CO-COMPOSTING OF FOOD AND GREEN WASTE

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Co-Composting of Food and Green Waste

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Co-Composting of Food and Green Waste

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<table>
<thead>
<tr>
<th>CONTENT</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>TABLE OF CONTENT</td>
<td>iv-vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF PLATES</td>
<td>x-xi</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>xii</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>xii</td>
</tr>
</tbody>
</table>

**CHAPTER ONE: INTRODUCTION**

1.1 General Background 1-3
1.2 Sarawak Scenario 3-4
1.3 Objectives of Composting 4
1.4 Importance of Composting 5

**CHAPTER TWO: LITERATURE REVIEW**

2.1 Waste Management 6-8
2.2 Composting of Food Waste 8-9
2.3 Composting of Green Waste 9-10
2.4 The Composting Process 10-11
2.5 Factors Affecting the Composting Process

2.5.1 Carbon-to-Nitrogen (C: N) Ratio

2.5.2 Moisture Content

2.5.3 Temperature

2.5.4 Aeration

2.5.5 Nutrient Content of Compost

2.5.5.1 Nitrogen

2.5.5.2 Phosphorus

2.5.5.3 Potassium

2.5.5.4 Calcium and Magnesium

2.5.5.5 Heavy Metals

2.6 Maturity

2.7 Organic Content and pH Analysis

2.8 Importance of Testing Compost Maturity

CHAPTER THREE: MATERIALS AND METHODS

3.1 Composting Material

3.1.1 Green Waste Samples

3.1.2 Food Waste Samples

3.1.3 Composting Pile

3.2 Composting Site

3.3 Machineries

3.3.1 Size Reduction
3.4 Composting Methods

3.5 Physical Analyses

3.5.1 Temperature

3.5.2 Fresh Weight

3.5.3 Dry Matter and Moisture Content

3.5.4 Maturity Analyses

3.6 Chemical Analyses

3.6.1 Preparation of Samples in the Laboratory

3.6.2 Organic Matter Content

3.6.3 Macronutrients and Micronutrients

3.6.4 pH Measurement

CHAPTER FOUR: RESULTS

4.1 Physical Analyses

4.1.1 Composition of Wastes

4.1.2 Temperature

4.1.3 Fresh Weight

4.1.4 Moisture Content and Dry Matter

4.1.5 Maturity Analysis

4.2 Chemical Analysis

4.2.1 pH Analysis

4.2.2 Carbon/Nitrogen Ratio

4.2.3 Macronutrients and Micronutrients
LIST OF TABLES

Table 1: Physical analyses for co-composting of food and green waste (1:1) 36
Table 2: Analysis germination index and growth index after for composted food and green waste 41
Table 3: Typical ranges of test parameters in quality compost of food and green waste 42
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>The initial composition of wastes for co-composting of food and green waste</td>
<td>34</td>
</tr>
<tr>
<td>Figure 2</td>
<td>The compost temperature profile</td>
<td>35</td>
</tr>
<tr>
<td>Figure 3</td>
<td>The moisture content and dry matter in co-composting of food and green waste</td>
<td>37</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Maturity test on composted mixture of food and green waste after 33 days</td>
<td>40</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Organic matter of food and green waste compost</td>
<td>44</td>
</tr>
<tr>
<td>Plate 1: Fresh green wastes delivered by DBKU using covered truck</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>----</td>
<td></td>
</tr>
<tr>
<td>Plate 2: Fresh green wastes delivered by DBKU to the composting site</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Plate 3: Fresh green wastes shredded by a Bandit Brush Machine</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Plates 4&amp;5: Food wastes collected from Demak Laut Catering</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Plates 6&amp;7: Mixture of food and shredded green waste and after manual mixing</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Plates 8&amp;9: Views of the composting centre at Sejingkat, Kuching</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Plate 10: A Bandit Brush Machine</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Plate 11: Close view of the Bandit Brush Machine</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Plate 12: A simple shredder is also using to shred matured compost</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Plates 13, 14, 15&amp;16: The turning process of compost pile</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Plates 17&amp;18: Measurement of temperature during composting period</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Plates 19&amp;20: Weighing method of the green and food wastes</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Plates 21: The sample was air dried for a few days at room temperature</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Plates 22: Bagged compost, sieved using 2mm sieve</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Plate 23a.: The samples in the crucible clay before oven-dried</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Plate 23b.: Close view of sample in the crucible clay before oven dried</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Plate 24: A furnace was used to measure organic matter</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Plate 25: The compost samples were placed on a shaker at room temperature for 24 hours prior to pH measurement</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Plate 26: The measurement of pH of the samples using a pH meter</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>
Plate 27: Growth and germination of green bean and sawi seeds on control 38
Plate 28: Growth and germination of green bean and sawi seeds at 20% 38
Plate 29: Growth and germination of green bean and sawi seeds at 40% 38
Plate 30: Growth and germination of green bean and sawi seeds at 60% 39
Plate 31: Growth and germination of green bean and sawi seeds at 80% 39
Plate 32: Growth and germination of green bean and sawi seeds at 100% 39
Plate 33&34: Co-composting of food and green waste produce leachate 57
Plates 35,36,37&38: Co-composting of food and green waste as a medium 58

for mushroom growth
ABSTRACT
Co-composting of food and green waste is considered as the best alternative for enhancing seeds growth and germination. The composting materials obtained food waste (chicken, fish, vegetables, fruits and kitchen wastes) and green waste (shredded fresh leaves, barks and twigs). Turned windrow system was chosen due to its simplicity. The composting materials reached matured stage after 33 days of composting period. The data on physical analyses (composition of wastes, temperature, fresh weight, moisture content, dry matter and maturity analysis) and chemical analyses (pH analysis, micro and macronutrients analyses) was carried out. The results showed that the extracted diluted compost in 40%, 60%, 80% and 100% of concentration can perform greater growth and germination of green bean and sawi seeds. The best performance of growth and germination is showed in 40% of extracted compost. Compost produced has a pH in range 7.0 to 8.0. The fresh weight is reduced more than a third or almost a half of the fresh weight of the composting pile. Compost is found environmental friendly and to be beneficial in enhancing and as a promoter to the seeds growth.

Keywords: Co-composting, food wastes, green waste, physical analyses, chemical analyses, seeds growth, promoter.

ABSTRAK

Kata kunci: Pengkomposan, sisa makanan, sisa hijau, analisa fizikal, analisa kimia, pertumbuhan biji benih, penggalak
CHAPTER ONE
INTRODUCTION

1.1 General Background

Composting is the biological decomposition of organic constituents of wastes under
controlled conditions. The term "decomposition" is used instead of "stabilization", because when
applied to a practical usage, the process is rarely carried on to the point at which the waste is
completely stabilized. The term "biological" distinguishes composting from other types of
decomposition, such as chemical or physical. Organic is applicable because, with few exceptions,
only the organic portion of wastes is subject to biological breakdown. A very important term in the
definition of composting is "controlled". It is the application of control that distinguishes
composting from the natural rotting, putrefaction or other decomposition that takes place in an open
dump, a sanitary landfill, in a manure heap, or in an open field (Marshill, 2003).

Since composting is a microbially mediated process, providing the proper environmental
conditions for microbes to decompose raw organic materials is crucial for success. The three most
important factors for making good compost are the chemical makeup of the raw ingredients or
feedstocks (quality and quantity of carbon and minerals, pH), the physical size and shape of the
feedstocks and the porosity of the pile, and the population of organisms involved in the composting
process (macrofauna and mesofauna; micororganisms including bacteria, actinomycetes, fungi).
Compost "happens" either aerobically or anaerobically when organic materials are mixed and piled
together. Aerobic composting is the most efficient form of decomposition and produces finished
compost in the shortest time. Microbes break down organic compounds to obtain energy to carry on life processes. Under aerobic conditions, the "heat" generated in composting is a by-product of biologic "burning," or aerobic oxidation of organic matter to carbon dioxide. If the proper amounts of food (carbon), water, and air are provided, aerobic organisms will dominate the compost pile and decompose the raw organic materials most efficiently. Optimal conditions for rapid, aerobic composting include carbon-nitrogen (C:N) ratio of combined feedstocks between 25:1 and 35:1, moisture content between 45% and 60% by weight, available oxygen concentration greater than 5%, feedstock particle size no greater than 1 inch, bulk density less than 1,000 pounds per cubic yard, and pH between 5.5 and 8.5 (Cooperband, 2000).

The supply of carbon relative to nitrogen (C:N ratio) determines whether net mineralization or immobilization of nitrogen will occur. Mineralization is conversion of organic nitrogen to mineral forms (i.e., ammonium and nitrate); immobilization is incorporation of nitrogen into microbial biomass. As a general rule, if the C:N ratio is greater than 20:1, microbes will immobilize nitrogen into their biomass. If C:N is less than 20:1, nitrogen can be lost to the atmosphere as ammonia gas, causing odor. In general, green materials have lower C:N ratios than woody materials or dead leaves do, and animal wastes are more nitrogen rich than plant wastes are. The complexity of the carbon compounds also affects the rate at which organic wastes are broken down. Fruit and vegetable wastes are easily degraded because they contain mostly sugars and starches. In contrast, leaves, stems, nutshells, bark, and tree limbs and branches decompose more slowly because they contain cellulose, hemicellulose, and lignin.
Mesofauna such as mites, sowbugs, worms, springtails, ants, nematodes, and beetles do most of the initial mechanical breakdown of organic materials into smaller particles. Mesophilic bacteria, fungi, actinomycetes, and protozoa (microbes that function at temperature between 10°C and 45°C) initiate the composting process, and as temperature increases as a result of oxidation of carbon compounds, thermophiles (microorganisms that function at temperature between 45°C and 70°C) take over. Temperature in a compost pile typically follows a pattern of rapid increase to 49°C to 60°C within 24 to 72 hours of pile formation and is maintained for several weeks. This is the active phase of composting, in which easily degradable compounds and oxygen are consumed, pathogens (e.g., Escherichia coli, Staphlococcus aureus, Bacillus subtilis, Clostridium botulinum) and weed seeds are killed, and phytotoxins (organic compounds toxic to plants) are eliminated. During the thermophilic, active composting phase, oxygen must be replenished by mixing, forced aeration, or turning of the compost pile (Cooperband, 2000).

1.2 Sarawak Scenario

In Sarawak, waste management is handled by authorized organizations. In Kuching, there are divided into two regions, known as Dewan Bandaraya Kuching Utara (DBKU) and Majlis Bandaraya Kuching Selatan (MBKS), which has the responsibility to handle north and south area, respectively. However, the waste management is under a privatization scheme. The contractors involved in waste management is centralized under one organization, the Trinieken Sdn Bhd. This is a large organization and plays the role to train these contractors to manage wastes wisely and provides them with a better technology to make sure the management is done professionally and
efficiently. DBKU also plays a role to maintain the quality of waste management in Kuching, with the initiative to reduce the quantity of waste by promoting a recycle campaign.

1.3 Objectives of Composting

Composting is the biological conversion of organic wastes under controlled conditions into a hygienic, humus-rich, relatively biostable product that improves land and fertilizes plants. The process and the product of composting is thus defined by the many objectives it achieves together, not independently (Mathur, 1991). For example, organic wastes can be biostabilized by desiccation and sanitized by irradiation, but neither will produce humus or concentrate plant nutrients. Similarly, combined applications of available plant nutrients and organic wastes to land will neither sanitize the wastes nor achieve their potential for generating humus, as the leachable nutrients may not remain with the organic wastes for long. Potentials for humus production and nutrient conservation are not fulfilled when nutrient-rich wastes such as farmyard manure (FYM) are stockpiled to rot under uncontrolled conditions. The resulting product is not mature compost (Levi-Minzi et al., 1986; Rynk, 1992).

Aerobic biodegradation of certain wastes alone, e.g. bark or sawdust, may generate enough heat to sanitize the waste but will not produce the nutrient-rich compost that fertilizes plants. In contrast, compost has the combined capacities for nourishing crops and adding humus to soils, without threatening the life or health of plants and animals. Composting achieve these capacities through the completion of many biological and physico-chemical processes during biotransformation of the wastes (Mathur, 1991). Without completion of all the processes, the compost remains immature.
1.4 Importance of Composting

Traditionally, gardeners have created their own compost using leaves, grass, shrub clippings and other useful organic materials found in the garden. Applying compost to soils provides an excellent conditioner and mulch, which fertilizes and provides soil structure, retains moisture and can restrict weed growth. Man-made compost is an alternative to the peat-based compost extracted from important natural wildlife sites. Besides, compost returns organic matter to the soil in a usable form. Organic matter in the soil plant growth by: stimulating the growth of beneficial microorganism, loosening heavy clay soils to allow better root penetration, improving the capacity to hold water and nutrients particularly in sandy soils and adding essential nutrients to any soil. Healthy plants help clean air, conserve soil, and beautify landscapes.

In recent years there has been interest in the creation of garden compost from organic household waste, as a result of the growing awareness of the environmental problems created by the traditional disposal methods.
CHAPTER TWO

LITERATURE REVIEW

2.1 Waste Management

Management of the increasing quantities of solid waste is a global environmental issue due to the increasing amount and the currently inadequate management system. In general, there is a glaring lack of organization and planning in waste management due to the insufficient information about regulations and due to financial restrictions in many developing countries as in Malaysia.

The major components of solid waste in Malaysia are food and organic waste. Food and organic waste are suitable substrates for composting. Because of the economic conditions that encourage agricultural activities in Malaysia, it is thought that composting will gain importance due to its potential benefits such as improving organic fertilizer handling and enhancing soil fertility. Composts, because of its high concentration of organic matter, are a valuable soil amendment and are used to provide nutrients for plants. When applied into the soil, composts promote proper balance between air and water; helps to reduce soil erosion and serves as fertilizer (EPA, 1995).

The main advantage of composting is that most type of organic wastes can be processed without the need for costly pretreatment prior to its usage. The recent increase in need of composting can be attributed to several factors, including increasing landfill-tipping fees, decreasing landfill capacity and increasingly restrictive measures imposed by regulatory agencies (EPA, 1995). At the same time, composting offers attractive benefits to the food industry, agriculture, and environment. Food service and food processing industries can benefit
economically by the lower disposal fee charged by the composting facilities or the lower cost of operating an on-site or off-site composting operation than the fee charged by commercial waste haulers. Composting also can improve operation's public relations by showing the public their concern for the environment. On the economic side, revenue can be generated for composting operations through the sale of the finished product. For example, Upper Valley Recycling in U.K sold the finished product for $22 to $25/ton to vineyard growers, local residents, and nurseries (Block and Glen, 2000).

Furthermore, solid waste management is one of the three major environmental problems faced by municipalities in Malaysia (World Bank 1993). The amount generated will continue to increase, not only with increases in population and economic activities, but also in terms of per capita generation rate. Together with increasing industrialization and modernization, the types of solid wastes produced are becoming more complex and the sources are becoming increasingly more diverse.

Despite the massive amount and complexity of waste produced, the standards of waste management in the country are still poor (Nasir et al. 1995a). These include outdated and poor documentation of waste generation rates and its composition, inefficient storage and collection systems, co disposal of municipal wastes with toxic and hazardous waste, indiscriminate disposal or dumping of wastes and inefficient utilization of disposal site space.

Most municipalities in Malaysia are facing the problem of getting new disposal sites as most of the existing disposal sites are nearly exhausted. In 1990, out of the 230 waste disposal sites available, 80% of them have a remaining operating lifetime of less than 2 years (Matsufuji & Sinha 1990). Thus, waste managers should be flexible to accept new ideas and technologies, particularly
programmes of waste reduction and recycling in their waste management plans, so as to conserve disposal space and resources.

2.2 Composting of Food Waste

Organic materials generated by commercial facilities, such as hotels, supermarkets, food processors and restaurants have the potential for generating large amounts of food, soiled and waxed cardboard, and paper. In a supermarket, for example, organic residuals composed 75 to 90% of the total waste stream (Ligon and Garland, 1998). Food waste represents approximately 50 to 65 percent of the weight and volume, respectively, of the solid waste generated in commercial and noncommercial food service operations (Byers et al., 1997). If other organics were included, the quantity of waste that could be composted would be even higher.

Food residue has unique characteristics that require special consideration when used as a feedstock for composting. Due to its high moisture content and low physical structure, food waste must be mixed with a bulking agent that will absorb some of the excess moisture and provide structure to the matrix (Risse and Faucette, 2000). This process is referred to as co-composting. The EPA (1995) defined co-composting as "the composting of two or more feed stocks with different characteristics, for example, the co-composting of biosolids in liquid/dewatered form with yard trimmings and leaves". It was reported that most food waste compost programs mix other organic materials, such as sawdust, wood chips, yard trimmings, or manure, with food wastes to
produce high quality compost. Yard trimming is the most frequently used bulking agent added to food waste compost, followed by wood chips and sawdust (USEPA, 1998).

2.3 Composting of Green Waste

According to Colliver et al (1999), green waste is identified as garden waste, which includes grass clippings, leaves, weeds, pruning of trees and shrubs. It may also include some forestry waste such as bark and sawdust. Green waste such as leaf litter is natural mulch. Mulch is a layer of leaf litter or other organic material placed or formed over a soil surface. Compost is the best form of mulch achieved by recycling required amounts of suitable organic materials under the right condition.

In this country, there are numerous raw 'wastes' from the agricultural sectors - which are potentially polluting to the environment, in the absence of proper disposal techniques - which can be composted, either to produce a product (compost) or as an alternative disposal treatment. Oil palm residues for example are rich in fatty materials, which is an immediate source of energy for microorganisms to initiate a composting effect. Other than left-overs from the harvesting and oil extraction processes, the fronds and leaves when shredded can be composted. In this manner, disposal of oil-palm wastes is no longer an immediate problem and the compost produced can be sold through the set-up of proper marketing channels. Other possible materials include sago processing wastes and residues from the timber industry (sawdust, wood shaving, tree bark, etc.). Composting of molasses from brewing industries, fungal mycelium from antibiotic production
For this project, the use of garden clippings, grass cutting and organic waste generally from the trimmings of ornamental plants planted and trimmed by DBKU will be used as the major component of the green waste. The fresh green wastes are collected by (DBKU), generally from the trimmings of these ornamental plants. These feedstocks were then sent to the composting site situated at Lot 22, Blok 7 Muara Tebas Land District (MTLD), Sejingkat that has an area of 2,496 hectares.

2.4 The Composting Process

Composting of organic wastes is an environmentally sound means of diverting organic waste from landfills and producing valuable soil amendments. Composting is a microbial mediated process that requires a specific set of chemical and physical conditions. Compost can be produced on a variety of levels ranging from home composting to large commercial operations. Compost can be used in agriculture, horticulture, and silviculture production, as well as landscaping, home gardens, and remediation of contaminated sites. States and municipalities could adopt goals for reducing or eliminating organic waste land filling so that composting becomes more widespread and more economically viable. In addition, Malaysia could develop federal guidelines for compost quality standards to maximize beneficial use of finished compost.

The three most important factors for making good compost are the:
chemical makeup of the raw ingredients or feed stocks (quality and quantity of carbon and minerals, pH)

- physical size and shape of the feed stocks and the porosity of the pile

- population of organisms involved in the composting process (macro fauna and mesofauna; microorganisms including bacteria, actinomycetes, fungi) (Cooperband, 2000).

2.5 Factors Affecting the Composting Process

2.5.1 Carbon-to-Nitrogen (C: N) Ratio

While an important relationship to remember for aerobic bacteria nutrition is the carbon-to-nitrogen the C:N ratio of the food source, its significance in composting toilets is often overstated. Microorganisms require digestible carbon as an energy source for growth, and nitrogen and other nutrients, such as phosphorous and potassium, for protein synthesis to build cell walls and other structures. When measured on a dry weight basis, an optimum C:N ration for aerobic bacteria is 25:1.

Primarily due to the high nitrogen (from urea, creatine, ammonia, etc.) content and low carbon (glucose) content of urine (0:8:1), human urine has a low C: N ratio. Therefore, if the objective is to oxidize all of the nitrogen urinated into the toilet; this would require adding digestible carbonaceous materials on a regular basis. However, the practical fact is that urine, which contains most of the nitrogen, settles by gravity to the bottom of the composter, where it is drained