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PRETREATMENT OF KENAF (Hibiscus cannabinus L.) CORE FIBRE FOR FERMENTABLE SUGAR AND LACTIC ACID PRODUCTION

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By

NG SIM HONG

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

PRETREATMENT OF KENAF (*Hibiscus cannabinus L.*) CORE FIBRE FOR FERMENTABLE SUGAR AND LACTIC ACID PRODUCTION

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Institute: Tropical Forestry and Forest Products

Kenaf (*Hibiscus cannabinus* L.) core which is mainly used for low range products contains high cellulose content (46.9%) possesses great potential for fermentable sugar production. Kenaf core can be converted into lactic acid (LA) through enzymatic hydrolysis and fermentation process. However, pre-treatment is essential prior to enzymatic hydrolysis for higher fermentable sugar yield. In this study, three types of pre-treatments were applied: i) Physical pre-treatment (hammer milling, HM); ii) Physical and thermal pre-treatment (HMTH) iii) Physical and chemical pre-treatment (HMCH). The cellulase enzyme from *Trichoderma reesei* was used to hydrolyze the pre-treated kenaf core. Lactic acid bacteria, *Lactobacillus delbrueckii, Lactoccocus lactis* NZ9000 and *Lactoccocus lactis* MG 1363 were used for fermentation in batch cultivation for 24 hours using kenaf core hydrolysate. The chemical composition of kenaf core was analyzed according to TAPPI Standard

methods and the concentration of fermentable sugar and LA yield was analyzed using HPLC.

The study showed that NaOH pre-treated kenaf core recorded the highest alpha cellulose content (91.5%) at >80 mesh among the pre-treatments. After hydrolysed by cellulose, NaOH pre-treated kenaf core generated the highest amount of glucose (11.64 g/L) compared to the untreated (40-60 mesh) kenaf core (0.04 g/L). In fermentation by *L. delbrueckii* using kenaf core hydrolysate prepared from 2.0 mL enzyme loading as a substrate, the highest lactic acid production with 11.80 g/L was obtained at 12th hour of cultivation with 2.86 g/L of cell growth. However, the maximum concentration of 12.78 g/L of lactic acid was obtained with 3.05 g/L of maximum cell growth at 24 hours of cultivation. *L. delbrueckii* recorded the highest cell efficiency to produce lactic acid at 4.24 g/g, and therefore, recorded the highest productivity at 0.533 g/L/h. The results show that NaOH pre-treated kenaf core is the most suitable pre-treatment to obtain the highest glucose yield by increasing the alpha cellulose content. Subsequently, *L. delbrueckii* is the most suitable lactic acid bacteria to produce lactic acid from kenaf core hydrolysates and can be used as a potential lactic acid bacteria for other lignocellulose bioconversion to lactic acid.

Keywords: kenaf core, enzymatic hydrolysis, glucose, fermentation, *Lactobacillus delbrueckii*, lactic acid

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PRAPENGOLAHAN KENAF (*Hibiscus cannabinus L.*) SERAT TERAS UNTUK PENGHASILAN GULA TERFERMENTASI DAN ASID LAKTIK

Oleh

NG SIM HONG

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Pengerusi: Profesor Paridah Md Tahir, PhD

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Bahagian teras Kenaf *(Hibiscus cannabinus L.*) yang biasanya digunakan untuk produk julat rendah sebernarnya mengandungi kandungan celulosa yang tinggi (47.7%) yang tinggi dan mempunyai potensi yang tinggi untuk pengeluaran gula terfermentasi. Bahagian teras kenaf boleh ditukar menjadi asid laktik melalui proses hidrolisis enzimatik dan fermentasi. Untuk penghasilan gula terfermentasi (glukosa) yang lebih tinggi, pra-rawatan perlu dilakukan sebelum proses hidrolisasi enzimatik. Dalam kajian ini, tiga jenis pra-rawatan diterapkan: i) Pra-rawatan fizikal (HM); ii) pra- rawatan fizikal dan terma (HMTH) iii) pra-rawatan fizikal dan kimia (HMCH). Enzim selulosa dari *Trichoderma reesei* telah digunakan untuk menghidrolisis bahan kenaf teras selepas pra-rawatan. Bakteria asid laktik, *Lactobacillus delbrueckii*, *Lactoccocus lactis* NZ9000 dan *Lactoccocus lactis* MG 1363 telah digunakan untuk fermentasi yang berkelompok selama 24 jam. Kesan pra-rawatan komposisi kimia pada teras kenaf dianalisis berdasarkan kaedah Piawai TAPPI dan kepekatan glukosa (g/L) serta asid laktik (g/L) yang terhasil telah dianalisis menggunakan HPLC.

Kajian in menunjukkan bahawa, teras kenaf yang dipra-rawat dengan NaOH mencatatkan kandungan alfa selulosa tertinggi (91.5%) dengan >80 mesh saiz.

Selepas hidrolisi berenzim, teras kenaf yang dipra-rawat dengan NaOH menghasilkan glukosa tertinggi iaitu (11.63 g/L) manakala teras kenaf yang tidak dirawat (40-60 mesh) memberi hasil (0.04 g/L). Dalam fermentasi oleh *Lactobacillus delbrueckii* dengan glukosa yang didapati daripada 2.0 mL enzim, pengeluaran asid lactic yang tertinggi tercatat pada 11.80 g/L dan diperolehi pada jam ke-12 dengan 2.86 g/L pertumbuhan sel. Kepekatan maximum asid laktik sebanyak 12.78 g/L telah diperolehi pada jam ke-24 dengan 3.05 g/L pertumbuhan sel maximum. *Lactobacillus delbrueckii* telah mencatatkan kecekapan sel untuk menghasilkan asid laktik yang tertinggi pada 4.24 g/g dan, dengan ini, telah mencatatkan produktiviti tertinggi pada 0.533 g/L/h. Keputusan dalam kajian ini menunjukkan bahawa teras kenaf yang dipra-rawat dengan NaOH adalah pra-rawatan yang paling sesuai untuk mendapatkan hasil glukosa yang tinggi dengan meningkatkan kandungan alfa selulosa. *Lactobacillus delbrueckii* adalah bakteria asid laktik yang paling sesuai bagi menghasilkan asid laktik daripada glukosa yang didapati daripada teras kenaf dan juga berpotensi digunakan untuk sumber lignoselulosa yang lain.

Kata kunci: bahan teras kenaf, hidrolisis enzimatik, glukosa, *Lactobacillus delbrueckii*, asid laktik

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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