

## INTISARI

Tandan kosong kelapa sawit (TKKS) merupakan limbah padat yang dihasilkan oleh industri pengolahan kelapa sawit yang dapat dimanfaatkan lebih lanjut menjadi gula sederhana dengan proses fermentasi padat menggunakan jamur *Aspergillus niger*. Struktur lignoselulosa pada TKKS yang kuat dan liat membutuhkan perlakuan awal sebelum proses fermentasi padat. Perlakuan awal secara fisis dengan proses *milling* (pengecilan ukuran partikel) mampu memperluas *surface area* dan mengurangi kristalinitas selulosa. Sedangkan perlakuan perendaman NaOH akan merusak stuktur lignin yang membungkus selulosa TKKS. Kedua perlakuan ini akan mempermudah kerja enzim dalam mengkonversi selulosa menjadi gula sederhana. Penelitian ini bertujuan mempelajari pengaruh variasi ukuran partikel TKKS dan perlakuan perendaman NaOH 10% (90 °C, 2 jam) terhadap produksi gula sederhana oleh jamur *Aspergillus niger*.

Pada penelitian ini proses persiapan substrat TKKS dilakukan dengan proses pengeringan, *milling* dan pengayakan menggunakan saringan berukuran 10, 30, 40, dan 80 mesh (ukuran -10+30 mesh, -30+40 mesh, -40+80 mesh, -80 mesh). Sebagian substrat TKKS hasil ayakan direndam dalam NaOH 10% , 90 °C, selama 2 jam, kemudian dicuci sampai pH filtrat netral dan dikeringkan dengan oven. Selain itu biakan jamur *Aspergillus niger* juga dipersiapkan dalam medium PDA miring dengan masa inkubasi selama 7 hari pada suhu ruang. Proses fermentasi padat diawali dengan memasukkan lima gram TKKS dengan ukuran tertentu dalam erlenmeyer 250 ml kemudian disterilkan dengan *autoclave* pada suhu 121 °C selama 15 menit. Setelah didinginkan, sebanyak 16 ml medium cair sebagai nutrisi ditambahkan dalam erlenmeyer tersebut. Komposisi medium cair meliputi : 10 gr/L KH<sub>2</sub>PO<sub>4</sub>, 3 gr/L MgSO<sub>4</sub>, 3 gr/L CaCl<sub>2</sub> dan 5 gr/L yeast ekstrak. Kemudian masing-masing erlenmeyer diinokulasi dengan 1 ml spora jamur *Aspergillus niger*. Selanjutnya diinkubasi selama 10 hari pada suhu ruang. Pengambilan sampel dilakukan setiap hari dan dilakukan pengukuran pH, konsentrasi gula sederhana dan kadar protein. Pengukuran konsentrasi gula sederhana dilakukan dengan metode DNS sedangkan kadar protein dengan metode Lowry. Proses tersebut diulangi untuk TKKS dengan perlakuan NaOH dan tanpa perlakuan NaOH pada berbagai ukuran.

Hasil pengujian menunjukkan semakin halus ukuran TKKS maka pertumbuhan jamur dan produksi gula sederhana semakin baik. Pertumbuhan jamur tertinggi 0,97 berat kering jamur (konsentrasi protein 2,967 g/L) dan konsentrasi gula sederhana tertinggi 15,042 g/L untuk ukuran TKKS -80 mesh. Perendaman NaOH 10% (90 °C, 2 jam) membuat pertumbuhan jamur menjadi kurang subur dan produksi gula sederhana menurun (konsentrasi gula tertinggi hanya 7,847 g/L pada TKKS -80 mesh). Model kinetika orde satu dapat menggambarkan secara kuantitatif proses fermentasi padat TKKS oleh jamur *Aspergillus niger*. Nilai konstanta kecepatan hidrolisis selulosa semakin besar pada ukuran TKKS yang semakin halus ( $k_h$  tertinggi 0,17 g/L.hari untuk ukuran TKKS -80 mesh)

**Kata kunci :** TKKS, ukuran partikel, gula sederhana, *Aspergillus niger*, fermentasi padat

## ABSTRACT

*Oil palm empty fruit bunches (OPEFB) is a solid waste produced by palm oil industry that can be further converted into simple using *Aspergillus niger*. The structure of lignocellulose of OPEFB is strong and resilient so that it requires pretreatment prior to the solid state fermentation. The physical pretreatment by a milling process (particle size reduction) contributes to an expansion of the surface area and a reduction of the crystallinity of cellulose. Meanwhile, the chemical pretreatment involves a treatment of NaOH immersion that may damage the structure of lignin. Both of these treatments facilitate the performance of enzyme in converting cellulose to simple sugars . The aim of this research was to study the effect of particle size of OPEFB and the treatment of NaOH 10% (90 °C, 2 hours) immersion for simple sugar production by solid fermentation using *Aspergillus niger*.*

*In this research, the preparation of OPEFB was performed by the process of drying, milling and sieving using a sieves of 10, 30, 40, and 80 mesh (in size of -10+30 mesh, -30+40 mesh, -40+80 mesh, -80 mesh). Some part of sieved OPEFB was immersed in 10% NaOH, 90 °C for 2 hour, and then washed to neutral pH and dried in an oven. The culture of *Aspergillus niger* was prepared in the PDA slant medium with an incubation period of seven days at room temperature. Solid state fermentation was started by putting five grams of OPEFB with a certain particle size in a 250 ml erlenmeyer and then autoclaved at 121 °C for 15 minutes. After cooling, 16 ml of liquid medium as nutrients was added in the erlenmeyer. The composition of the liquid medium was as follows: 10 g/L of  $\text{KH}_2\text{PO}_4$ , 3 g/L of  $\text{MgSO}_4$ , 3 g/L of  $\text{CaCl}_2$  and 5 g/L of yeast extract. Then it was inoculated with 1 ml of *Aspergillus niger* inoculum. Next, it was incubated for 10 days at room temperature. Sampling was done every day to measure pH, concentration of simple sugar and protein content. The measurement of the concentration of simple sugar was performed by DNS method while the protein content was done by Lowry method. The process was repeated for OPEFB with NaOH 10% treatment (90 °C, 2 hours) and without NaOH treatment in a variety of particle sizes.*

*The result of this research showed that the smaller the particle sizes of OPEFB, the greater the growth of fungus and the production of simple sugar could be yielded. The highest growth of fungus was 0.97 of dry weight (protein concentration of 2.967 g/L) and the highest concentrations of simple sugars was 15.042 g / L for OPEFB with particle size of -80 mesh. The treatment of NaOH 10% immersion (90 °C, 2 hours) caused a less fertile and also a declining production of simple sugar (the highest sugar concentration is only 7.847 g / L for OPEFB with particle size of -80 mesh) . Based on the experiment, a model of first order kinetics could quantitatively describe the mechanism of OPEFB solid fermentation using *Aspergillus niger*. The hydrolysis rate constant of cellulose increased by the reduction of the particle size (the highest  $k_h$  was 0.17 g/L.day for OPEFB with particle size of -80 mesh).*

**Keywords** : OPEFB, particle size, simple sugars, *Aspergillus niger*, solid fermentation