UNIVERSITI PUTRA MALAYSIA

POTENTIAL TREATMENT OF BIODEGRADABLE ORGANIC MATTER IN WASTEWATER FROM WET MARKET USING AGRO-BASED MIXED CULTURE (ABMC)

SYAZRIN SYIMA SHARIFUDDIN

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By

SYAZRIN SYIMA SHARIFUDDIN

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POTENTIAL TREATMENT OF BIODEGRADABLE ORGANIC MATTER IN WASTEWATER FROM WET MARKET USING AGRO-BASED MIXED CULTURE (ABMC)

By

SYAZRIN SYIMA BINTI SHARIFUDDIN

January 2013

Chair: Mohd Kamil Yusoff, PhD

Faculty: Environmental Studies

Wastewater from wet market is mainly composed of suspended solids, high levels of organic pollutants, fats, oil, and grease and often being classified as 'high strength'. This wastewater must be treated in a manner that minimizes potential harm to public health and detrimental impacts on the environment. The conventional technologies require high cost. Increasing volumes of wastewater combined with limited space availability and tightening environmental standards has promoted the development of biotechnological processes for the treatment of wastewater. A laboratory-scaled shake-flask systems experiment was conducted to test the potential of using Agro-Based Mixed Culture (ABMC) to treat biodegradable organic matter in wastewater from wet market. Different variables were tested for 13 days treatment optimization including: types of agro-base material, mixture, concentration (%v/v) and agitation (rpm). The results were subsequently compared with wastewater sample without adding ABMC as the control. All water quality parameters analyzed showed significant difference (improving water quality) compared to untreated sample ($P<0.01$). Treatment for all parameters tested were highest using non-sterile ABMC,

50% ABMC mixture, 100% ABMC concentration, 150 rpm agitation speed for 13 days. Highest percentage reduction of water quality parameter can best be observed for Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) with 86% and 63%, respectively, followed by Ammoniacal Nitrogen (AN) with 55% reduction. Dissolved Oxygen (DO) and turbidity gives only 36% improvement and 44% reduction. The pH turns acidic from 6.10 to 5.24. Optimized ABMC treats better than Commercial EM. A larger scale and long-term treatment was tested using suspended growth batch bioreactor for 31 days treatment. At day 13, treatment performance for all parameter was better in bioreactor as compared to shake-flask system. However, by prolonging the treatment time, treatment efficiency for DO and turbidity reduced. For BOD, COD and AN, the value became constant after certain period of time. The reduction of BOD, COD and AN achieved was up to 91%, 72% and 62%, respectively. DO improve only by 14% while turbidity reduction was 48%. This study indicated that ABMC has potential to treat biodegradable organic matter in wastewater from wet market. The application of ABMC in wastewater treatment is capable of being a cost-effective biological treatment method because it is from local agricultural product which is cheap and easy to obtain.

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

POTENSI RAWATAN BAHAN ORGANIK BIODEGRADASI DI DALAM AIR KUMBAHAN PASAR BASAH MENGGUNAKAN KULTUR CAMPURAN AGRO-MEDIA (ABMC)

Oleh

SYAZRIN SYIMA BT SHARIFUDDIN

Januari 2013

Pengerusi: Mohd Kamil Yusoff, PhD

Fakulti: Pengajian Alam Sekitar

Air kumbahan dari pasar basah mengandungi komponen Pepejal Terampai (SS), kandungan bahan organic yang tinggi, lemak, minyak dan gris yang biasanya diklasifikasikan sebagai "sangat kuat". Air kumbahan ini harus dirawat melalui kaedah yang tidak menjejaskan kesihatan awam dan mempengaruhi sebarang kemerosotan kualiti alam sekitar. Kaedah konvensional umumnya memerlukan kos yang tinggi. Peningkatan isipadu air kumbahan dan kawalan standard alam sekitar yang digunapakai meransang pembangunan kaedah bioteknologi yang baru dan intensif bagi tujuan rawatan air. Eksperimen sistem rawatan berskala kecil telah dijalankan bertujuan mengenalpasti potensi rawatan bahan organik biodegradasi air kumbahan dari pasar basah menggunakan kultur campuran mikroorganisma agro-medium (ABMC). Rawatan selama 13 hari dengan aplikasi persekitaran yang berbeza telah dikaji bagi tujuan optimasi rawatan merangkumi: jenis agro-medium, campuran agro-medium, kepekatan (%v/v) dan agitasi (rpm). Hasil ujikaji menujukkan bahawa semua parameter kualiti air yang dirawat menunjukkan perbezaan peningkatan yang signifikan berbanding air kumbahan yang tidak dirawat

($p<0.01$). Rawatan adalah maksima pada penggunaan variasi ABMC yang tidak steril, 50% campuran ABMC, 100% kepekatan ABMC, 150 rpm agitasi selama 13 hari rawatan. Peratusan penurunan parameter air kualiti air yang tertinggi adalah bagi Permintaan Oksigen Biokimia (BOD) dan Permintaan Oksigen Kimia (COD) dengan 86% dan 63% penurunan setiap satu diikuti dengan Ammoniacal Nitrogen (AN) dengan 55% penurunan. Oksigen Terlarut (DO) dan kekeruhan hanya memberi 36% peningkatan and 44% peningkatan setiap satu. pH menjadi semakin berasid dari 6.10 ke 5.24. Penggunaan ABMC juga menunjukkan peningkatan kualiti air yang lebih baik berbanding penggunaan mikroorganisma efektif komersial. Rawatan berskala besar dengan peningkatan tempoh rawatan kepada 31 hari menggunakan bioreaktor turut dikaji. Analisis yang dijalankan pada hari ke-13 rawatan, menujukkan rawatan adalah lebih baik berbanding kaedah sistem rawatan berskala kecil. Walaubagaimanapun, dengan pelanjutan tempoh rawatan, efisiensi rawatan bagi DO dan kekeruhan menurun. Bagi BOD, COD dan AN bacaannya mendatar selepas tempoh masa tertentu. Pengurangan BOD, COD dan AN meningkat sebanyak 91%, 72% dan 62% setiap satu. DO meningkat hanya 14% manakala kekeruhan menurun kepada 48%. Kajian yang dijalankan membuktikan bahawa optimasi ABMC menunjukkan potensi rawatan bahan organik biodegradasi air kumbahan dari pasar basah. Aplikasi ABMC dalam rawatan air kumbahan berupaya menjadi salah satu kaedah rawatan biologi yang kos efektif dan mudah.

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APPROVAL

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 of Science. The members of the Supervisory Committee were as follows:

Mohd Kamil Yusoff, PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Normala Halimoon, PhD
Faculty of Environmental Studies
Universiti Putra Malaysia
(Member)

_____

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which has 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.

SYAZRIN SYIMA BINTI SHARIFUDDIN

Date: 29 January 2013

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LIST OF ABBREVIATIONS

AN	-	Ammoniacal Nitrogen
ANOVA	-	Analysis of Variance
BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
DO	-	Dissolved Oxygen
DOE	-	Department of Environment
DMRT	-	Duncan's Multiple Range Test
EEAT	-	The Environmental Engineering Association of Thailand
EM	-	Effective Microorganisms
EQA	-	Environmental Quality Act
FAU	-	Formazin Attenuation Units
IMOs	-	Indigenous Microorganisms
N	-	nitrogen
NTU	-	Nephelometric Turbidity Unit
P	-	phosphorous
PAH	-	Polycyclic Aromatic Hydrocarbon
PAISB	-	PKPS Agro Industries Sdn Bhd
PCB	-	Polychlorinated Biphenyl
RBCs	-	Rotating Biological Contactors
RM	-	Ringgit Malaysia
TDS	-	Total Dissolved Solid
TKN	-	Total Kjeldahl Nitrogen
TS	-	Total Solid

TSS	-	Total Suspended Solid
UPM	-	Universiti Putra Malaysia
WQI	-	Water Quality Index

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CHAPTER 1

INTRODUCTION

1.1 Background

Water pollution is currently emerging as a major problem in the developing world. The problem of removing pollutants from water and wastewater has grown with rapid industrialization. Wastewater treatment has become ever more critical issue due to diminishing water resources, increasing wastewater disposal costs, and stricter discharge regulations that have lowered permissible contaminant levels in waste streams. In the midst of growing concerned on the environmental input of wastewater effluent, tightening regulatory requirements will inevitably lead to increasing wastewater disposal costs. Various pollutants being introduce into water streams will lead to different pollution effect. In view of this, it is of crucial need to develop means to handle and treat wastewater. Currently, it is hard to claim that there is a single method applicable for all wastewater types and act as a powerful method to handle different pollutants. Therefore, huge attempts have been carried out to study the most cost-effective method to treat wastewater.

Wet market is a facility provided by the local authorities for the convenience of local community to get their everyday needs. Agamuthu and Fauziah (2007) expressed their concerns that though hypermarkets and supermarkets have become the main supplier of goods for most Malaysian households, growers market or wet-markets still play major roles in providing fresh agro-supplies. The increasing

functional of wet market also makes the place as one of the source of wastewater generation. The wastewater is high in organic material, suspended solids, fats, oils and grease. This wastewater commonly contains twice the organic matter and solids typically found in residential wastewater, classifying market sources as “high strength” (Carlito and Robbins, 2006).

Bioremediation seems to be a promising technology for wet market wastewater treatment. Sasikumar and Papinazath (2003) distinctively defined "bio-remediate" as to use biological organisms to solve an environmental problem. Microbes are the only entities in the biosphere with an exceptional ability to exploit various organic/inorganic compounds for their growth and transform them to chemical products no longer hazardous to human health and the environment suggesting that expensive chemical or physical remediation processes might be replaced with biological processes that are lower in cost and more environmentally friendly (Sasikumar and Papinazath, 2003). Extensive research has resulted in isolation of unusual microbes, capable of degrading a vast array of toxic organic compounds. Though these pollutants are relatively alien for the microbes, Kulkarni and Chaudhari (2007) reviewed that they have evolved novel pathway(s) for their metabolism. Even dead microbial cells can be useful in bioremediation technologies. Based on these discoveries, Sasikumar and Papinazath (2003) recommended that further exploration of microbial diversity is likely to lead to the discovery of many more organisms with unique properties useful in bioremediation.

Studies have shown that the utilization of microbiotic consortiums offers considerable advantages over the use of pure cultures in the degradation of

pollutants. It could be attributed to the effects of synergistic interactions among members of the association (Mukred *et al*., 2008; Alexander, 1999; Forgacs et al., 2004). There are three principal organisms in the concept of microbial ecosystem; namely photosynthetic bacteria; lactic acid bacteria; and yeasts that are indispensable for mix groups of organisms and even if other species were not included, these bacteria would develop coexisting forms with other beneficial organisms (Higa, 1980; Higa and Parr, 1994). This concept can increase reliability of the beneficial microorganisms that possibly reduce the pathogenic microorganisms through competitive exclusion. It will help in balancing the microbial populations; subsequently improve the microbial system resilience in improving water quality (Higa, 1980).

1.2 Problem Statement and Significance of this study

In Malaysia, effluents from wet market are directly discharged into nearby river without first being properly treated. Increasing volumes of wastewater combined with limited space availability and progressively tightening environmental standards has promoted the development of new intensive biotechnological processes for wastewater treatment. The most common and available proposed technologies in relation to wastewater treatment require extremely high cost (millions).

The significance of this study is to provide an evaluation of a local mixed microbial culture; Agro-based Mixed Culture (ABMC), for pollution control of wastewater and as a basis for future studies regarding the biological control of water

quality in other water resources. By using this technology, it can also help in reducing the treatment cost since ABMC is made of selected agro-based material which is papaya and mackerel. It is important to apply the optimum condition considering the concentration and mixture of ABMC in treating wastewater to maximize its efficiency. Previous research efforts have focused on various biological, chemical, and physical techniques for wastewater treatment. There is evidence that all three areas have potential for remediation. However, chemical or physical-chemical methods are generally costly, less efficient with limited applicability and often produce wastes, which were difficult to dispose of. In view of this, a study was carried out to identify the potential of local Agro-based Mixed Culture (ABMC) in reducing the biodegradable organic matter in wastewater from wet market.

1.3 Research Objectives

- To determine the optimum performance of ABMC for removing biodegradable organic matter in wastewater from wet market.
- To assess the effectiveness of ABMC in removing biodegradable organic matter in wastewater using suspended-growth batch bioreactor
- To evaluate the performance of ABMC in treating wastewater in comparison to effective microorganism.

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