

OPTIMASI TRANSESTERIFIKASI DALAM PREPARASI BODIESEL BIJI NYAMPLUNG (*CALOPHYLLUM INOPHYLLUM*) MELALUI PROSES DUA TAHAP

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INTISARI

Pemerintah terus mendorong penggunaan campuran biodiesel hingga 35% (B35) dalam Program Mandatori Biodiesel. Produksi biodiesel diutamakan menggunakan bahan non pangan supaya tidak bersaing dengan industri makanan. Salah satu bahan non pangan yang dapat dijadikan bahan baku biodiesel adalah biji nyamplung. Biji nyamplung memiliki kandungan minyak yang tinggi. Namun, kandungan asam lemak bebas (FFA) pada minyak nyamplung tinggi sehingga dapat mempersulit konversi minyak nyamplung menjadi biodiesel. Maka dari itu, dibutuhkan proses dua tahap yang terdiri dari esterifikasi *in situ* dan transesterifikasi untuk menurunkan kandungan FFA pada biji nyamplung.

Proses esterifikasi *in situ* dilakukan dengan pelarut metanol dan n-heksana dengan katalis H_2SO_4 sebagai tahap pertama. Hasil dari esterifikasi *in situ* menjadi bahan baku pada optimasi proses transesterifikasi dengan pelarut metanol dan katalis NaOH sebagai tahap kedua. Optimasi transesterifikasi menggunakan 2^4 full factorial Central Composite Design-Response Surface Methodology. Variabel bebas proses transesterifikasi yang digunakan adalah perbandingan molar metanol terhadap minyak hasil esterifikasi *in situ*, persentase massa katalis NaOH, suhu reaksi, dan waktu reaksi. Respon penelitian ini adalah *yield* dan bilangan asam. Bilangan asam ditentukan dengan metode titrasi berdasarkan AOCS Cd 3d-63. Uji GC-MS pada minyak nyamplung bertujuan untuk menentukan komposisi *fatty acid methyl ester* (FAME).

Kondisi optimum proses transesterifikasi diperoleh pada perbandingan molar metanol terhadap minyak hasil esterifikasi *in situ* sebesar 5,10: 1, persentase massa katalis NaOH sebesar 0,79 wt.%, suhu reaksi sebesar 30°C, dan waktu reaksi selama 1,23 jam. Kondisi optimum transesterifikasi menghasilkan *yield* maksimum sebesar $(88,19 \pm 1,38)\%$ dan bilangan asam minimum sebesar $(0,83 \pm 0,05)$ mg KOH/g.

Kata kunci: Biodiesel, nyamplung, dua tahap, esterifikasi *in situ*, transesterifikasi, *yield*, bilangan asam

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OPTIMIZATION OF TRANSESTERIFICATION IN NYAMPLUNG (*CALOPHYLLUM INOPHYLLUM*) SEEDS BIODIESEL PREPARATION THROUGH A TWO-STEP PROCESS

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ABSTRACT

The government continues to encourage the use of biodiesel blends of up to 35% (B35) in the Mandatory Biodiesel Program. Biodiesel production was prioritized using non-edible ingredients to avoid competition with the food industry. One of the non-edible ingredients that could be used as biodiesel raw material was *nyamplung* seeds. *Nyamplung* seeds had a high oil content. However, the free fatty acid (FFA) content of *nyamplung* oil was high, which could complicate the conversion of *nyamplung* oil into biodiesel. Therefore, a two-step processes consisting of *in situ* esterification and transesterification were needed to reduce the FFA content of *nyamplung* seeds.

In situ esterification process was carried out with methanol and n-hexane solvents catalyzed with H₂SO₄ as the first step. The result of *in situ* esterification became the raw material in the optimization of the transesterification process with methanol solvent and NaOH catalyst as the second step. Transesterification optimization used 2⁴ full factorial Central Composite Design-Response Surface Methodology. The independent variables of the transesterification process were the molar ratio of methanol to oil from *in situ* esterification, mass percentage of NaOH catalyst, reaction temperature, and reaction time. The response of this research was yield and acid number. The acid number was determined by titration method based on AOCS Cd 3d-63 method. The GC-MS test on *nyamplung* oil aimed to determine the composition of *fatty acid methyl ester* (FAME).

The optimum conditions of the transesterification process were obtained at a molar ratio of methanol to oil from *in situ* esterification of 5.10:1, NaOH catalyst mass percentage of 0.79 wt.%, reaction temperature of 30°C, and reaction time of 1.23 hours. The optimum transesterification conditions resulted in a maximum yield of (88.19 ± 1.38)% and a minimum acid number of (0.83 ± 0.05) mg KOH/g.

Keywords: Biodiesel, *nyamplung*, two-step, *in situ* esterification, transesterification, yield, acid value

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