UNIVERSITI PUTRA MALAYSIA

PRODUCTION OF XYLITOL FROM SAGO TRUNK HYDROLYSATE USING CANDIDA TROPICALIS

NURUL LINA BINTI MOHAMAD

PRODUCTION OF XYLITOL FROM SAGO TRUNK HYDROLYSATE USING *CANDIDA TROPICALIS*

By

NURUL LINA BINTI MOHAMAD

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

May 2011

DEDICATION

For my beloved parent, husband and children,

Who offered me unconditional love and support throughout the course of this thesis

Abstract of thesis presented to senate of University Putra Malaysia in fulfillment of the requirement for the degree of Master Science

PRODUCTION OF XYLITOL FROM SAGO TRUNK HYDROLYSATE USING *CANDIDA TROPICALIS*

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Chairman: Associate Professor Siti Mazlina binti Mustapa Kamal

Faculty: Faculty of Engineering

Xylitol is natural alternative sweetener and used in some foods because of a number of advantageous natural properties. Production of xylitol from agricultural waste, sago trunk cortex using *Candida tropicalis* was performed. Many researches have been carried out to increase the production of xylitol from various plant sources. Xylose, an intermediate carbon source for the xylitol production, was obtained from hemicellulose fraction of sago trunk cortex lignocellulosic compound. The diluted acid hydrolysis method was used to hydrolyze the xylose component. The influence of acid concentration and reaction time to obtain the optimum condition for xylose production was determined using Response Surface Methodology (RSM). It was found that xylose production was 22.78 g L^{-1} when operated with 8% sulfuric acid concentration for 60 minutes reaction time. Results showed the formation of toxic compounds which are furfural and phenolic compound from hydrolysis process, inhibited the microorganism performance and subsequently reduced the product formation. Further improvement of xylitol production by *Candida tropicalis* was

observed when using detoxification method. Detoxification of sago trunk hydrolysate was done using activated charcoal and overliming method. The activated charcoal method was found to be the best detoxification method with the highest xylitol concentrations were achieved when 2.5% (w/v) charcoal and adsorption time of 60 minutes was employed. In this condition, the xylitol concentration, volumetric productivity and yield were found 19.53 g L^{-1}, 0.37 g $L^{-1}h^{-1}$, 0.78 g g^{-1}, respectively. The fermentation conditions for *Candida tropicalis* were again obtained using RSM by varying the pH, temperature and agitation speed. The responses from RSM study for xylitol concentration, xylitol yield and volumetric productivity were found to be 19.23 g L^{-1}, 0.79 g g^{-1} and 0.4 g $L^{-1}h^{-1}$, corresponding to the temperature of 34°C, pH 4 and agitation speed of 250 rpm. Based on the optimization parameter, an inoculum preparation was done in the sago trunk hydrolysate medium without adding nutrient in shake flasks. By performing the fermentation process in the bioreactor in attempt to further improve xylitol production by *Candida tropicalis*, it was found that the application of fermentation conditions has resulted in increased by 6% of xylitol concentration and 10% of volumetric productivity when compared to the results obtained under the shake flasks. The specific growth rate was found to be higher when fermentation was done in bioreactor compared to shake flasks. This indicating that the cell growth was favored by controlled conditions in the bioreactor than in the shake flasks.

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

PENGHASILAN XILITOL DARIPADA KULIT BATANG SAGU MENGGUNAKAN *CANDIDA TROPICALIS*

Oleh

Nurul Lina binti Mohamad

Mei 2011

Pengerusi: Profesor Madya Siti Mazlina binti Mustapa Kamal

Fakulti: Kejuruteraan

Xilitol adalah gula gantian semulajadi dan digunakan didalam beberapa penyediaan makanan disebabkan oleh kelebihan pada sifat semulajadinya. Penghasilan xilitol dari sisa pertanian iaitu kulit batang sagu telah dijalankan. Pelbagai kajian telah dilakukan bagi meningkatkan hasil xilitol daripada pelbagai sumber pertanian. Xilosa, adalah sumber karbon bagi penghasilan xylitol, yang diperolehi daripada gentian hemiselulosa a kulit batang sagu. Kaedah hidrolisis asid digunakan bagi menghidrolisis komponen xilosa daripada kulit batang sagu. Kesan kepekatan asid dan tindakbalas masa dijalankan bagi mendapatkan kepekatan xilosa yang optimum dengan menggunakan kaedah tindakbalas permukaan (RSM). Hasil ujian ini, kepekatan xilosa adalah 22.85 g L^{-1} apabila menggunakan 8% kepekatan asid sulfurik yang bertindakbalas selama 60 minit. Hasil ujikaji menunjukkan terhasilnya komponen toksik yang akan menyebabkan perencatan kepada pertumbuhan mikrob dan menghadkan penghasilan xylitol. Komponen toksik didalam media kulit batang sagu dapat dikurangkan dengan menggunakan kaedah penyahtoksik menggunakan

penyerapan karbon teraktif dan pengalkalian media. Kaedah penyerapan karbon teraktif telah dilihat sebagai kaedah yang paling berkesan bagi menyahtoksik berbanding kaedah pengalkalian dengan menghasilkan kepekatan xylitol paling tinggi apabila diserapkan dengan 2.5% karbon dan bertindakbalas selama 60 minit. Keadaan ini menghasilkan kepekatan xylitol, produktiviti dan hasil xylitol adalah 19.53 g L^{-1}, 0.37 g L^{-1} dan 0.78 g g^{-1}. RSM digunakan sekali lagi untuk mengoptimumkan keadaan fermentasi dengan menggunakan parameter berubah, pH, suhu dan kelajuan putaran. Hasil daripada kaedah ini, kepekatan xilitol, hasil xilitol dan produktiviti yang didapati adalah 19.23 g L^{-1}, 0.79 g g^{-1} dan 0.4g $L^{-1}j^{-1}$, sesuai dengan suhu 34ºC, pH 4 dan 250 rpm bagi kelajuan putaran. Berdasarkan parameter ini, penyediaan inokulum didalam media batang sagu tanpa nutrisi dilakukan di dalam kelalang kon dan proses itu dilanjutkan didalam bioreactor bagi meningkatkan pengeluaran xylitol. Hasil fermentasi di dalam bioreactor menghasilkan peningkatan sebanyak 6% bagi kepekatan xilitol dan 10% bagi produktiviti apabila dibandingkan dengan hasil yang diperolehi bagi fermentasi di dalam kelalang kon.

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I certify that an Examination Committee has met on **6 May 2011** to conduct the final examination of **Nurul Lina binti Mohamad** on her degree thesis entitled **"Production of xylitol from sago trunk hydrolysate by using *Candida tropicalis*"** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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

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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.

NURUL LINA MOHAMAD

Date: 6 May 2011

TABLE OF CONTENTS