

## INTISARI

Enceng gondok merupakan bahan lignoselulosa yang berpotensi untuk dikembangkan menjadi bahan baku pembuatan bioetanol. Hal ini disebabkan karena enceng gondok memiliki kandungan selulosa dan hemiselulosa yang tinggi dan ketersediaannya di alam sangat melimpah. Permasalahan untuk mengolah lignoselulosa terkendala adanya lignin. Lignin dapat menghalangi akses enzim selulase pada proses hidrolisis enzimatik. Oleh karena itu lignin harus dikurangi untuk membuka akses enzim selulase. Penghilangan lignin pada lignoselulosa dapat dilakukan dengan proses *pretreatment*. Penelitian mengenai proses *pretreatment* yang telah banyak dilakukan menggunakan bahan lignin yang memiliki kadar lignin tinggi. Enceng gondok tergolong bahan lignoselulosa berkadar lignin rendah hanya sekitar 3-10%. Lignin didalam enceng gondok rendah tetapi struktur morfologinya masih utuh sehingga masih menghalangi akses enzim selulase. Oleh karena itu masih diperlukan penelitian untuk mengevaluasi proses *pretreatment* pada lignoselulosa berkadar lignin rendah dan pengaruhnya terhadap hasil glukosa pada proses hidrolisis enzimatik.

Tujuan *pretreatment* enceng gondok ini adalah mendegradasi lignin dan merusak struktur morfologinya sehingga dapat dihasilkan yield glukosa yang tinggi. Penelitian ini menggunakan jamur *Phanerochaete Chrysosporium*. Metode yang digunakan adalah *solid state fermentasi (SSF)* secara *batch*. Proses *pretreatment* dimulai dengan menginokulasikan jamur pada enceng gondok yang telah disterilkan dan diletakkan dalam bioreaktor yang bervolum 500 ml. Enceng gondok diinkubasi dengan jamur selama 84 hari pada berbagai variasi kondisi proses yaitu kadar air (50%, 60%, 70% dan 80%), ukuran butir (kurang 0,426; 0,426-2,38; 2,38- 4,76 dan 4,76-10 mm), penambahan tetes (0,5; 1, 2 dan 5%) dan penambahan *co-factor*  $Mn^{2+}$  (0,05; 0,1; 0,5 dan 1%). Analisis sampel dilakukan setiap 7 hari. Analisis sampel yang dilakukan adalah menentukan kadar lignin, selulosa dan hemiselulosa menggunakan metode *Chesson-Datta*, sedangkan berat jamur menggunakan analisis kadar protein jamur dengan metode *Total Kjeldahl Nitrogen (TKN)*. Untuk mengevaluasi kerusakan struktur morfologi lignin digunakan analisis *Scanning Electrone Microscope (SEM)*.

Hasil penelitian menunjukkan bahwa yield glukosa meningkat seiring dengan degradasi lignin. Hal ini hanya terbatas sampai perolehan yield glukosa maksimum. Jika tercapai yield glukosa maksimum maka diindikasikan terjadi kerusakan struktur morfologi lignin signifikan sehingga proses *pretreatment* sebaiknya dihentikan untuk menghindari terjadinya kehilangan selulosa dan hemiselulosa. Pemilihan kondisi proses *pretreatment* pada kadar air 70%, ukuran butir 4,76-10 mm, penambahan tetes 2% dan penambahan *co-factor*  $Mn^{2+}$  0,5% dapat meningkatkan degradasi lignin dan mempercepat terjadinya kerusakan struktur morfologi lignin. Selain itu pemilihan kondisi proses *pretreatment* juga dapat meningkatkan yield glukosa dari 16,67% menjadi 67,66% (g glukosa/selulosa awal) dan mempersingkat waktu *pretreatment* dari 84 hari menjadi 16 hari inkubasi. Penambahan tetes dengan konsentrasi 2% dapat mengurangi tingkat degradasi selulosa dari 42,51% menjadi 2,24% dan hemiselulosa dari 47,69% menjadi 2,71%. Analisis kinetika pertumbuhan jamur dan degradasi substrat menunjukkan bahwa pada *pretreatment* enceng gondok dengan jamur PC sesuai dengan model degradasi substrat serentak.

**Kata kunci :** *Pretreatment*, degradasi, lignin, jamur, enceng gondok, yield glukosa

## ABSTRACT

Water hyacinth is a lignocellulosic material which has the potential used into a bioethanol feedstock. This is because water hyacinth has high contents of both cellulose and hemicellulose. Water hyacinth occurs naturally in abundance and it has a very rapid growth that can disrupt the freshwater ecosystems and wetlands, therefore it is necessary to find a solution to its utilization i.e. as a bioethanol feedstock. The difficulty with degrading lignocellulose to become bioethanol production to presence of lignin. Lignin can barrier the access of cellulose enzymes in the enzymatic hydrolysis process. Therefore, the lignin has to be eradicated in order to increase the fermentable sugar yield in this hydrolytic process. Water hyacinth is a lignocellulosic materials classified as low lignin content about 3-10%. Although lignin in water hyacinth is low, but still blocking access of cellulase enzymes, so it is still necessary pretreatment process.

The purpose of study is degrade the lignin and damage its morphological structure so that a high fermentable sugar yield is obtained. This research used *Phanerochaete chrysosporium* and the method used is *solid state fermentation (SSF)*. The pretreatment process is started by inoculating the fungus into water hyacinth which has been put in a bioreactor with volume 500 ml. Water Hyacinth incubated with the fungus for 84 days in various process conditions i.e in water contents of: (50%, 60%, 70% and 80%), using grain sizes of: (0,426 mm, 0,426-2,38 mm, 2,38-4,76 mm and 4,76-10 mm) and incubated for 24 days with the addition by drops of various concentrations (0,5%, 1%, 2% and 5%) and various concentrations of the addition of *co-factor Mn<sup>2+</sup>* (0,05%, 0,1%, 0,5% and 1%). During the incubation, a sample is analysed every 7 days. Analysis of lignin, cellulose and hemicellulose use the *Chesson-Datta* method and the dry weight of fungus is analysed using the *Total Kjeldahl Nitrogen (TKN)* method. *Scanning Electron Microscope (SEM)* analysis was used to evaluate the damage to the morphological structure of the lignin.

The study result shows the fermentable sugar yield increased with increasing lignin degradation, then the fermentable sugar yield decreased with increasing cellulose and hemicellulose are degraded. The incubation time which showed the maximum fermentable sugar is indicated as significant damage to the morphological structure of lignin, in condition recommended to stopped of the *pretreatment* process to prevention of cellulose and hemicellulose degradation. The selection of the process conditions with the consideration that there will be damage to the morphological structure, shows that the higher of lignin degradation and fermentable sugar yield and shorter the incubation time. Selection *pretreatment* process conditions on the moisture content of 70%, from 4.76 to 10 mm grain size, adding drops of 2% and the addition of a co-factor of 0.5%  $Mn^{2+}$  can improve of accelerate lignin degradation and the damage of morphological of lignin. This conditions can also increase the fermentable sugar yield from 16.67% to 67.66% (g glucose / initial of cellulose) and shorten the pretreatment period of 84 days to 16 days of incubation. The addition of molasses with a concentration of 2% can reduce the degradation of cellulose from 42.51% to 2.24% and hemicellulose from 47.69% to 2.71%. In evaluating fungal growth kinetics following the logistic equation, the kinetics of degradation of the substrate showed following substrate degradation occurs simultaneously.

**Keywords:** *Pretreatment*, degradation, lignin, fungus, water hyacinth, fermentable sugar yield