FABRICATION AND CHARACTERIZATION OF POLYMERIC BASED ASYMMETRIC ULTRAFILTRATION MEMBRANE FOR LYSOZYME SEPARATION TOWARDS BIOTECHNOLOGY DEVELOPMENT

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MASTER OF SCIENCE
UNIVERSITI MALAYSIA TERENGGANU
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SOFIAH HAMZAH

Thesis Submitted in Fulfillment of the Requirement for the Degree of Master of Science in the Faculty of Science and Technology Universiti Malaysia Terengganu

December 2009

This thesis is dedicated to

My husband (Mohd Shukri Samsuddin)

My Parents (Hamzah Abdullah and Rokiah Abdullah)

My Son (Muhammad Amirul Irsyad)

My family

And

All those noble and sublime personalities whose serenity, courage and wisdom

led me to the Path of Guidance

Abstract of this thesis presented to the Senate of Universiti Malaysia Terengganu due to the fulfillment of the requirement for the Master Degree of Science

FABRICATION AND CHARACTERIZATION OF POLYMERIC BASED ASYMMETRIC ULTRAFILTRATION MEMBRANE FOR LYSOZYME SEPARATION TOWARDS BIOTECHNOLOGY DEVELOPMENT

SOFIAH BINTI HAMZAH

December 2009

Chairperson : Assoc. Prof. Dr. Nora'aini Ali

Member : Dr. Marinah Mohd Ariffin

Faculty : Science and Technology

This study is aimed to develop an optimum asymmetric ultrafiltration membrane for protein lysozyme separation. The effects of polymer concentration and post treatment medium on membrane performance and morphology have studied. The optimum membrane obtained, was used to study the effect of the physicochemical environment (pH and ionic strength) which is strongly believed to influence the lysozyme transmission. For the first stage of this research, three types of ultrafiltration membrane with different polymer concentration (13 wt. % [UF13], 15 wt. % [UF15] and 17 wt. % [UF17] polyethersulfone) were prepared via a simple dry/wet phase inversion technique. The fabricated membranes were characterized in term of permeability coefficient, membrane morphology, molecular weight cut-off (MWCO) and membrane surface charge. The separation performances of these

membranes were evaluated using single solution of protein lysozyme. In the second stage of this study, the best membrane formulation which could produce a high flux and lysozyme transmission was chosen to develop the new UF membranes with different post-treatment medium (methanol, ethanol, propanol and glycerol). Membrane characterization and performance evaluation were carried out as the first stage of this research. UF15-M which consisted of 15% polymer concentration and post-treated with methanol has chosen as the best membrane since all its characteristics were close to the range of ultrafiltration membrane. Its morphology shows an asymmetric structure which comprises a skin layer that is well developed and supported by a porous support layer. This polymeric membrane performed molecular weight cut off for about 43kD and its surface has been negatively charged (-62 mV). These characteristics have improved the potential of UF15-M for lysozyme separation. The effect of pH and ionic strength on lysozyme transmission were examined at pH 5, 7, 9, 11 and 13 and ionic strength 0.05, 0.1, 0.2, and 0.3M. A promising result was observed at pH 9 with 0.1M ionic strength which promoted the optimum flux and transmission around 35 x 10^{-6} $m^3/m^2.s$ and 98%, respectively, at operating pressure of 3 bars. This study has proved that the polymer concentration and post treatment medium have greatly influenced the performance and morphology of UF membrane which in turn exhibiting an improvement in separation ability. The pH and ionic strength of the feed solution had also given a significant impact on lysozyme transmission since both of these factors would influence the solute-solute and membrane-solute interaction. These interactions

were believed to improve the filtrate flux to a significant degree. Eventually, the outcomes of this research are expected to be a stepping stone to design and optimize a protein purification system which can be a great achievement in the development of biotechnology field in the future.

Abstrak thesis ini dikemukakan kepada senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

FABRIKASI DAN PENCIRIAN ASIMETRIK MEMBRAN ULTRATURASAN BERASASKAN POLIMER UNTUK PENGASINGAN LISOZIM KE ARAH PEMBANGUNAN BIOTEKNOLOGI

SOFIAH BINTI HAMZAH

Disember 2009

Pengerusi : Prof. Madya Dr.Nora'aini Ali

Ahli : Dr. Marinah Mohd Ariffin

Fakulti : Sains dan Teknologi

Kajian ini bertujuan untuk menghasilkan membran ultraturasan yang opitima bagi pemisahan protein lisozim. Kesan kepekatan polimer dan media pasca rawatan ke atas prestasi dan morfologi membran telah dikaji. Membran optima yang diperolehi telah digunakan untuk mengkaji kesan persekitaran fizikal-kimia larutan (pH dan kekuatan ionik) yang dipercayai akan memberikan kesan penting ke atas pemisahan lisozim. Peringkat pertama kajian ini , tiga jenis membran ultraturasan yang mempunyai kepekatan polimer yang berlainan (13% [UF13], 15% [UF15] dan 17% [UF17] polieterrsulfona) telah dihasilkan melalui kaedah fasa balikan kering/basah. Membran yang difabrikasi telah dicirikan terhadap pengukuran kebolehtelapan, morfologi membran, nilai pemintasan jisim molekul dan cas permukaan membran. Prestasi ketelapan membran-membran ini dinilai menggunakan larutan tunggal protein lisozim. Pada peringkat kedua kajian ini, formulasi membran yang terbaik yang dapat

menghasilkan fluks dan kebolehtelapan lisozim yang tinggi telah dipilih untuk menyediakan membran ultraturasan yang baru, menggunakan media pasca rawatan yang berlainan (metanol, etanol, propanol dan gliserol). Pencirian dan penilaian prestasi membran telah dibuat seperti mana pada peringkat pertama kajian ini. UF15-M yang mengandungi kepekatan polimer sebanyak 15% yang direndam di dalam metanol telah dipilih sabagai membran terbaik kerana keseluruhan ciri-ciri membran ini lebih kurang sama dengan julat membran ultraturasan. Morfologi membran ini menunjukkan struktur tak simetri yang mengandungi satu lapisan luar yang terbina dengan baik dan disokong oleh lapisan sokongan yang berliang. Membran ini mempunyai nilai pemintasan jisim molekul dalam lingkungan 43kD dan permukaannya bercas negatif (-62 mV). Ciri-ciri ini telah meningkatkan potensi UF15-M untuk pemisahan lisozim. Kesan pH ke atas kebolehtelapan lisozim telah dikaji pada pH 5, 7, 9, 11 and 13 dan kekuatan ionik pada 0.05, 0.1,0.2 dan 0.3M. Keputusan yang memberangsangkan telah diperoleh pada pH 9 dengan kekuatan ionic 0.1M di mana fluks dan kebolehtelapan lisozim mencapai tahap optima di dalam lingkungan 35 x 10^{-6} m^3/m^2.s dan 98%, pada tekanan optima 3 bar. Kajian ini telah membuktikan bahawa kepekatan polimer dan media pasca rawatan sangat mempengaruhi prestasi dan morfologi membran ultraturasan yang seterusnya meghasilkan peningkatan di dalam keupayaan pemisahan. pH dan kekuatan ionik larutan suapan juga telah memberikan impak yang berkesan pada transmisi lisozim kerana kedua-dua faktor ini boleh mepengaruhi interaksi antara zarah-zarah dan zarah-membran. Interaksi ini telah dipercayai mampu

meningkatkan fluks ke tahap yang signifiken. Hasil daripada kajian ini diharapkan mampu untuk menjadi batu loncatan untuk mereka bentuk dan mengoptima sistem penulinan protein yang boleh menjadi pencapaian yang baik untuk membangunkan bidang bioteknologi pada masa hadapan.