UNIVERSITI PUTRA MALAYSIA

EXTRACTION OF STARCH, XYLOSE AND GLUCLOSE FROM OIL PALM STEM USING CHEMICAL STEEPING AND DILUTE ACID HYDROLYSIS METHODS

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MASTER OF SCIENCE

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EXTRACTION OF STARCH, XYLOSE AND GLUCLOSE FROM OIL PALM STEM USING CHEMICAL STEEPING AND DILUTE ACID HYDROLYSIS METHODS

By

WONG LIH JIUN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,

in Fulfillment of the Requirements for the Degree of Master of Science

July 2011

DEDICATION

To my beloved parents,

"Wong Choo Koh and Lim Yoke Sim"

sisters,

"Wong Chuan Kuan and Wong Wen Jun"

brother,

"Wong Chao Ching"

And

All my beloved friends…

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

EXTRACTION OF STARCH, XYLOSE AND GLUCOSE FROM OIL PALM STEM USING CHEMICAL STEEPING METHOD AND DILUTE ACID HYDROLYSIS METHODS

By

WONG LIH JIUN

JULY 2011

Chairman: H'ng Paik San, PhD

Faculty: Faculty of Forestry

In Malaysia, oil palm industry is the largest biomass producers compared to other types of biomass generated. With the growth of palm oil production in Malaysia, the amount of oil palm stem generated also shows a corresponding increase. The utilization of oil palm stem in plywood production is not so economically sound due to great variations in physical and mechanical properties. As a result, numerous researches and studies on the chemical derivatives of oil palm trunk have been conducted.

This study focused on the total extractable amount of starch, xylose and glucose from oil palm stem using chemical steeping method and dilutes acid hydrolysis. The specific objectives were to determine the chemical composition and the effect of chemical steeping variables (steeping temperature and steeping hours) on the starch yield, and acid hydrolysis parameters (particle sizes, acid concentration and reaction time) on

glucose and xylose yield. This research also served to investigate the effectiveness of chemical steeping as pre-treatment for dilute acid hydrolysis.

Oil Palm stem were used in powder form of 40 mesh size and dried to 5% moisture content for chemical composition tests prior to chemical analysis whilst 20 mesh, 40 mesh and 60 mesh sizes were used for chemical steeping and dilute acid hydrolysis. Chemical analysis was based on TAPPI standard T 203 for determination of its main composition. Low lignin, hemicelluloses and cellulose content were found in this batch of study. Hemicellulose content is the one for the most important factors for xylose production and glucose produced from cellulose from lignocellulosic.

Starch in the oil palm stem was extracted by using chemical steeping method. The oil palm stem powder (20, 40 or 60 mesh) was steeped with 0.2% of sodium metabisulphite ($Na_2S_2O_5$) and 0.5% of lactic acid ($C_3H_6O_3$) at room temperature (±26˚C), 40˚C and 50˚C for 36, 48 hours respectively. The result showed that higher starch yield was obtained when steeped with temperature. The optimum starch yield can be obtained by chemical steeping method under 50˚C for 48 hours.

Two treatments were employed for dilute acid hydrolysis in producing xylose and glucose from oil palm stem which were carried out 1) without pre-treatment 2) with pre-treatment. The chemical steeping method was treated as a pre-treatment, which the optimum variable from steeping was chosen as the pre-treatment variable (50˚C and 48 hours) for dilute acid hydrolysis. Each of the treatments was treated with three different

sulfuric acid concentrations (2%, 4% and 6%) at two different reaction time (30 minutes and 60 minutes) at temperature 115˚C.

Analysis of variance revealed statistically significant difference in dilute acid hydrolysis variables for xylose and glucose yield. Significant interaction among the variables was observed for glucose yield, whereas no significant interaction for the dilute acid hydrolysis variable was observed for xylose. For xylose, individual variables were affecting the xylose yield independently. The Tukey test showed the highest glucose yield, which is 25.5% (dry w/w) was obtained using the dilute acid hydrolysis with parameter of 2% sulfuric acid concentration reacted for 30 minutes on 60 meshes without pre-treated oil palm stem powder. On the other hand, the presence of pre-treatment before dilute acid hydrolysis process contributed to higher xylose yield (35.0%) from oil palm stem. The particle sizes of oil palm stem powder (20 mesh, 40 mesh dan saiz 60 mesh) and acid concentration (2%, 4% dan 6%) were not significant different for xylose yield but higher xylose yield can be extracted with the presence of pre-treament and hydrolysis for 60 minutes.

Conclusively, the oil palm stem has substantial amount of starch, xylose and glucose. Starch was effectively extracted from oil palm stem using chemical steeping method. The presence of chemical steeping as pre-treatment was the most independent variable in affecting the optimum glucose and xylose yield extracted from oil palm stem.

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

PENGEKSTRASI KANJI, XYLOSA DAN GLUKOSA DARIPADA BATANG KELAPA SAWIT DENGAN MENGGUNAKAN KIMIA SEDUHAN DAN HIDROLISIS ASID CAIR

Oleh

WONG LIH JIUN

JULAI 2011

Pengerusi: H'ng Paik San, PhD

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Di Malaysia, industri minyak sawit adalah penghasil biojisim lignoselulosa terbesar jika dibandingkan dengan biojisim-biojisim yang lain. Dengan pertumbuhan pengeluaran kelapa sawit di Malaysia, secara tidak langsung jumlah batang kelapa sawit yang dihasilkan juga menunjukkan peningkatkan. Walaubagaimanapun, pengeluaran batang kelapa sawit sebagai papan lapis tidak begitu cerah dari segi ekonomi kerana variasi yang besar dalam sifat fizikal dan mekanikal. Oleh sebab itu, banyak kajian dan penyelidikan telah dilakukan atas cara-cara penerbitan bahan kimia dari batang kelapa sawit.

Penyelidikan ini fokus pada jumlah kandungan kanji, xylosa dan glucosa yang dapat diekstrak dari batang kelapa sawit dengan menggunakan kaedah seduhan bahan kimia dan hidrolisis asid cair. Objektif spefisik adalah untuk mengenalpasti komposisi bahan kimia dan mengujikaji pengaruh size serbuk dan parameter pemprosesan (suhu seduhan

dan masa) ke atas hasil kanji yang diekstrak dari batang kelapa sawit. Untuk hidrolisis acid cair, kesan saiz serbuk batang kelapa sawit dan parameter hidrolisis (kepekatan acid sulfurik dan masa hidrolisis) ke atas hasil jumlah xylosa dan glukosa yang diekstrak dari batang kelapa sawit dinilai. Keberkesanan seduhan bahan kimia sebagai pra-rawatan untuk hidrolisis asid cair juga dinilai.

Untuk analisis komposisi kimia, batang kelapa sawit dalam bentuk serbuk yang bersaiz 40 mesh dikeringkan sehingga 5% kandungan air bagi tujuan siri analisis kimia dijalankan berdasarkan piawai Tappi T 203 untuk mendapatkan kandungan lignin, selulosa dan hemiselulosa dalam batang kelapa sawit. Kandungan lignin yang rendah dan kandungan hemicellulosa, selulosa didapati pada kajian tersebut. Hemiselulosa bertanggungjawab untuk pengeluaran xylosa dan selulosa adalah bertanggungjawab untuk pengeluaran glukosa.

Kandungan kanji diekstrak dari batang kelapa sawit dengan menggunakan kaedah seduhan bahan kimia. Serbuk batang kelapa sawit (20, 40 atau 60 mesh) direndam dengan kepekatan 0.2% metabisulfit natrium ($Na_2S_2O_5$) dan 0.5% laktat asid ($C_3H_6O_3$) pada suhu bilik (± 26 ˚ C), 40 ˚ C dan 50 ˚ C; masing-masing selama 36 jam dan 48 jam. Keputusan menunjukkan bahwa kandungan kanji yang tinggi didapati jika dengan kehadiran suhu. Dengan itu, hasil kanji yang optimum boleh diperolehi melalui cara seduhan bahan kimia di bawah keadaan suhu 50˚C selama 48jam.

Untuk hidrolisis asid cair, dua teknik yang berbeza digunakan; 1) teknik dengan tanpa pra-rawatan 2) teknik pra-rawatan. Kaedah seduhan kimia yang dianggap sebagai pra-rawatan diaplikasikan sebelum hidrolisis. Sebelum hidrolisis asid cair, serbuk batang kelapa sawit dirawat dengan seduhan bahan kimia pada suhu 50˚C selama 48 jam. Setiap sampel direaksikan dengan tiga jenis kepekatan asid sulfurik yang berbeza (2%, 4% dan 6%) pada dua tempoh reaksi yang berbeza (30 minit dan 60 minit) dengan suhu 115 ˚ C.

Analisis varian menunjukkan bahawa perbezaan signifikasi didapati pada parameter hidrolisis asid cair dalam penghasilan xylosa dan glukosa. Interaksi signifikasi antara pelbagai pembolehubah didapati bagi penghasilan glukosa, sedangkan tidak ada interaksi yang signifikasi bagi penghasilan xylosa. Setiap pembolehubah hidrolisis asid cair memberi kesan individual ke atas hasil xylosa. Keputusan ujian analisis Tukey menunjukkan bahawa hasil glukosa yang tertinggi 25.5% (jisim kering/ jisim) diperolehi daripada 60 mesh serbuk batang kelapa sawit tanpa pra-rawatan dengan parameter hidrolisis yang menggunakan kepekatan asid sulfurik 2% bereaksi selama 30 minit. Ini adalah dipercayakan bahawa kandungan glukosa adalah dikonversi daripada kanji dan ikatan karbon adalah mudah dihidrolisiskan oleh kepekatan asid yang rendah dalam masa reaksi yang singkat. Umumnya, kewujudan pra-rawatan sebelum proses hidrolisis asid cair menyumbang ke atas hasil xylosa yang lebih tinggi daripada batang kelapa sawit. Saiz serbuk batang kelapa sawit (20 mesh, 40 mesh dan saiz 60 mesh) dan kepekatan asid sulfurik (2%, 4% dan 6%) tidak membawa signifikan yang berbeza untuk menghasilkan xylosa sedangkan waktu reaksi hidrolisis (30 minit dan 60 minit) membawa perbezaan yang signifikan bagi hasil xylosa. Keputusan kajian tersebut

menunjukkan bahawa hasil xylosa yang lebih tinggi boleh dihasilkan dengan pra-rawatan dan dihidrolisis dalam masa reaksi yang lebih lama iaitu selama 60 minit.

Secara kesimpulannya, batang kelapa sawit mengandungi kandungan kanji, xylosa dan glucosa yang tinggi. Kandungan kanji dapat diekstrak daripada batang kelapa sawit dengan menggunakan kaedan seduhan kimia. Selain itu, kaedah seduhan kimia merupakan pembolehubah yang paling membawa kesan individu untuk mempengaruhi pengekstrakan hasil optimum glucosa dan xylosa daripada batang kelapa sawit.

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Last but not least, my deepest appreciation goes to my beloved parents, sisters, brother for their undying love, concern and moral support.

Thank You.

I certify that a Thesis Examination Committee has met on 26th July 2011 to conduct the final examination of Wong Lih Jiun on her thesis entitled "**Extraction of Starch, Xylose and Glucose from Oil Palm Stem Using Chemical Steeping and Dilute Acid Hydrolysis Methods**." In accordance with the Universities and University Colleges Act 1971 and the Constitution of the University Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Member of the Examination committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare 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 University Putra Malaysia or at any other institution.

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WONG LIH JIUN

Date: 26 JULY 2011

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