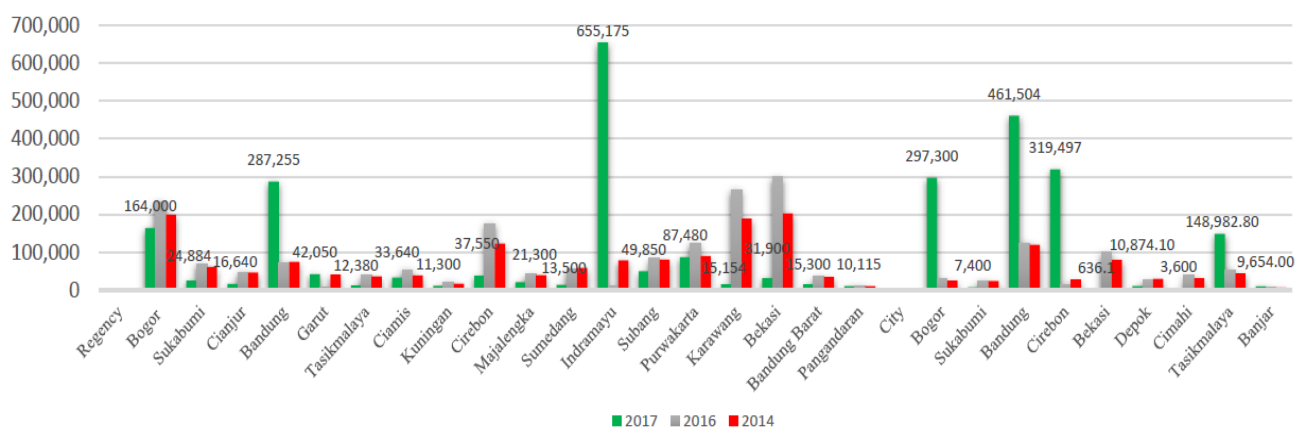


Fig. 1. Diesel consumption in West Java, 2017, 2016, 2014 (Kiloliters) [14].

According to data from BPS collected over 3 years, namely, 2017, 2016, 2014 describes total diesel consumption in West Java, diesel fuel consumption has increased in 2017 which is 2,788,920 kiloliters increased by 713,253.52 kiloliters by 2016 (2,075,666.48 Kiloliters) (Fig. 1), the dynamic activity of the community along with its mobility are fast implications for diesel reserves. The large demand for diesel but the depletion of the availability diesel supply is feared to increase prices in the world market, in addition to the economy, environmental pollution in the form of air pollution is very likely to occur if used for a long period without any effort to reduce it and reduce greenhouse gas emissions.

The needs will always be in the era of the industry today, the searching for a solution is absolutely done but still profitable and environmentally friendly. Palm biodiesel blend (PB10, PB20, JB10) is a type of fuel that has experienced mixing with diesel, PB20 produces lower CO and HC than diesel [15]. Beside that, for *Calophyllum inophyllum* named Calophyllum inophyllum methyl ester (CIME30, CIME60, and CIME100) [16]. The blends of CIME could be used as fuel without any diesel engine modifications [16].

Using or mixing 20% of biodiesel about total diesel consumption of 445,326.92 kiloliters blend with biodiesel of B-20 fuel is very appropriate in finding solutions to the problems discussed earlier, it is not impossible to do it especially because biodiesel is very effective and not destructive engine and environment. The advantages of

using this type of fuel are suitable for diesel engine [16]. It is also hoped that the mixing of biodiesel greater than 20% until 100%, it is not impossible to execute it. More benefit for many parties will be gain, including for the government, academics, entrepreneurs and of course the community have the potential to be carried out it by small and medium industries.

### C. Cultivation Area for Nyamplung

The area of West Java Province is 35,377.76 km<sup>2</sup> (Fig. 2) with the people forest area that can be used as nyamplung cultivation area of 244,926 hectares (Fig. 3). West Java is one of the provinces with suitable nyamplung (*Calophyllum inophyllum*) plant life support, for example in the case in Ciamis, the characteristics of the district are the natural forest, coast, 2-5m asl elevation, soil texture sandy, the temperature of 23-32°C, and rainfall 3000mm/ year [17]. It is mean West Java which shows that this plant grows well.



Fig. 2. Map of West Java (Source: BPS, 2018)

The cultivation area is very potential in the development of biodiesel. The community able to be educated and then invited to use their forests. People forests are forests managed by the community to meet their needs by planting economically valuable crops, such as teak (*Tectona grandis*),

silk tree (*Paraserianthes falcataria*) and agricultural commodity crops. In the case of manufacturing the biodiesel industry, planting of nyamplung (*Calophyllum inophyllum*) provides added value for utilization of the community's natural resources.

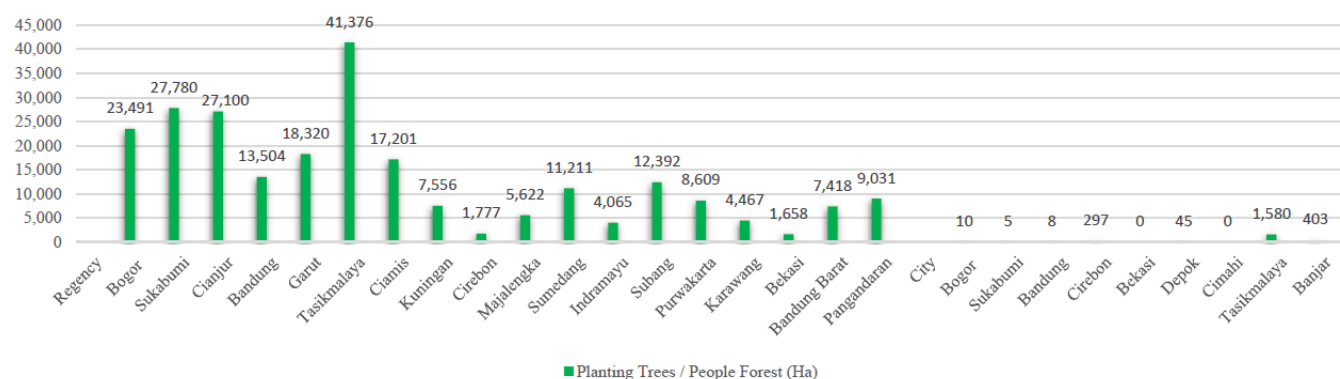


Fig. 3. People Forest (Ha), 2015 (Source: BPS, 2018).

#### D. Stages of Biodiesel Production Process

The process of biodiesel production used in this paper is carried out several processes, namely:

##### 1) Nyamplung extraction

Based on the research by Rustam *et al.* on (2017) using 100 kg wet weight of raw materials with the results obtained of 18.78 kg dry weight, after that using pressing process obtained as much as 7.98 kg of yield oil or this process obtained the yield oil 42.06% of dry weight. The size and humidity for making biodiesel must be considered. The good seed particle size of 8.60 mm and humidity of 1.2%. [18]. Based on Fadhlullah *et al.* research, oil yields obtained 33.39% for dry weight basis with humidity of 1.2%, while, oil yield obtained of 33.46% for dry weight basis for particle size 8.60 mm, then if using mechanical extraction obtained efficiency of 58.19% oil yields [18], estimated amount of oil production with particle size 8.60 mm is 4.75 L/tree/year and the humidity of 1.2% results in an estimated oil yield of 5.13 L/tree/year [18].

##### 2) Degumming [19]

The purpose of the degumming process was to separate the oil from the sap produced by pressing the nyamplung seeds (*Calophyllum inophyllum*). The next processing after being pressed, heated at 70°C, then add it C<sub>2</sub>H<sub>4</sub>O<sub>2</sub> 0.3% absorbent while stirring for 30 minutes using a magnetic stirrer for 30 minutes. The last step is putting oil for 24 hours in a separating funnel.

The data obtained (Table I) still requires better evaluation and processing of nyamplung oil accompanied by more careful processing.

The use of C<sub>2</sub>H<sub>4</sub>O<sub>2</sub> adsorbent 0.3% still needs further study in maximizing the production of nyamplung oil for biodiesel purposes.

Other absorbances that able to be done besides C<sub>2</sub>H<sub>4</sub>O<sub>2</sub> was using 85% phosphorus acid (0.2% b/b) (H<sub>3</sub>PO<sub>4</sub>), the results obtained at this stage according to Qiqmana and Sutjhajo (2017) was better than phosphorus acid (H<sub>3</sub>PO<sub>4</sub>) 20%. According to Haribuan *et al.* (2013) the indicator in the purification of oil with its color, the results will be better as the amount of phosphorus acid (H<sub>3</sub>PO<sub>4</sub>) is given, the

more it is given, the clearer it will be. After using phosphorus acid 0.8% sodium hydroxide (NaOH) is used to clean impurities that couldn't be dissolved by acid absorbances. The treatment was same between phosphorus acid (H<sub>3</sub>PO<sub>4</sub>) and Sodium Hydroxide (NaOH), which was heated and then stirred at 80°C for 20 minutes after that which leave it for a day [19].

TABLE I: THE VALUE OF THE DEGUMMING PROCESS USES 0.3% C<sub>2</sub>H<sub>4</sub>O<sub>2</sub> ABSORBANT [19]

Chemical properties	Value	Standardization	explanation
Flash point	63°C	SNI 7182:2015	Minimum 100°C
Pour point	4°C	SNI 7182:2015	Maximum 18°C
Water content	0,18%	SNI 7182:2015	Not fulfilling (0,05 % volum)
Heating Value	8943,97 Kal/grm	17,918 Kal/gr	Not fulfilling
Density	0,9259 g/cm <sup>3</sup>	0,8500 g/cm <sup>3</sup> 0,8900 g/cm <sup>3</sup>	Not fulfilling
Viscosity	2,5 mm2/s	2,0 mm2/s – 4,5 mm2/s	Satisfy
Free fatty acid levels (FFA)	0,19%	6,76%	Not fulfilling

##### 3) Transesterification

In general, the using of biodiesel is problematic in engines because of its relation to the high viscosity of biodiesel fuel. To reduce it, the carbon chain is terminated by alcoholism with the help of a catalyst. The right catalyst is a base catalyst, namely NaOH [20].

Base catalysts are far more efficient such as NaOH for transesterification than acid catalysts, transmetalation occurs around 4000 times faster [20]. Base catalysts have a low corrosive effect on the equipment used during for industry, thus the catalyst is suitable for the commercial stage [20].

The transesterification stage starts from triglycerides to alkyl esters with alcoholic reactions accompanied by glycerol byproducts [20] (Fig. 4). Transesterification was carried out for 1 hour at a temperature of 60°C in a ratio of 1: 6, each mole of triglycerides produces 3 moles of esters and 1 mole of glycerol based on their stoichiometry so that an excessive amount of alcohol was needed to move the product in the reaction [20]. The advantage in the reaction

was that the ester product can be taken directly, but it was still mixed with the remainder of the solvent and impurity, so it requires a final refining process [20].

Based on the research by Silitonga *et al.* (2014) explained about the acid-alkaline catalyst transesterification that has been used, the ratio for optimum condition were methanol and oil of 9:1 with 1% (v/v) of  $H_2SO_4$  and 1% (w/w) of KOH, obtained of yield was 98.53% for *Calophyllum inophyllum* [21]. The characteristics of physical and chemical methyl ester from *Calophyllum inophyllum* based on the research by Silitonga *et al.* compare petrol diesel characteristics (Table II).

TABLE II: PHYSICAL AND CHEMICAL OF CIME\* [21]

Chemical properties	ASTM D6751	Standard	CIME*	Petrol diesel
Density at 15° C (kg/m <sup>3</sup> )	D 1298	880	896.6	839
Kinematic viscosity at 40°C (mm <sup>2</sup> /s)	D 445	1.9-6.0	4.57	2.91
Acid number (mg KOH/g)	D 664	Max. 0.5	0.45	0.15
Flash point (°C)	D 93	Min. 130	158.5	71.5
Pour point (°C)	D 97	-15 to 16	-1	-3
Cloud point (°C)	D 2500	-3 to 12	-1	-5
Calorific value (MJ/kg)	EN 14214	35	40.104	45.825
Oxidation stability at 110°C (hours)	EN 14112	Min.3	13.08	23.7

\* CIME: *Calophyllum inophyllum* Methyl Ester

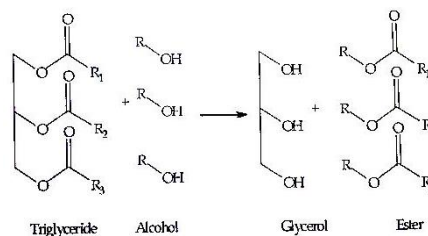


Fig. 4. Transesterification reaction [22].

#### E. Economic Effect Nyamplung of West Java

Demand for biodiesel fuel is very good for regions with the highest population and population density in Indonesia such as West Java Province. The need for large diesel fuel threatens national petroleum reserves. No one can expect it to happen because the national petroleum reserves have declined by 3% every year since 2004 and even until anytime.

The big opportunity for developing the nyamplung biodiesel industry is still wide open for anyone, including the community. The number of open unemployment in West Java were 1,839,428 (Fig. 5) people spread in 18 Regencies and 9 Cities in West Java in 2017 and the most in Bogor Regency which are 248,368 people [23]. Open unemployment is a serious problem for the local government but these are a great opportunity as a provider of labor in supporting the establishment of a household-based biodiesel industry with the concept of small and medium enterprises.

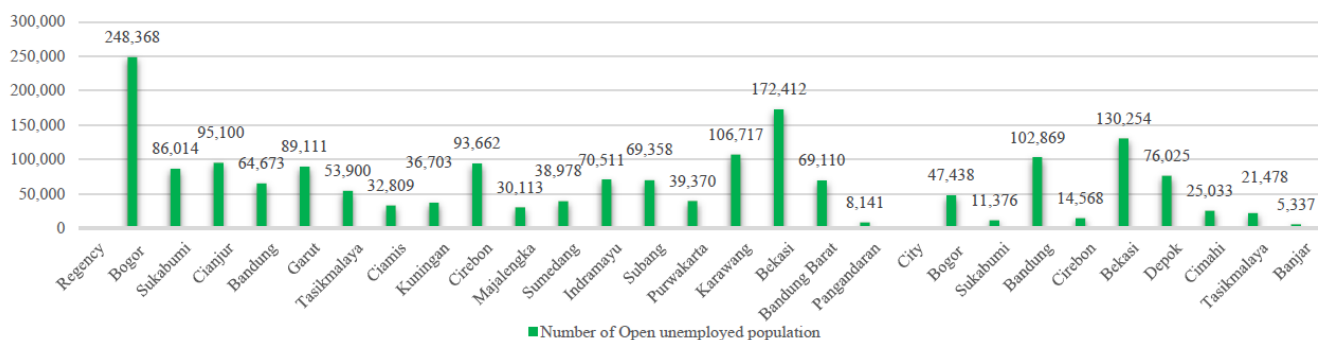


Fig. 5. West Java residents as Open Unemployment (Person) in August 2017 (Source: BPS, 2018).

Procurement of raw materials for the biodiesel industry in West Java is carried out on plantation businesses or planting people forest land covering 244,926 ha (Fig. 3) People forests are not plantations which generally only produce wood but are more extensive, such as seeds plant of nyamplung for the benefit of biodiesel. This area is able to be the right solution to reduce open unemployment and make West Java the main biodiesel production center in Indonesia, sales and marketing for domestic and export needs.

#### IV. CONCLUSION

West Java is suitable to be used as a place for producing nyamplung oil based considering the need for large diesel fuel. The great potential of nyamplung grows well in the area of people forest covering an area of 244,926 hectares (Fig. 3) to meet the needs of the population of 46,709,600

people and the processing of biodiesel is easy and able to be done with simple technology by all levels of society.

Industrial procurement in West Java by maximizing people forests covering 244,926 ha by empowering people who are open unemployed to develop industries, both large industries and home industries based on small and medium enterprises. Support for the government through related agencies is needed to coordinate the production of biodiesel of nyamplung (*Calophyllum inophyllum*) starting from planting, harvesting, processing to marketing biodiesel fuel.

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