CO-DIGESTION OF FRUITS AND VEGETABLE WASTE (FVW) WITH PALM OIL MILL EFFLUENT (POME) FOR BIOGAS PRODUCTION

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A report submitted in partially fulfilment of the
requirements for the award of the degree of
Master of Science

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MAY 2018

ACKNOLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful

Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this Master Report.

I dedicate this dissertation to my parents; Suhaimi Mohd Ariffin and Jasni Abdul Razak for their endless love, prayers and encouragement.

I gratefully acknowledge Dr Zarina Ab Muis for her supervision and constant support along this study.

I want to show my appreciation to Prof Haslenda Hashim, Nur Ezrina, Mr Bob, Mr Latfi, Raja Afiqah, Mazlinda, Afiqah Kassim, Sivanyanam and Ikmal for their direct or indirect support.

To those who indirectly contributed in this research, your kindness means a lot to me.

Thank you very much.

Huda Suhaimi

May 2018, Johor Bahru

ABSTRACT

Biogas is one of the most important sources of renewable energy and considered as an environmental friendly energy source. In this research, biogas produce from fruit and vegetable wastes (FVW) co-digest with palm oil mill effluent (POME). Biomethane Potential (BMP) Test, and quality improving effects for biogas production were studied. For this purpose, the BMP test was carried out in batch mode at mesophilic temperature (38°C). Substrates were pretreated and divided into 2 group: in slurry (Test1) and liquid form(Test2) before co-digest with POME for 10 days. In this study, the biogas yield of inoculum (mono digestion) and substrate (Co-digestion) using BMP test was measured to compare the biogas yield of two different form of co-substrates. Then, the composition of methane (CH_4) and carbon dioxide (CO_2) of the biogas produced were examined. The BMP method used to check the biogas potential, based on a volumetric test, which was measured by the displacement of a liquid. The influences of total solid(TS), volatile solids (VS) and pH were also evaluated. Biogas yields obtained were between 241 ml/day to 316 ml/day for test 1 while 301 ml/day to 326 ml/day for test2. The result demonstrate slightly increases in methane production when co-digesting FVW with pretreatment (liquid) with POME which contain 41% methane compared to co-digesting FVW without pretreatment (slurry) with POME which contain 37% methane. This may have been attributed to the pre-treatment of the substrate. The particle size of substrate influenced methane production rates during BMP tests. The results indicated that smaller particle size of substrate, yield higher amount of methane.

ABSTRAK

Biogas merupakan salah satu daripada sumber tenaga yang boleh diperbaharui dan dianggap sebagai sumber tenaga mesra alam sekitar. Dalam kajian ini, biogas dihasilkan dari hasil buangan buah-buahan dan sayur-sayuran (FVW) yang dicerna bersama kumbahan minyak kelapa sawit (POME). Ujian Biomethane Potential (BMP), dan kesan peningkatan kualiti bagi pengeluaran biogas telah dikaji. Untuk tujuan ini, ujian BMP dijalankan dalam mod berkelompok pada suhu mesophilic (38 ° C). Substrat telah dirawat dan dibahagikan kepada 2 kumpulan: dalam sluri (Ujian 1) dan dalam bentuk cecair (Ujian 2) sebelum dicerna dengan POME selama 10 hari. Dalam kajian ini, hasil biogas daripada inokulum dan substrat menggunakan ujian BMP diukur untuk membandingkan hasil biogas daripada dua bentuk substrat yang berbeza. Kemudian, komposisi metana (CH_4) dan karbon dioksida (CO_2) daripada biogas yang dihasilkan telah diperiksa. Kaedah BMP yang digunakan untuk memeriksa potensi biogas adalah berdasarkan ujian volumetric yang diukur melalui perubahan anjakan penghalang cecair.. Pengaruh bagi keseluruhan pepejal (TS), pepejal tidak menentu (VS) dan pH juga dinilai. Hasil biogas diperoleh antara 241 ml / hari hingga 316 ml / hari untuk ujian 1 manakala 301 ml / hari menjadi 326 ml / hari untuk ujian 2. Hasilnya menunjukkan sedikit peningkatan dalam pengeluaran metana bagi kombinasi FVW dengan POME yang mengandungi 41% metana berbanding dengan kombinasi FVW tanpa rawatan (sluri) dengan POME yang mengandungi metana 37%. Hal ini disebabkan oleh pra-rawatan substrat. Saiz zarah bagi substrat mempengaruhi kadar pengeluaran metana semasa ujian BMP. Keputusan menunjukkan semakin kecil saiz zarah, semakin meningkat penghasilan gas metana.

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LIST OF SYMBOLS AND ABBREVIATIONS

BMP	-	Bio Methane Potential
FVW	-	Fruit and Vegetable Waste
CH4	-	Methane
C/N	-	Carbon to Nitrogen Ratio
CHP	-	Combined Heat and Power
COD	-	Chemical Oxygen Demand
COD/VS	-	Chemical Oxygen Demand to Volatile Solid ratio
H_2	-	Hydrogen Dioxide
H_2S	-	Hydrogen Sulphate
I/S	-	Inoculums-to-substrate ratio
MSW	-	Municipal Solid Waste
POME	-	Palm Oil Mill Effluent
TS	-	Total Solid
VFA	-	Volatile Fatty Acid
VS	-	Volatile Solid
WWTP	-	Waste Water Treatment Plant

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The world's energy demand has increased over time and over dependence on fossil fuel brought forward the need for alternative energy sources. The use of fossil fuels like coal and petroleum-based products as a primary source of energy has led to a variety of adverse effects that have created an imbalance in the environment on many fronts, from climate change to human health issues to the harming of ecological systems and the degradation of natural resources.

One of the most cost-effective technologies for reducing environmental pollution related to biomass waste is biogas production, which is known to improve hygiene, reduce odours and GHG emissions, and also reduce the need for mineral fertilizers and pesticides (Sommer et al., 2004; Jiang et al., 2011; Triolo et al., 2012). A common use of this biomass, especially those that constitute organic waste products makes this renewable source so valuable is its ability to be converted into energy via anaerobic digestion in enclosed bioreactors.

The anaerobic co-digestion of organic wastes has several advantages. For example, the inhibitory compounds are diluted and the diversity of bacterial species increases due to the nutrition from a wide variety of organic wastes and helps stabilize a digester ecosystem. Malaysia provides the possible limitless options of renewable energy resources. POME showed good potential for biogas production. Fruits and vegetable wastes (FVW) represent a potential energy resource if they can be properly and biologically converted to methane. They are renewable and their net CO_2 contribution to the atmosphere is zero.

The biogas production can be further enhanced by co-digestion of vegetables waste with POME. This study, therefore, investigates the feasibility of co-digestion of POME and FVW at mesophilic temperature range. This have been carried out by applying the Biomethane Potential (BMP) test. They are expected to have a great potential to be integrated together as substrates source for the biogas production. The feasibility of co-digesting of POME with the locally FVW were evaluated.

1.2 Statement of the Problem

There are two different biogas systems have been be proposed for this research. Fruit and vegetables waste (FVW) were selected as substrate in this study as there are available at the market and contain sugar and hemicellulose for biogas enhancement. The first proposed system, FVW was grinded and directly put in anaerobic digester (AD) tank before adding the palm oil mill effluent (POME). Second proposed system is the pre- treatment of substrate. FVW was grinded and fermented about seven days. Then only the liquid will be taken out and co-digest with POME in AD tank.

So, proving with experiments the yield-increasing and quality improving effects of different type substrates (slurry and liquid) are needed. However, there must be pro and cons between both co substrates. Through the experimental study, pro and cons were identified.

1.3 Objective of the Study

This study embarks on the following objectives:

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1. To measure the biogas yield of inoculum (mono digestion) and substrate (Co-digestion) using BMP test in batch culture.

2. To compare the biogas yield of two different form of substrates that categorized into;
   i. Slurry co-digest with POME.
   ii. Liquid co-digest with POME.

3. To determine the composition of methane and carbon dioxide of the biogas produced.

1.4 Scope of the Study

i. To conduct biogas generation experiment using mono-digestion and co-digestion and compare the yield.
ii. Method for biomethane potential determination by using Biochemical Methane Test
iii. To analyze the composition of the biogas by determining the amount of CH_4, CO_2 and other type of gases produced.

1.5 Significance of Study

A BMP assay provides a measure of the anaerobic digestibility of a given substrate. The use of FVW as co substrate will enhance the biogas yield as it contains sugar and hemicellulose for biogas enhancement, co digest with POME. The information provided by BMPs is valuable when evaluating potential anaerobic substrates and will be used for proposed biogas pilot plant system. Co-digestion substantially improves the sustainability of waste management practices (Kim and Kim, 2010).

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