Production Of Biodiesel By Using A *Packed Bed Reactor* From*Crude Palm Oil* (CPO) With Immobilized Lipase Enzyme Catalyst

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Abstract. *Biodiesel is an alternative fuel based on renewable energy. In general, chemical processes such as transesterification and esterification are used to make biodiesel. The biodiesel process using lipase enzyme as a catalyst has the advantage of specific activity and easy separation due to catalyst heterogeneity. Considering the expensive price of the enzyme, immobilization in the matrix using cation resin is carried out. The purpose of this study was to determine the effect of reaction time on the activation of immobilized lipase enzyme catalyst on biodiesel produced using Packed Bed Reactor and obtain optimum biodiesel product characteristics with variations in reaction time on viscosity, density, %yield, iodine number, saponification number, cetane number, biodiesel acid number, total glycerol, methyl ester content, and flash point. This research obtained the highest %yield of 86,35%, density of 878 Kg/m^3, viscosity of 4,39 cSt, cetane number 68,65, saponification of 144,58 mg KOH/g, acid number 0,47 mg KOH/g, iodine number 68,53 g I_2/100g, total glycerol 0,19%, methyl ester 97,31% and flash point 101°C. From the ratio of oil and methanol 1:10, which has met the quality requirements of SNI 7182:2015.*

Keywords: *Biodiesel, Crude Palm Oil (CPO), Enzim Lipase, Esterifikasi, Transesterifikasi.*

1 Introduction

Palm oil is an important crop in Indonesia and still has good opportunities for development. The area of oil palm land in Indonesia in 2020 is 14,858,300 Ha. While in East Kalimantan in 2020 the area of oil palm is 1,378,136 hectares consisting of 373,479 hectares as community crops, 14,402 hectares owned by State-Owned Enterprises (BUMN) as the core and 912,030 hectares owned by Large Private Plantations.

N. L. Husni et al. (eds.), *Proceedings of the 8th FIRST 2024 International Conference on Global Innovations (FIRST-ESCSI 2024)*, Advances in Engineering Research 261,
https://doi.org/10.2991/978-94-6463-678-9_15

The production of Fresh Fruit Bunches (FFB) processed in 2020 was 17,723,864 tons or equivalent to 3.8 million tons of Crude Palm Oil (CPO) [8].

Crude Palm Oil (CPO) is one of the main products with the most production capacity that can be produced by oil palm plants (Harahap et al., 2020). Indonesia has large natural resources, Indonesia is the center of oil palm plantation production and is the largest exporter of Crude Palm Oil (CPO) in the world. This is also due to the support of increased exports of Crude Palm Oil (CPO) which can export on a global scale [6].

Esterification is the conversion step from free fatty acids to es-ter. Esterification can react fatty acids with alcohol. The esterification reaction is the reaction between carboxylic acids and alcohols that form esters by converting the free fatty acids (ALB) contained in triglycerides into methyl esters. Transesterification is one of the methods used to produce biodiesel. Transesterification is the process of removing glycerin compounds from oil and reacting its free fatty acids with methanol into methyl esters [5].

The enzyme lipase is a hydrolase product that plays a role in digesting and processing fats. Lipase must break down different types of fats and oils. Each unit per mL of lipase activity can release 1µ mol of free fatty acids in one minute. Lipase activity reaches its peak under optimal temperature and pH conditions, which can be measured by observing changes in enzymatic activity at various temperature and pH variations[1].

Table 1. Comparison of previous research results

No.	Raw Materials	Catalyst	Reactor	Ratio	Analysis Result			Referensi
					%Yield	Iodine Number (g I_2/100g)	Cetane Number	
1.	*Crude Palm Oil* (CPO)	Sulfuric Acid	*Batch*	1:6	60	32,1223	75,35	Mardawatidkk, 2019
2.	Tamanu Oil	Lipase Enzyme	*Batch*	1:3 and 1:5	87, 67	59,64	74,58	Aznury dkk, 2022
3.	Nyamplung oil	Lipase Enzyme	*Batch*	1:3	41, 5	-	-	Kusumaningtsyasdkk, 2022
4.	*Crude Palm Oil* (CPO)	Lipase Enzyme	Esterifikasi,Transesterifikasi	1:10	86, 35	68,53	68,65	Current Research

2 Materials and Methods

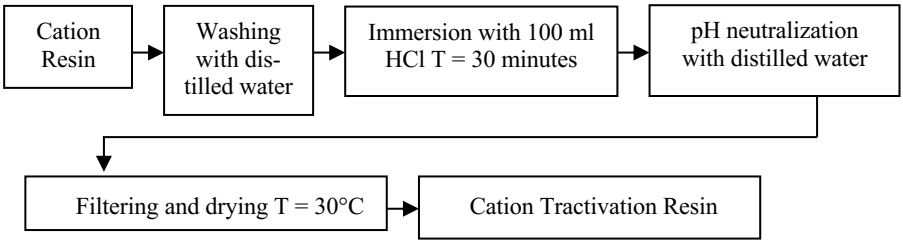
2.1 Materials

Tools used packed bed reactor, erlenmeyer (iwaki), measuring cup (py-rex), analytical balance (radwag), measuring pipette (pyrex), spatula (pyrex), dropper pipette (iwaki), glass funnel (pyrex), beaker (iwaki), watch glass (pyrex), pycnometer (pyrex), gas chromatography (agilent 8890), bottle (CC 1000), and LVM viscometer (labtron).

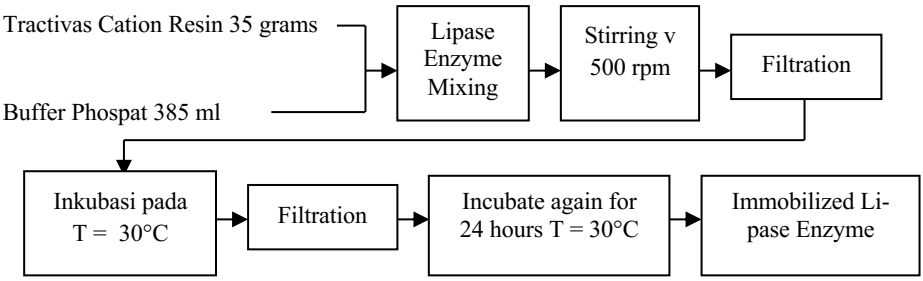
Materials used in this study were Crude Palm Oil (CPO), lipase enzyme (eversa transform 2.0), CH_3OH (NGI chemical), distilled water (puma), cation resin (flotrol S+), phosphate buffer (easy blessing), $Na_2S_2O_3$ (merck), wijs (smart lab), $CHCl_3$ (smart lab), and HCl (merck).

2.2 Methods

Cation Resin Activation Stage Diagram

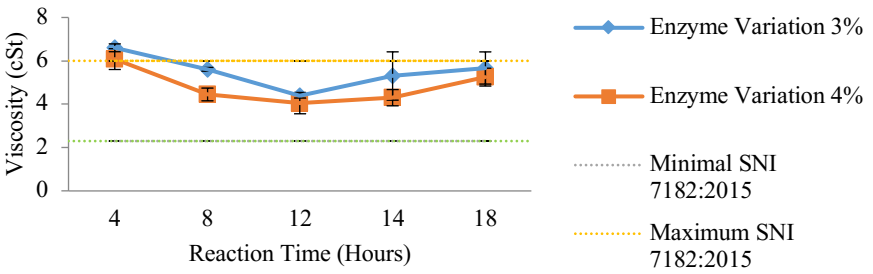


Lipase Enzyme Immobilization Stage Diagram



3 Results and Discussion

3.1 Viscosity (SNI 7182:2015)

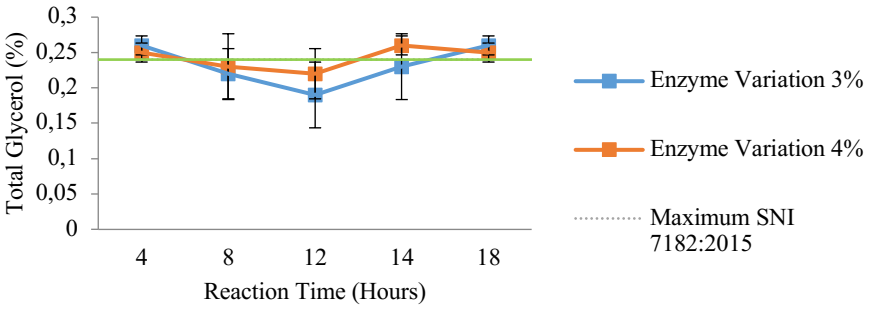


Graph of the Effect of Reaction Time on Lipase Enzymes on the Viscosity of Biodiesel Products

From the results of this study, there is a viscosity value that does not meet SNI standards, namely at a recreation time of 4 hours of 3% lipase enzyme variation. This is comparable to the high density at 4 hours reaction time of 4% lipase enzyme variation. At a reaction time of 4 hours and 18 hours, the graph increases because there is a very high substrate concentration, the enzyme becomes saturated with the substrate and a higher substrate concentration does not increase the reaction rate. Where the viscosity and density values are comparable, when the density value increases, the viscosity value will also increase and vice versa [3].

The viscosity value of biodiesel is also affected by the length of the fatty acid chain, the number of double bonds, the type of alcohol used and the position. The longer the chain length of fatty acids and alcohols in esters or aliphatic hydrocarbons, the greater the viscosity value.

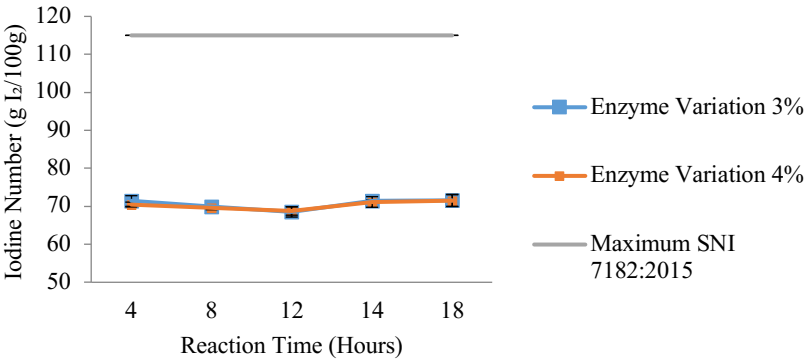
3.2 Total Glycerol(SNI 7182:2015)



Graph of the Effect of Reaction Time on Lipase Enzymes on Total Glycerol of Biodiesel Products

The results of this study with good results at a reaction time of 12 hours with 3% enzyme variation and this time has a glycerol value of 0,19. This can occur allegedly due to an increase in reaction time which can increase the conversion of glycerol because the longer the reaction time, the more active particles move and experience collisions between molecules that can accelerate the rate of recreation. In addition, the total glycerol content contained in biodiesel is thought to be less than perfect in the separation process between glycerol and biodiesel [7].

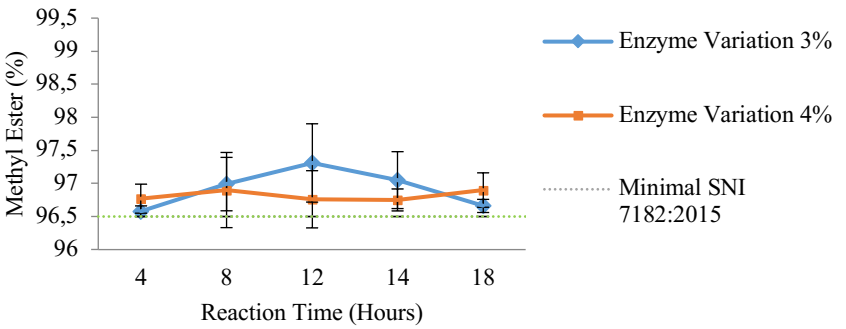
3.3 Iodine Number (SNI 7182:2015)



Graph of the Effect of Reaction Time on Lipase Enzymes on the Iodine Number of Biodiesel Products

The results of the iodine number analysis can be seen that the iodine number of the research results with the average number obtained is 55,58-71,49. In the graph above, it can be seen that at a reaction time of 12 hours with 3% enzyme the graph decreases while at a reaction time of 18 hours the 4% enzyme variase graph looks up. The higher the value of the iodine number obtained, the higher the number of double-bonded fatty acids contained in the oil. The more double bonds a biodiesel sample has, the greater the potential for polymerization due to lower stability. A high iodine number is an unfavorable property for fuels. A low iodine number indicates the resulting product has a low ease of oxidation and polymerization [4].

3.4 Methyl Ester(SNI 7182:2015)



Graph of the Effect of Reaction Time on Lipase Enzyme on Methyl Ester Biodiesel Products

The results of the methyl ester research have been calculated, where the methyl esters obtained start from 96,58%-97,31% where the methyl ester results on the graph are not far surgical. At a reaction time of 4 hours, the 3% enzyme variation obtained a low methyl ester value of 96,58%. The reaction time of 12 hours with 3% enzyme variation, the highest value of methyl ester was obtained, which was 97,31% at this reaction time, getting a good methyl ester value. In the graph above the quality standards set by the Indonesian National Standard (SNI) 7182:2015. The quality standard for methyl ester content that has been set is at least 96,5%[2].

References

1. Aznury, M., Zikri, A., Junaidi, R., Lupikawaty, M., &Oktariyensi, C. (2022). PengaruhMetanoldalamProduksi Biodiesel dari Tamanu Oil MenggunakanKatalis Lipase. *JurnalSelulosa*, *12*(01), 33-40.
2. Busyairi, M., Muttaqin, A. Z., Meicahyanti, I., &Saryadi. (2020). PotensiMinyakJelantah-Sebagai Biodiesel dan PengaruhKatalis Serta Waktu ReaksiTerhadapKualitas Biodiesel Melalui Proses Transesterifikasi. Serambi Engineering, Volume V, No. 2, 933-940.
3. Damayanti, Y., Lesmono, A. D., &Prihandono, T. (2018). Kajian PengaruhSuhuterhadapViskositasMinyak Goreng sebagaiRancanganBahan Ajar PetunjukPraktikumFisika. *JurnalPembelajaranFisika, 7(3)*, 307-314.
4. Jauhari, M. F., Maryati, R. S., &Khairani, K. (2018). Analisa PerbandinganKualitas Biodiesel Dari MinyakJelantahBerdasarkanPerbedaanPenggunaanJenisReaktor. *Intekna*, *18*(1), 31-39.
5. Monde, J., Faransiskus, H., Lutfi, M., &Kumalasari, P. I (2020). PengaruhSuhu pada Proses Tranesterifikasiterhdap Kualitas Biodiesel dariMinyakJelantah. *Jurnal Pendidikan Tambusai, Vol. 6, No. 1,* 1325-1330.
6. Nurmalita, V P. A. W. (2019). AnalisisFaktor-faktorEkspor, MempengaruhiKelapa, Minyak. Economic Education Analysis Journal, 8(2), 605–619.

7. PrihandanaR,. R. Hendroko dan M. Nuramin. (2006). *Menghasilkan Biodiesel MurahMengatasiPolusi dan Kelangkaan BBM.* PT. Agromedia Pustaka. Jakarta.
8. Sya'rawi, M.M. 2021. *KaltimHinggaSaatini Milik 94 PabrikKelapaSawit.* Bisnis.com,Samarinda.https://kalimantan.bisnis.com/read/20210414/408/138115/kaltim-hingga-saat-ini-milik-94-pabrik-kelpa-sawit. (Diakses pada tanggal 13 Maret 2024).