INVESTIGATION OF DIFFERENT HARVESTING METHODS FOR MICROALGAE *COCCOMYXA SP.* BIOMASS

KHOO ZENYANG

UNIVERSITI SAINS MALAYSIA

JUNE 2020

PUSAT PENGAJIAN TEKNOLOGI INDUSTRI
UNIVERSITI SAINS MALAYSIA

BORANG PENYERTAAN DISERTAI MUTAKHIR
SATU (1) NASKAH

Nama Penyelia: NOOR AZIAH BINTI SERRI

Bahagian: TEKNOLOGI BIOPROSES

Saya telah menyemak semua pembetulan/pindaan yang dilaksanakan oleh Encik/Puan/Cik KHOO ZENYANG

mengemui disertainya sebagaimana yang dipersetujui oleh Panel Pemeriksa di Viva Vocenya.

2. Saya ingin mengesahkan bahawa saya berpuashati dengan pembetulan/pindaan yang dilaksanakan oleh calon.

Sekian, terima kasih.

DR NOOR AZIAH SERRI
Senior Lecturer
School of Industrial Technology
Universiti Sains Malaysia

(Tandatangan dan cop)

18 July 2020

Tarikh

INVESTIGATION OF DIFFERENT HARVESTING METHODS FOR MICROALGAE *COCCOMYXA SP.* BIOMASS

by

KHOO ZENYANG

A dissertation submitted in the partial fulfillment of the requirements for the degree of
Bachelor of Technology (B.Tech) in the field of Bioprocess Technology
School of Industrial Technology
Universiti Sains Malaysia

June 2020

DECLARATION BY AUTHOR

This dissertation is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. The content of my dissertation is the result of work I have carried out since the commencement of my research project and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution.

Khoo Zenyang

June 2020

ACKNOWLEDGEMENT

First and foremost, I would like to acknowledge Universiti Sains Malaysia that supported this project by providing the Bridging-Incentive Grant (6316214) thus allowing me to complete this project. I would like to express deepest gratitude to my final year project supervisor, Dr. Noor Aziah binti Serri and co-supervisor, Dr. Mohamad Asyraf bin Kassim for guiding me throughout the journey of my project and thesis writing. Thank you for all the invaluable advices and guidance given to me.

I would also like to acknowledge School of Industrial Technology for allowing me to use the available facilities and equipment throughout my research study. My sincere appreciation goes to Encik Azmaizan bin Yaakob and Puan Najmah binti Hamid for providing me apparatus and materials as well as spending their valuable time to help me in completing the project. They always offered positive feedback to my enquiries and uncertainties, giving me guidance on how to operate the equipment in a proper way. I am also very thankful for having Miss Lavanya A/P Anbalagan who always guided me and explained the harvesting process of microalgae to me during my project. Thank you for all their guidance and help.

Besides, my completion of this project could not have been accomplished without the support of my classmates and friends. Thanks for their encouragement and support throughout the four years of my life in Universiti Sains Malaysia. Last but not least, I am not forgetting to thank my beloved family for their love, moral support and encouragement. Thank you very much.

Khoo Zenyang

June 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

Symbol	Caption
±	Plus-minus
>	More than
<	Less than
%	Percentage
=	Equal to
℃	Degree of celcius

Abbreviation	Caption
μm	Micrometer
ANOVA	Analysis of variance
g	Gram
L	Litre
mg	Milligram
mL	Millimeter
nm	Nanometer
rpm	Revolutions per minute
pH	Potential of hydrogen
sp	Species

PENYELIDIKAN PELBAGAI TEKNIK PENUAIAN BIOMAS MIKROALGA BAGI MIKROALGA *COCCOMYXA SP.*

ABSTRAK

Kaedah penuaian mikroalga kini dapat diklasifikasikan sebagai mekanikal, kimia, biologi, dan elektrik. Pengemparan, flokulasi dan penapisan adalah tiga teknik penuaian yang amat bersesuaian untuk mendapat biomas mikroalga bagi aplikasi seperti biofuel, makanan manusia dan haiwan dan pemulihan kualiti air. Kajian ini meneliti faktor-faktor yang mempengaruhi kecekapan pemulihan biomas mikroalga melalui kaedah sentrifugasi, flokulasi dan penapisan. *Coccomyxa sp.* tempatan telah diasingkan dan dibiakkan untuk penyelidikan dan perbandingan kecekapan penuaian bagi setiap kaedah yang digunakan dalam kajian ini. Berdasarkan hasil kajian ini, kelajuan sentrifugasi sebanyak 5000 rpm dapat meningkatkan peratus penuaian biomas >95% dalam 5 minit. Masa sentrifugasi pada 2 minit ke atas mampu mencapai >90% pemulihan biomas mikroalga manakala masa sentrifugasi lebih lama daripada 5 minit tidak menunjukkan peningkatan yang signifikan dalam peratus penuaian. Kelajuan dan masa sentrifugasi telah menunjukkan kesan yang signifikan ($P<0.05$) terhadap kecekapan penuaian menurut ANOVA sehala. Bagi kaedah flokulasi, peningkatan pH kultur mikroalga sehingga 10 menyebabkan autoflokulasi *Coccomyxa sp*. dan 73.65% penuaian biomas telah dicapai pada pH 11. Namun, tiada pengaruh yang signifikan dari pH 5-9 untuk pembentukan flok mikroalga. Penggunaan flokulan bukan organik ($CaCl_2$) pada pH 11 menghasilkan peratus penuaian biomas >90% pada kadar hanya 10 mg/L $CaCl_2$. Peratus tertinggi telah diperoleh pada 150 mg/L $CaCl_2$, iaitu 99.62%. Kedua-dua pH dan konsentrasi mempunyai kesan yang signifikan terhadap peratus penuaian biomas mikroalga. Selain itu, kaedah penapisan berjaya mencapai peratus penuaian biomas yang tertinggi sebanyak 99.65% dengan

menggunakan penapis mikrofiber kaca dengan ukuran pori 1.2 μm. Namun, kaedah tersebut memerlukan masa yang lebih panjang daripada kaedah lain yang digunakan dalam kajian ini kerana lebih kurang 40 minit diperlukan untuk menghilangkan air kultur mikroalga sepenuhnya.

INVESTIGATION OF DIFFERENT HARVESTING METHODS FOR MICROALGAE *COCCOMYXA SP.* BIOMASS

ABSTRACT

Microalgae harvesting methods can currently be classified as mechanical, chemical, biological and electrical. Centrifugation, flocculation and filtration are among the top three preferred harvesting techniques to obtain microalgal biomass for applications such as biofuel, human and animal food, and water quality restoration. The present study investigated the variables affecting the biomass recovery efficiency via centrifugation, flocculation and filtration method. *Coccomyxa sp.* microalgae strain was locally isolated and cultivated for the investigation and comparison of harvesting efficiency for each method. Based on the results in this study, a centrifugal speed of 5000 rpm can give rise to harvesting efficiency >95% at 5 minutes. Centrifugation time at 2 minutes and above was capable of attaining >90% of microalgal biomass recovery while centrifugation time longer than 5 minutes did not show significant increase in harvesting efficiency. Both centrifugal speed and time exhibited significant effects on harvesting efficiency. For flocculation method, increasing the pH of microalgae culture to 10 induced autoflocculation of *Coccomyxa sp*. and 73.65% harvesting efficiency was reached at pH 11. However, there was no significant effect of pH from 5-9 on the formation of microalgal flocs. Flocculation using inorganic flocculant, $CaCl_2$ at pH 11 resulted in >90% harvesting efficiency at only 10 mg/ L $CaCl_2$. The highest efficiency was obtained at 150 mg/L $CaCl_2$, which was around 99.62%. There existed significant effects of both pH and dosage of flocculant on harvesting efficiency. Filtration successfully achieved the highest harvesting efficiency (99.65%) using a glass microfiber filter with pore size of 1.2 μm. However, it was very time consuming than other methods as it took around 40 minutes to completely dewater the microalgal culture.