

Sintesis Ester Fruktosa Oleat secara Enzimatis Menggunakan Larutan Fruktosa *Supersaturated* dan Ultrasonik dalam *Fluidized Bed Reactor*

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INTISARI

Kelarutan fruktosa merupakan salah satu kendala utama yang dapat menghambat aktivitas enzim dalam sintesis ester gula asam lemak secara enzimatis. Sintesis tersebut membutuhkan waktu yang lama. Penelitian ini bertujuan untuk memperoleh kondisi terbaik sintesis EFO menggunakan larutan fruktosa *supersaturated* dan ultrasonik.

Reaksi dilakukan dengan menambahkan larutan fruktosa *supersaturated* dan asam oleat yang dialirkan menuju lipase amobil yang berada dalam *jacketed fluidized bed reactor* yang dilengkapi dengan ultrasonikator. Sintesis EFO dipengaruhi oleh beberapa faktor diantaranya: lama waktu esterifikasi, daya ultrasonik, dan kecepatan alir. Ketiga faktor tersebut dievaluasi berdasarkan konsentrasi ester hasil analisis TLC, selanjutnya dikarakterisasi ikatan ester dan sifat emulsifikasinya.

Hasil penelitian menunjukkan bahwa terdapat $8,08 \pm 2,75$ mg lipase/g matrik yang teradsorpsi saat amobilisasi enzim dengan aktivitas hidrolisis dan esterifikasi masing-masing $5,70 \pm 3,32$ U/g matrik dan $36,45 \pm 9,95$ U/g matrik. Konsentrasi fruktosa dalam larutan fruktosa *supersaturated* yaitu $12,30 \pm 2,33$ mg/mL. Kondisi terbaik untuk sintesis EFO diperoleh dari 180 W dan 0,2 mL/menit selama 180 menit reaksi setelah melewati 1x rangkaian alat esterifikasi. EFO memiliki konsentrasi ester $85,13 \pm 9,56\%$ dengan R_f 0,2 hingga $\sim 0,8$. Gugus ester yang dikonfirmasi menggunakan analisis FT-IR berada pada bilangan gelombang ~ 1712 cm^{-1} (ikatan C=O) dan 1373 cm^{-1} (ikatan C-O). Kapasitas emulsi, stabilitas emulsi, ukuran dan distribusi ukuran droplet, nilai HLB, dan jenis emulsi EFO secara berturut-turut yaitu: $99,86 \pm 0,01\%$; $99,29 \pm 0,04\%$; $1,00$ μm dengan distribusi yang tidak seragam ($\text{PdI}=1,00$); $13,65 \pm 0,51$; dan emulsi O/W.

Kata kunci: esterifikasi, larutan fruktosa *supersaturated*, asam oleat, lipase amobil, ultrasonik, *fluidized bed reactor*

Enzymatic Synthesis of Fructose Oleic Ester Using Supersaturated Fructose Solution and Ultrasound in Fluidized Bed Reactor

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ABSTRACT

Fructose solubility is one of the main obstacles that can inhibit enzyme activity in enzymatic synthesis of fatty acid sugar ester. The synthesis takes a long time. The objective of this research was to obtain the best conditions for FOE synthesis using a fructose supersaturated solution and ultrasound.

The reaction was carried out by adding the fructose supersaturated solution and oleic acid to the immobilized lipase in the jacketed fluidized bed reactor, which was equipped with an ultrasonicator. Factors of FOE synthesis such as esterification time, ultrasound power, and flow rate were evaluated based on the ester concentration from the TLC analysis, then the ester bond and its emulsification properties were characterized.

The results showed that there were 8.08 ± 2.75 mg lipase/g matrix adsorbed during the enzyme immobilization with hydrolysis and esterification activity were 5.70 ± 3.32 U/g matrix and 36.45 ± 9.95 U/g matrix, respectively. The fructose concentration in the supersaturated fructose solution was 12.30 ± 2.33 mg/mL. The best conditions for synthesis FOE were obtained at 180 Watt and 0.2 mL/min for 180 min of reaction after through one time a series of esterification apparatus. The FOE concentration was $85.13 \pm 9.56\%$, in which R_f was 0.2 to ~ 0.8 . The occurring of ester group was confirmed using FT-IR analysis at the wavenumber ~ 1712 cm^{-1} (C=O group) and 1373 cm^{-1} (C-O group). Its emulsification properties of emulsion capacity, emulsion stability, droplet size and its distribution, HLB value, and emulsion type were $99.86 \pm 0.01\%$; $99.29 \pm 0.04\%$; 1.00 μm with not uniform distribution ($\text{PdI}=1.00$); 13.65 ± 0.51 and oil in water emulsion (O/W), respectively.

Keywords: esterification, supersaturated fructose solution, oleic acid, immobilized lipase, ultrasound, fluidized bed reactor