



UNIVERSITI PUTRA MALAYSIA

***EFFECT OF COW MANURE CONCENTRATION FOR
BIOMETHANE
PRODUCTION IN BATCH FERMENTATION***

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By:

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Thesis submitted to the Faculty of Biotechnology and Biomolecular Sciences in
fulfilment of the requirement for the Degree of Bachelor of Science (Honours)
Biotechnology

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ABSTRACT

Abstract of thesis presented to the Faculty of Biotechnology and Biomolecular Sciences in fulfilment of the requirement for the Degree of Bachelor of Science (Honours) Biotechnology

EFFECT OF COW MANURE CONCENTRATION FOR BIOMETHANE PRODUCTION IN BATCH FERMENTATION

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June 2015

Supervisor: Prof. Madya Dr. Nor'Aini Abdul Rahman

Faculty: Faculty of Biotechnology and Biomolecular Sciences

Biomethane is a valuable gaseous compound that is chemically similar with natural gas. Thus, it can be used for the same application as in natural gas, for example; electricity generation, water heating, space heating, cooking as well as fuel for vehicles. This study was carried out to evaluate the effect of different concentration of cow manure for biomethane production in batch fermentation. The sample used in this study were a mixture of cow manure and food waste at different concentration with adjusted initial pH 7. The sample consist of 10% cow manure, 20% cow manure, 30% cow manure, 40% cow manure, 50% cow manure, 100% cow manure and 100% food waste. All the samples were fermented in batch fermentation at 37°C for three weeks. The gas produced was collected and measured in daily basis. The gas collected was analysed using gas chromatography to determine the concentration of biomethane in the sample. From the result obtained, the concentration of biomethane was observed to be highest (36.9%) at 100% cow manure sample.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Fakulti Bioteknologi dan Sains Biomolekul sebagai memenuhi sebahagian daripada keperluan untuk Bacelor Sains (Kepujian) Bioteknologi

KESAN KEPEKATAN NAJIS LEMBU TERHADAP PENGHASILAN BIOMETANA DI DALAM FERMENTASI SISTEM BATCH

Oleh:

QATRUN NADIA BINTI MIN ATHAHA

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Penyelia : Prof. Madya Dr. Nor'Aini Abdul Rahman

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Biometana merupakan gas berharga yang mempunyai persamaan kimia dengan gas asli. Oleh itu, ia boleh diaplikasikan sama seperti gas asli. Contoh aplikasi biometana ialah untuk menjana elektrik, memanaskan air, memanaskan ruang, memasak dan juga sebagai bahan bakar untuk kenderaan. Dalam pembelajaran ini, analisa kesan kepekatan berlainan najis lembu terhadap penghasilan biometana di dalam fermentasi sistem batch telah dilakukan. Sampel yang digunakan ialah campuran najis lembu dan sisa makanan di kepekatan berlainan dengan pH permulaan diubah kepada pH 7. Sampel terdiri daripada 10% najis lembu, 20% najis lembu, 30% najis lembu, 40% najis lembu, 50% najis lembu, 100% najis lembu dan 100% sisa makanan. Semua sampel difermentasi di suhu 37°C untuk tempoh tiga minggu. Gas terhasil dikumpul dan diukur setiap hari. Gas dikumpul dianalisa menggunakan kromatografi gas untuk menentukan kepekatan biometana di dalam sampel. Melalui keputusan analisa yg diperolehi, kepekatan biometana didapati lebih tinggi (36.9%) di dalam sampel 100% najis lembu.

FACULTY OF BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES

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Date:

LETTER OF PERMISSION

It is thereby to state that I, QATRUN NADIA BINTI MIN ATHAHA (Matric No: 164665) have done a final year project entitled “Effect of Cow Manure Concentration for Biomethane Production in Batch Fermentation” under the supervision of Prof. Madya Dr. Nor’Aini Abdul Rahman from the Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia.

I hereby give permission to my supervisor to write and prepare a manuscript from the results of this research to be published in any form, if I do not do so in six (6) months from the date above, on condition that my name is also added as one of the article’s authors. The arrangement of the names depends on the supervisor herself.

Yours sincerely,

(QATRUN NADIA BINTI MIN ATHAHA)

FACULTY OF BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES

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APPROVAL SHEET

This thesis entitled “Effect of Cow Manure Concentration for Biomethane Production in Batch Fermentation” is submitted by QATRUN NADIA BINTI MIN ATHAHA (Matric No: 164665) in fulfilment of the requirement for the Degree of Bachelor of Science (Honours) Biotechnology in Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia.

Approved by,

Date:

(Prof. Madya Dr. Nor'Aini Abdul Rahman)

Project supervisor

Department of Bioprocess Technology

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Universiti Putra Malaysia

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LIST OF ABBREVIATIONS

% CM	Percentage cow manure
% FW	Percentage food waste
μL	Microlitre
μm	Micrometer
$\text{C}_2\text{H}_5\text{OH}$	Ethanol
$\text{C}_6\text{H}_{10}\text{O}_4$	Organic waste mixture
$\text{C}_6\text{H}_{12}\text{O}_6$	Glucose
$\text{CH}_3\text{CH}_2\text{COO}^-$	Propanoate ion
$\text{CH}_3\text{CH}_2\text{COOH}$	Propionic acid
CH_3COO^-	Acetate ion
CH_3COOH	Acetic acid
CH_4	Methane
CO_2	Carbon dioxide
COD	Chemical oxygen demand
Eq.	Equation
H^+	Hydrogen ion
H_2	Hydrogen gas
H_2O	Water
H_2SO_4	Sulphuric acid
HCl	Hydrochloric acid
HCO_3^-	Bicarbonate
HPLC	High performance liquid chromatography
M	Molar
Mg	Milligram
mg/L	Milligram per litre

mL	Millilitre
mL/min	Millilitre per minute
mM	Millimolar
Mm	Millimeter
NaOH	Sodium hydroxide
Nm	Nanometer
OLR	Organic loading rate
Psi	Pounds per square inch
RPM	Revolutions per minute
TS	Total solids
TSS	Total suspended solids
VSS	Volatile suspended solids

CHAPTER 1

INTRODUCTION

Malaysia has a vast land area of 336 745 km², the 67th largest country in the world in term of area (World Factbook, 2006). However, despite the large land area, Malaysia still need to import livestock products to cater to the high demand. In 1997, approximately 2.5 billion Ringgits were spent for import of livestock products with 1-2% on ruminants (Wong & Chen, 2006). This is due to the lack of growth in ruminant production. Knowing their importance, according to the latest statistic by Department of Veterinary Services (2013), cattle production in Malaysia have increased from a total of 742,558 in 2012 to the total of 751,781 in 2013. Cow can be raised either in pasture or feedlot. Cow raised in pasture usually excrete their manure directly onto land which can serve as fertilizers. However, cow raised in feedlot will excrete their manure in the place they live in. With an increasing population of cows, there is an urgent need in the efficient management of cow manure.

Manure produced in cow farm can be treated as solid, semi-solid or liquid. The solid treatment for cow manure involved making it into compost by mixing them with the used bedding spread in the cow shed. The compost is then applied to land as fertilizer. The benefits of cow manure if it is land-applied are diverse. It can serve as nutrient source for crop growth because it contain significant amount of primary nutrients which are Nitrogen, Phosphorus and Potassium as well as other essential plant nutrients (Hubbard and Lowrance, 1998). Beside that, it can also improve soil quality, increase water infiltration, enhance nutrient retention and promotes growth of beneficial organism. However, excess application or improper application of manure can cause surface runoff and leaching. Leaching of cow manure can contribute to eutrophication which can pose a threat to the aquifers and surface's water (Sommer et al, 2008). Meanwhile, manure in semi-solid or liquid form are usually treated in lagoons by aerobic process, anaerobic process or combination of both. Treatment of cow manure in lagoons can take up to months, a long process that will emit harmful gases as the manure decompose. There are also irresponsible farmers who dispose off their cow manure without prior treatment. This is usually done in Asia where the manure are simply discharged into waterways, posing danger to both people and environment (Sommer et al, 2008).

One of the main factors that contribute towards the global warming are the production of greenhouse gas and livestock productions are widely known as the contributor to these gases. Sommer et al (2008) reported that "The atmospheric concentration of a greenhouse gas, methane has increased with 45% since 1850 and livestock manure is estimated to contribute 5% to the total emission of methane in the 1990s." Beside that, the increase in concentration of another greenhouse gas which is nitrous oxide has also been connected to the manure production.

Anaerobic digestion is a process where organic materials are decomposed biologically in the absence of oxygen. The most valuable product of anaerobic digestion is the biogas which have a variety of uses and can be used as a relatively low-cost fuel for the generation of energy and heating purposes, such as cooking. Biogas technology is widely known due to its advantage of producing energy as well as ability to generate fertilizer (Karim et al., 2005). Anaerobic digestion of manure involve firstly, the liquefaction of organic substrate by bacteria which is followed by a two-step process involving acid production by acid-forming bacteria (acidogenesis) and methane production from the acids with methane-forming bacteria (methanogenesis).

Anaerobic digestion is not a new thing especially in Europe. Various new technology have been developed to enhance the production of anaerobic digestion. The use of various substrate have been tested and cow manure is one of the widely studied substrate. In the case of Malaysia, there is no known anaerobic digestion of cow manure can be found (Omar et al, 2008). Despite that, the Department of Veterinary Services Malaysia suggest the integration of anaerobic digester for waste management in cattle and poultry farming but the system is not favored by the small farmers due to high cost and lack of environmental awareness.

The production of biomethane was studied in the co-digestion of cow manure and food waste sample at different concentration. The gas produced was collected daily and the volume was recorded to know the pattern of biogas formation. The biogas collected was analysed using gas chromatography to determine the concentration of biomethane.

The objective of this study is to evaluate the effect of different concentration of cow manure for biomethane production in batch fermentation.

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