STUDY OF FOOD WASTE COMPOSTING BY USING BREADFRUIT PEEL AS FERMENTATION LIQUID

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PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

For my beloved husband, son, daddy, mommy and my late mother…

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ABSTRACT

Food waste represents almost 60% of the total municipal solid waste disposed in the landfill. This is due to the lack knowledge and exposure of food waste recycling practice. Composting is one of low cost alternative method to dispose the food waste. The purpose of this research is to provide an alternative disposal method which is composting for food waste from MRMI in Parit Kuari Darat, Johor. The industry area is far from the main road and out of local authorities collection zone, and the solid waste management were perform improperly without collection and facilities provided. The aim of this study is to identify the physical, chemical and biological parameters of composting food waste from MRMI. The physical parameters are temperature, pH value and moisture content. Meanwhile, the chemical parameter are nitrogen, phosphorus, potassium, total organic carbon and heavy metals. As for biological parameters, bacteria count were tested during the study. Breadfruit peel was used as fermentation liquid because of it suitability and it is one of food waste that produced by MRMI and soil with coconut fiber were used as the decomposing medium. Takakura composting method was conducted in this study with 8 reactors which is reactors A1, B1, C1 and D1 (research compost) and reactors A2, B2, C2 and D2 (commercial compost). The results showed total food waste generated by MRMI is 1221.84 kg. In terms of chemical properties, the highest N content for research compost is 2240 ppm, P with 14.143 ppm and K with 704.5 ppm. Meanwhile, NPK content for commercial compost obtained the highest N value with 2268 ppm, P with 11.615 ppm and K with 645.55 ppm. In addition, TOC and C/N ratio for all reactors decreased significantly along the study and has reached the maturity stage. Traces of heavy metals were found lower than the standards. As the conclusion, research compost in this study is comparable with commercial compost and the NPK value for matured compost shows that the compost nutrient value is higher than organic fertilizer from previous study and the compost can be used as fertilizer and suitable for agricultural purposes.

ABSTRAK

Sisa makanan mewakili 60% daripada jumlah sisa pepejal yang dilupuskan di tapak pelupusan. Pengkomposan adalah satu kaedah kos rendah untuk melupuskan sisa makanan. Tujuan penyelidikan ini adalah untuk menyediakan satu kaedah pelupusan iaitu pengkomposan untuk sisa makanan dari MRMI di Parit Kuari Darat, Johor. Kawasan ini jauh dari jalan utama dan di luar zon kutipan sisa pepejal oleh pihak berkuasa tempatan, dan pengurusan sisa pepejal dilakukan secara tidak teratur tanpa kemudahan yang disediakan. Tujuan kajian ini adalah untuk mengenal pasti parameter fizikal, kimia dan biologi pengkomposan sisa makanan dari MRMI. Parameter fizikal adalah suhu, pH dan kandungan lembapan manakala parameter kimia ialah nitrogen, fosforus, kalium, jumlah karbon dan logam berat. Parameter biologi adalah kiraan bakteria. Kulit buah sukun digunakan di dalam cecair penapaian kerana kesesuaiannya dan sabut kelapa digunakan di dalam media penguraian. 8 reaktor digunakan dalam kaedah pengkomposan Takakura ini iaitu reaktor A1, B1, C1 dan D1 adalah kompos penyelidikan dan reaktor A2, B2, C2 dan D2 adalah kompos komersial. Komposisi sisa makanan menunjukkan jumlah keseluruhan sisa makanan yang dihasilkan oleh MRMI adalah 1221.84 kg. Untuk parameter kimia, kandungan N tertinggi untuk kompos penyelidikan ialah 2240 ppm, P dengan 14.143 ppm dan K dengan 704.5 ppm. Sementara itu, kandungan NPK untuk kompos komersial memperoleh nilai N tertinggi iaitu 2268 ppm, P dengan 11.615 ppm dan K dengan 645.55 ppm. Selain itu, nisbah TOC dan C/N untuk semua menurun dengan ketara sepanjang proses penguraian kompos dan mencapai tahap kematangan. Kesimpulannya, kompos penyelidikan dalam kajian ini adalah dengan kompos komersil dan nilai NPK untuk kompos akhir menunjukkan bahawa nilai nutriennya adalah lebih tinggi daripada baja organik daripada kajian sebelumnya dan kompos di dalam kajian ini boleh digunakan sebagai baja dan sesuai untuk tujuan pertanian.

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LIST OF SYMBOLS AND ABBREVIATIONS

^{o}C	-	Degree celcius
%	-	Percent
AAS	-	Atomic Absorption Spectroscopy
As	-	Arsenic
Cd	-	Cadmium
CH_4	-	Methane
C:N	-	Carbon to Nitrogen
CO_2	-	Carbon dioxide
Cr	-	Chromium
Cu	-	Copper
HM	-	Heavy metals
ICPMS	-	Inductively Coupled Plasma Mass Spectrometry
K	-	Potassium
Kg	-	Kilogram
M.C	-	Moisture Content
MHLG	-	Ministry of Housing and Local Government

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MPRC	-	Micropollutant Research Centre
MSW	-	Municipal solid waste
MRMI	-	Makanan Ringan Mas Industry
MWM	-	Municipal waste management
N	-	Nitrogen
Ni	-	Nickel
P	-	Phosphorus
Pb	-	Lead
Ppm	-	Part per million
TKN	-	Total Kjeldahl Nitrogen
TOC	-	Total organic carbon
Zn	-	Zinc

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CHAPTER 1

INTRODUCTION

1.1 Background Study

Municipal waste management (MWM) in Malaysia has become a challenging task in recent years due to population growth, industrialisation and an increase in quantity and variation in the types of waste generated. Currently, Malaysia produces approximately 25,000 metric tonnes of waste per day with a general rate of 0.85 kg/person/day (Nadzri, 2013). The waste consists of domestic and industrial refuse. Waste management resulting out of rapid urbanization has become a serious concern for government departments, pollution control agencies, regulatory bodies and also the public.

Proper waste management is crucial to prevent further environmental destruction and to promote sustainable development. The annual increase in solid waste generation requires appropriate facilities and technologies that are not available to match the requirement for sustainable waste management (Agamuthu *et al*., 2007). This makes the management of waste in Malaysia a more delicate matter to handle and a constrain to establish a sustainable waste management system. The characteristics of municipal solid waste (MSW) components also play important roles to determine the suitability of the disposal systems. According to Yeny and Yulinah (2012), the solid waste composition in

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most asian countries is highly biodegradable with high moisture contents such as food waste, paper, plastic/foam, agriculture waste, rubber/leather, wood and textiles. In Malaysia, the average components of municipal solid waste (MSW) are quite similar with the largest categories consisting of food waste (47%), plastics (14%) followed by paper (15%), metal (4%) and lastly 3% for glass and others (17%) (Shamsuddin, 2015). Therefore, a continuous effort is required to identify the most suitable alternative for long terms solutions to reduce the burden of existing MSW disposal systems such as open dumping and landfilling.

Most landfills in Malaysia are in bad conditions, and operated without proper protective measures, such as lining systems, leachate treatment and gas venting (Ismail and Manaf, 2013). In Terengganu, three of seven waste disposal sites in the state were in critical condition with overflowing solid waste, which is environmentally hazardous (The Star, 2016). All types of wastes including food waste are disposed in landfills without any pre-treatment (Ismail and Manaf, 2013).

Malaysia's solid waste management challenges could be reasonably addressed by the adoption of waste management options such as source reduction and reuse, recycling and composting. Some countries have already started to create legislation to address this solid waste issue. Eureka Recycling, an organization focusing on reuse, recycling, composting and waste reduction, explained that there were two kinds of composting processes, anaerobic and aerobic. Anaerobic composting happens when organic materials are broken down by bacteria without the presence of oxygen, which is what happens to food disposed in landfills. This process produces methane, a gas more powerful than carbon dioxide (CO_2) when it comes to global warming. On the other hand, the aerobic process happens when organic materials are broken down by bacteria in the presence of oxygen. This process emits CO_2 in negligible quantities and does not emit methane. The diversion of food waste and all other organic waste from landfills for composting represents a clear option for local governments and communities when trying to reduce greenhouse gas emissions.

The composting method continues to attract more and more people not only due to being an environmentally sustainable product but also for its great soil enrichment properties. Compost use not only helps to improve soil quality and reduces soil loss, but

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also increases soil water retention and reduces the need for extra inputs (USCC, 2008). The composting process is seen as the best method in overcoming the issues of increased organic solid waste being disposed directly in landfills and production of various gases. The purpose of composting is to stabilize the waste for landfilling, reduce the volume and mass of solid waste and return the organic substances to their natural state. In Malaysia, the composting process is recognized as the most adequate pre-treatment in order to obtain a composted material which may respond more efficiently and safely than the raw material to the soil (Kala *et. al*, 2011).

1.2 Problem Statement

In this study, the composting study is focused on one of small and medium industries (SMI) in Johor. SMI is defined as manufacturing enterprises or companies providing manufacturing related services. In Malaysia, there are many opportunities for SMI in the form of joint venture that has the full support of the government. Most of the SMIs in Parit Raja are focusing on food industry.

One of the SMI is Makanan Ringan Mas Industry (MRMI), which is located in a rural area at Parit Kuari Darat, Johor. MRMI produces processed food such as chips and coconut candy. The area is far from the main road and out of the local authority collection zone, and the solid waste management were done improperly without any collection and disposal facilities. Solid waste generation from MRMI which are mostly food waste were burned and dumped into the river by the workers, thus affecting the environmental sanitation, causing air and water pollution. Burning of solid waste often releases high levels of particulates, acid gasses, heavy metals, dioxins and other toxins. Furthermore, food waste that had been dumped into the river became one of the causes to water pollution such as ‘green colored’ river due to algae blooms and high level of sedimentation in the river which has an adverse impact to humans. Water pollution is a change of state water reservoirs and reduce the water quality. In addition to the impact towards the environment, without a proper collection system, the food waste generation contributes to the highest

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percentage of wastes in the landfills. The high amount of food waste generated is the main cause to most issues related to landfills such as foul odor, toxic leachate and emission of greenhouse gases.

In this study, MRMI's generated waste is mostly raw food waste such as banana peel, tapioca peel, breadfruit peel and grated coconut waste as well as processed food waste such as leftover coconut candy and chips. To minimise this food waste problem at MRMI, food waste composting as an alternative disposal method were conducted for better food waste management. Furthermore, the study includes the investigation of waste generation, characteristics, composition and classification of food waste generation from MRMI as well as the physical, chemical and biological parameters of the reactors.

Therefore this study is focused on food waste compost application at one of small and medium industry (SMI) in Parit Raja, Johor and aiming to maximize agronomic benefit and to reduce the environmental risk.

1.3 Objectives

The purpose of this research is to provide an alternative disposal method for food waste from MRMI in Parit Kuari Darat, Johor. The main objectives of the study are:

1. to identify the classification, the amount of waste generation, the composition and the characteristics of food waste generation from Makanan Ringan Mas Industry (MRMI).
2. to determine the physical, chemical and biological parameters of the food waste compost use in the composting treatment.
3. to compare the quality of the matuted research and commercial compost in terms of nitrogen, phosphorus, potassium and heavy metals contents.

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1.4 Scope of Study

This study is limited to the food waste composting produced by Makanan Ringan Mas Industry (MRMI), Parit Kuari Darat, Johor and is intended to be used as a reference or guide to the community to create a network of composting food waste.

Food waste generated from the industry are collected, separated, weighed and dried accordingly at FKAAS Geotechnics Laboratory to identify the amount, composition, characteristics as well as the classification of the waste. The separation and composition of the solid waste generated by MRMI are identified and measured for a period of twelve months from May 2015 to April 2016 in order to obtain an accurate composition of the waste. Moisture content and density of the food waste were also carried out. Fermentation liquid and decomposing medium based on food waste generated by MRMI which are coconut fiber, black soil and breadfruit peel have been set up, which made up to four reactors for research compost. Four more reactors act as control reactors using fermentation liquid and decomposing medium based on conventional method which is Takakura Composting Method (using rice husk, black soil and fermented soybean). Different types of processed and raw food waste by MRMI which are chips, coconut candy, grated coconut waste, tapioca and banana peel have been used as feeding materials for the reactors.

Preliminary test for this research project was focused on the decomposing medium and fermentation liquid. C:N ratio test was done for decomposing medium between research and commercial compost. As for fermentation liquid between research and commercial compost, bacteria count test was conducted.

Physical, chemical and biological parameters testing of all the reactors was conducted to determine the characteristics and the concentrations of nutrients contained in compost produced with food waste from MRMI. Physical parameters such as temperature, pH and moisture content was carried out at the laboratory. Chemical parameters such as heavy metal, NPK testing and total organic carbon was also carried out. Biological parameters which are bacteria count was also carried out to check the total bacteria in the composts.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Rapid urbanization and population growth have generally increased the standard of living in Malaysia and consequently increases in waste generation. Municipal solid waste consists of waste generated from residential, commercial, institution and public parks. The Solid Waste and Public Cleansing Management Act 2007 defines solid waste as controlled solid wastes which includes commercial solid waste, household solid waste, institutional solid wastes and public solid waste (Act 672). The management of solid waste in Malaysia is under the jurisdiction of Ministry of Housing and Local Government (MHLG). Climate change concerns do not have major influence on decisions concerning waste management and policies in Malaysia. However, it is gaining more recognition and it is gradually playing an important role in combating global green house gas emission through sustainable solid waste management (Chua *et al.*, 2011).

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2.2 Waste Generation

Quantity, type and composition of solid waste vary depending on the source of waste, whether it is derived from residential, commercial, institutional, industrial as well as construction and agriculture. In Malaysia, the average per capita generation rate increased from 0.67 kg/capita/day in 2001 to 0.85 kg/capita/day in 2012 (Nadzri, 2013; GOM, 2006). The amount is expected to double in line with the population growth by 2020. Statistics shows that waste generation is increasing every year and only 76% to 80% of waste collected (Ghafar, 2017). Based on Table 2.1, it shows an increase of waste generation per year and not all of the waste disposed in landfills.

Table 2.1: The increase in the total estimated waste (tons / year)

(Source: Zamali *et al*., 2013)

Year	**Population**	**Total of assume waste (tons/year)**
1996	15,146,236	13,068.97
2001	17,136,575	16,247.93
2015	31,773,889	7,772,402
2020	35,949,239	9,092,611

Solid waste problems in Malaysia are increasing; from 21,000 tons of waste per day in 2011 to 22,000 tons per day in 2012. This is expected to grow to 30,000 tons of waste per day by 2020 if the habits and lifestyles of today remain the same (Alias, 2010). Generation of municipal solid waste in Malaysia by state for 1996 through 2009 can be found in Table 2.2.

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