



**UNIVERSITI PUTRA MALAYSIA**

***EFFECT OF BIOCHAR ADDITION ON THE PHYSICOCHEMICAL  
PROPERTIES OF  
COMPOST FROM FOOD AND GARDEN WASTES***

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**FBSB 2015 36**

**EFFECT OF BIOCHAR ADDITION ON THE PHYSICOCHEMICAL PROPERTIES OF  
COMPOST FROM FOOD AND GARDEN WASTES**

**By:**

**NURUL MAISARAH BINTI ABDULLAH**

**Thesis Submitted to the Faculty Biotechnology and Biomolecular Sciences,  
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Bachelor Science (Hons) Biotechnology**

**2015**

**FACULTY BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES  
UNIVERSITI PUTRA MALAYSIA**

Date:

**LETTER OF PERMISSION**

It is thereby to state that I, NURUL MAISARAH ABDULLAH (Matric No: 163709) have done a final year project entitled “**Effect of Biochar Addition on The Physicochemical Properties of Compost From Food and Garden Wastes**” under supervision of Professor Dr. Mohd Ali Hassan 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 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, in condition that my name is also added as one of the article's authors. The arrangement of the name depends on the supervisor himself.

© Yours sincerely,

.....  
(NURUL MAISARAH ABDULLAH)

**FACULTY BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES  
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**APPROVAL SHEET**

This thesis entitled “**Effect of Biochar Addition on The Physicochemical Properties of Compost From Food and Garden Wastes**” is submitted by NURUL MAISARAH ABDULLAH (Matric No: 163709) 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.

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(Professor Dr. Mohd Ali Hassan)

Project Supervisor

Department of Bioprocess Technology

Date:

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

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**2015**

**Supervisor: Prof. Dr. Mohd Ali Hassan, PhD**

**Faculty: Faculty of Biotechnology and Biomolecular Sciences**

Food waste contains a high content of biodegradable organic material that can be recycled into compost. The utilization of food and garden wastes for compost production take place efficiently with the action of microorganisms depending on certain parameters such as temperature, aeration, agitation, moisture content, pH value and feedstock composition. Addition of bulking agents such as biochar and sawdust can also improve the carbon content for microbial growth and utilization. The objectives of this study are to investigate the effect of different percentages of biochar on the composting process of food and garden waste and to study the quality of compost produced from food and garden wastes with biochar addition. The In-vessel composting system was applied in this study due to higher flexibility in controlling and monitoring the agitation and aeration system. In physicochemical study, different percentage of

biochar (0%, 2%, 4% and 6%) was added to the system separately and the effect on composting process from the addition was evaluated. The quality of compost was assessed by Solvita test and germination test. The addition of biochar has accelerated the onset of thermophilic phase. The system was supplied with sufficient amount of oxygen in range of 7.1 - 21.4%. The moisture content also was maintained below 63.91% for the whole process. After 14 days of composting, finished compost with pH range 6 – 8 was obtained. The Solvita test of compost detected that the compost was not matured yet and not ready to be use. Further composting is needed. The germination rate of the compost within range 10.53% - 42.11% shows that the immature compost contained high level of phytotoxicity. In summary, the composting with 2% biochar has greatly enriched the compost with microbial populations and hence, improved the composting process.

Abstrak tesis yang dikemukakan kepada Fakulti Bioteknologi dan Sain Biomolekul  
sebagai memenuhi keperluan untuk Ijazah (Kep.) Bioteknologi

**KESAN TAMBAHAN BIOCHAR TERHADAP CIRI FISIKOKIMIA DARIPADA  
KOMPOS SISA-SISA MAKANAN DAN TUMBUHAN**

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Sisa makanan mengandungi kandungan yang tinggi bahan organik biodegradasi yang boleh dikitar semula menjadi kompos. Penggunaan sisa makanan dan tumbuhan untuk pengeluaran kompos berlaku dengan cekap dengan tindakan mikroorganisma yang bergantung kepada parameter tertentu seperti suhu, pengudaraan, pengadukan, kandungan kelembapan, nilai pH dan komposisi bahan mentah. Penambahan ejen pukal seperti biochar dan habuk papan juga boleh meningkatkan kandungan karbon untuk pertumbuhan mikrob dan penggunaan. Objektif kajian ini adalah untuk mengkaji kesan peratusan biochar yang berbeza ke atas proses pengkomposan makanan dan sisa hijau serta mengkaji kualiti kompos yang dihasilkan daripada sisa makanan dan tumbuhan dengan tambahan biochar. Sistem kompos dalam tangki telah digunakan dalam kajian ini kerana mempunyai fleksibiliti yang lebih tinggi dalam mengawal dan memantau pengadukan dan pengudaraan sistem. Dalam kajian fizikokimia, peratusan biochar (0%, 2%, 4% dan 6%) yang berbeza telah ditambah ke dalam sistem secara berasingan dan kesan ke atas proses pengkomposan itu dinilai. Kualiti kompos dinilai

melalui ujian Solvita dan ujian percambahan. Penambahan biochar telah mempercepat bermulanya fasa thermophilic. Sistem ini telah dibekalkan dengan jumlah oksigen yang mencukupi iaitu 7.1-21.4%. Kandungan lembapan juga dikekalkan di bawah 63,91% bagi keseluruhan proses. Selepas 14 hari pengkomposan, kompos dengan julat pH 6 - 8 telah diperolehi. Ujian Solvita kompos mengesan bahawa kompos itu belum matang lagi dan tidak bersedia untuk digunakan. Kompos lanjut diperlukan. Kadar percambahan kompos dalam julat 10.53% - 42,11% menunjukkan bahawa kompos tersebut mengandungi tahap phytotoxicity yang tinggi. Ringkasnya, kompos dengan 2% biochar telah banyak memperkayakan kompos dengan populasi mikrob dan dengan itu, meningkatkan proses pengkomposan.



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## LIST OF ABBREVIATIONS

MSW	-	Municipal solid waste
EFB	-	Empty fruit bunch
GHG	-	Greenhouse gases
CFU	-	Colony forming unit
EC	-	Electrical conductivity
NA	-	Nutrient agar
DCR	-	Digital colour reader
C:N	-	Carbon to nitrogen ratio

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of research

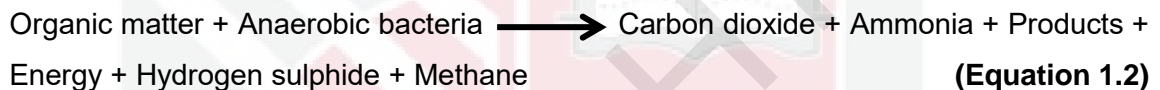
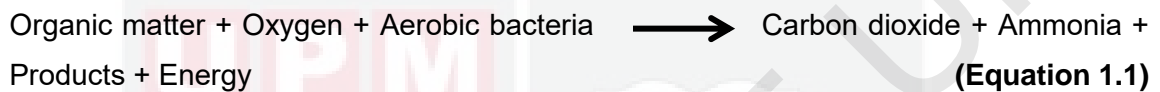
Solid waste generation in terms of the amount and composition in Malaysia has been increasing gradually since the year 2000 due to urbanization, increase of population and industrialization (Badgie *et al.*, 2012). Municipal Solid Waste (MSW) can be defined as useless and unwanted products derived from activities of and discarded by society including waste from household, institutional, commercial, municipal and industrial sources such as old newspaper, broken furniture, food waste and garden waste.

Food waste accounts the highest proportion among the other MSW which is 45% from the total MSW generated. There are about 8,000 tons of food being wasted a day by Malaysian as reported in The Sun Daily (2014). According to Press Statement (2013), it is estimated that, 5 million tons of food waste will be disposed of in the year 2020. High amount of food waste produced and being dumped in the landfills produce leachate, unpleasant odor due to anaerobic process and allows the emission of greenhouse gases (GHG) such as methane to the environment which contributes to global warming.

Currently, landfilling of MSW including food waste is the main handling and disposal method utilized by the Malaysian government. Due to rapid development and the lack of space for new landfills, authorities in most major cities in Malaysia are looking for another treatment. The option in the treatment of MSW is through incineration. The proportion of waste reduced up to 90% from the total amount after being incinerated (Makmal Sisa Pepejal, 2012). But, due to the technology limitation as well as the side effects from the process such as release of harmful gas, particles and ash which are dangerous to all living things makes citizens refuse to that kind of treatment. Nowadays, local and central governments looking towards more sustainable waste management to be applied which can be achieved through composting process.



Composting is a biological process that involves active decomposition of organic matter by microorganisms which may occur in both aerobic and anaerobic conditions, mostly in aerobic condition (Peter and Brian, 2001). The microorganisms that mostly involve in the degradation of organic matter are fungi, actinomycetes, bacteria and also possibly protozoa, in which the microbial population throughout the process will change (Peter and Brian, 2001). The overall biochemical reactions involve in aerobic and anaerobic system of composting process is shown in **Equation 1.1 and 1.2** below.



The composting process proceeds more efficiently when more than one organic waste being composted together which known as co-composting. The composting process comprises of organic wastes that act as carbon and nitrogen sources to the microorganism for utilization and cell growth. The sources of carbon can be from sawdust, hay, dried grass and biochar, meanwhile the food waste and fresh garden waste act as the nitrogen sources. In composting process, the ratio of carbon to nitrogen (C:N) need to be in correct proportion for best performance of composting process (Compost Interpretation, 2014).

The composting process involves four different stages which are mesophilic, thermophilic, cooling and maturation phase (Peter and Brian, 2001). The change in temperature throughout the composting process is due to the microbial activity in each of the phase. The utilization of food and garden waste for compost production take place efficiently with controlled composting parameters such as temperature, aeration and agitation rate, moisture content, pH value, feedstock composition and composition of microbial population. The efficiency of composting in terms of composting time is influenced by the main parameters. Composting of feedstock with very low pH value

may prolong the mesophilic phase, however the problem can be recovered by controlling the other parameters such as moisture content, aeration and agitation rate.

In this study, physicochemical characteristics of composting of food and garden waste with the addition of different percentages of biochar are investigated with specific objectives as follows:

1. To investigate the effect of different percentages of biochar on the composting process of food and garden wastes.
2. To study the quality of compost produce from food and garden wastes with biochar addition at different percentages.

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