Evaluation of Effective Microorganisms on Small Scale Food Waste Composting

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Introduction: Malaysia produced around 16,500 t/d of food waste that make up half of the 33,000 t/d municipal solid waste (MSW) generated. Most of the MSW end up in landfill. Landfill is the main source of greenhouse gases emission, notably the methane gas (CH_4). Among the waste processing mode, on-site composting have the least carbon emission and recommended to avoid pollutants emitted from landfill and transportation during waste collection. Small scale food waste composting at home can produce good quality of compost without unpleasant odours when handled adequately (Barrena et.al 2014; Lleó et al., 2013). The effectiveness of Effective Microorganisms (EM) (Higa, 1991), a commercial microbial inoculant (MI), in enhancing the composting process was widely reported however was lack of scientific evidence. There were studies reported that the addition of EM was not essential as the composting processes with and without EM performed equally well (Nair and Okamitsu, 2010). It is likely that the effectiveness of EM is highly depending on the composting materials and conditions during the process. In this study, the composting parameters and product characteristics including temperature, pH, C:N ratio, enzymatic assays, germination index, humic acid contents and nutrient contents were evaluated and compared with and without the addition of EM.

Materials and Methods: Composting of 4 kg feedstocks consisted 50% simulated kitchen waste (Hafid et al., 2010), 25% dried leaves and 25% rice bran was carried out in plastic bins for two months. Controlled turning was conducted manually once in a week. The dried leaves collected from Universiti Teknologi Malaysia, Skudai Johor was autoclaved at 121 ^{o}C, 15 min before mixed with the kitchen waste and rice bran. To compare the effectiveness, the feedstocks were treated separately with around 1.2 L of activated EM and Water. The moisture content was maintained between 40-60%. Temperature was determined daily using thermometer at a 50% depth of compost pile at three points. Odour performance was examined weekly by smelling. Simple random sampling method (FAO, 2000) was used where five sub-samples with a total weight of 50-70 g was selected. The pH values were indicated using SI Analytics Handylab 680FK. For C: N ratio, it was firstly dried at 60 ^{o}C, grinded and analyzed using CHNS/O elemental analyzer (Elementar vario MARCO cube CHNS, Germany). Humic acid was determined using CDFA method (Lamar and Talbot, 2009) and Fourier Transform Infrared Spectroscopy (FTIR). Four enzymatic assays, amylase (Mishra and Behera, 2008), cellulose (Ghose, 1987), protease (Cupp-Enyard, 2008), and lipase activity (Margesin *et al*., 2002) were determined weekly. The correlation among the parameters was determined using Person correlation coefficient to measure the strength of a linear association between two variables. The week 8 compost was tested for germination index. The nutrient content including total nitrogen (TN), soluble potassium (K_2O) and soluble phosphate (P_2O_5) were determined using Spectroquant® test kits (MERCK, Germany).

Results and Discussions: In general, all the measured parameters illustrated a similar trend of changes indicating the progression of decomposition process. The enzymatic activities of both treatments showed analogous changes and no significant different can be found. The structure of humic acid was gradually dominated by aromatic structure from aliphatic during the composting process. The compost with EM contained higher percentage of humic acid (4.8%) and with a sharper peak of aromatic C=C bond presenting a better degree of humification (Wei et al., 2007). Based on the examined parameters, significant differences were observed for temperature profile and odour, between the composting process with and without the use of EM. The feedstock treated with EM reached a higher temperature (50 ^{o}C) and creating thermophilic temperature in more than 3 consecutive days that was important to destroy pathogen. Besides, the composting process carried out with EM did not produce pungent smell but earthy smell two week earlier than the control (water). No significant difference was identified on the characteristics of the week 8 compost including pH (~7), C: N (<14), colour (dark brown), odour (earthy smell) and germination index (>100%) as all indicating good level of maturity. Overall, the nutrient content in both composts was within the recommended range. By comparison, compost with EM was found to contain more nitrogen (3.63%) but the phosphate and potassium content was nearly equal to the control. Based on the correlation among the assessed parameters, C: N ratio was correlated significantly with pH (-0.9406), amylase (0.9477) and cellulase activity (0.9853). This proposed that C: N ratio is a more fitting factor for determining compost maturity compared to other monitored parameter.

Conclusion: Composting of kitchen wastes carried out with and without the addition of EM showed similar performance and produced well matured composts within the two months duration. However, the study revealed that EM assists to achieve a higher temperature during the first two weeks of composting without foul odour compared to the control. Compost added with EM showed higher nitrogen content and enhanced the degree of humification. In addition, the findings suggested that C: N ratio is a good parameter for monitoring the composting process as it shows positive correlation for pH and negative correlation for amylase and cellulase activity.

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