BIOREACTOR CO-COMPOSTING OF SEWAGE SLUDGE AND RESTAURANT WASTE

By

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DEDICATION

My beloved wife, Nur Azanah bte Abdullah @ Azanah bt Oleh
Thanks for your invaluable love, patience, understanding and support

My beloved father & mother
Who provided the opportunities & with your blessing and do’a

Teachers
For your advice and guidance

Friends
Thank you for the support and help
Composting is an environmental-friendly method to tackle the disposal problem of sewage sludges and municipal solid waste. With appropriate nutrients, porosity, density and moisture content during composting, pathogens such as *Salmonella typhi*, *Escherichia coli* etc. will be destroyed and the organic matter will be stabilized producing a compost product that can contribute directly to soil fertility and conditioning. Composting process system has been modernized from the heap or windrow system to the reactor system, which is a comparatively fast process. A 200 liters rotating drum bioreactor/composter was designed, fabricated and used in this co-composting study. This bioreactor was designed in Universiti Putra Malaysia and was fabricated by Amsea Environment Sdn. Bhd. Three different types of dewatered sewage sludges, i.e. septic tank, oxidation pond and activated
sewage sludges were successfully co-composted with municipal solid waste in a two-stage process.

The physicochemical and biological characteristics of these municipal solid waste (restaurant waste) and sewage sludges were measured before being used as raw materials for the co-composting process. For the bioreactor composting, the raw materials were fermented for 7 days inside the 200 liters bioreactor before being matured outside the bioreactor in a windrow pile until fully matured and ready to be used. A 2:1 (w/w) ratio of municipal solid waste and sewage sludge was found to give the best initial C/N ratio for the composting process. The carbon content decreased and the nitrogen content increased towards the end of the composting process, which resulted in the reduction of C/N ratio during the composting process to below 20. The low C/N ratio of the final compost product was very important as the indicator of compost maturity and stability. The breakdown of organic materials inside the bioreactor did not increase the temperature to the thermophilic range (50-60°C), where breakdown of organic matter by microorganisms is at the optimum rate. In order to overcome the temperature problem, heated air was supplied to the bioreactor, increasing the temperature of the composting process. Shredded garden waste was added as bulking agent. Bioreactor co-composting took around 40-45 days to produce matured compost. The characteristics of the sewage sludge compost products were almost similar compared to commercial compost
available in the local market and also complied with the United States Environmental Protection Agency (USEPA) standard. By using bioreactor system the compost products were improved based on nutrient contents and duration of composting process. The planting out performance of spinach with the research compost showed satisfactory results.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENGKOMPOSAN BERSAMA ENAPCEMAR KUMBAHAN DAN SISA PEPEJAL MAJLIS PERBANDARAN MENGGUNAKAN BIOREAktor

Oleh

ABDUL RAHMAN BIN ABDUL RAZAK

Jun 2003

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Pengkomposan merupakan kaedah mesra alam bagi mengatasi masalah pelupusan enapcemar kumbahan daan sisa pepejal majlis perbandaran. Dengan kandungan nutrien, keporosan, ketumpatan dan kandungan lembapan yang sesuai semasa proses pengkomposan, mikrob yang berbahaya seperti Salmonella typhi, Escherichia coli dan sebagainya akan dimusnahkan dan bahan organik akan distabil menghasilkan produk kompos yang boleh menyumbang kepada kesuburan tanah. Sistem bagi proses pengkomposan telah dimodenkan dari sistem “windrow” atau timbunan longgokan/batasan kepada sistem reaktor yang terbukti satu proses yang lebih pantas. Dalam kajian ini, sebuah bioreaktor/komposter jenis drum berputar bersaiz 200 liter telah direka dan dibina bagi digunakan didalam penyelidikan pengkomposan bersama ini. Bioreaktor ini telah direka bentuk

kepada jual termofilik (50-60ºC) dimana penguraian bahan organik oleh mikroorganisma berlaku pada kadar yang optima. Bagi mengatasi masalah suhu, udara panas telah dibekalkan ke dalam bioreaktor yang berjaya meningkatkan suhu semasa proses pengkomposan. Sisa serpihan tanaman/kayu telah ditambah sebagai agen pempukal. Pengkomposan bersama menggunakan bioreaktor mengambil masa sekitar 40-45 hari bagi menghasilkan kompos yang matang. Ciri-ciri akhir produk kompos enapcemar kumbahan dan sisa pepejal majlis perbandaran adalah hampir sama berbanding dengan kompos komersil yang ada dipasaran tempatan dan juga menepati piawaian Agensi Perlindungan Alam Sekitar Amerika Syarikat (USEPA). Dengan menggunakan sistem bioreaktor, produk kompos dapat diperbaiki berdasarkan kepada kandungan nutrien dan jangkamasa proses pengkomposan. Ujian tanaman pokok bayam bagi mengukur kualiti hasil produk kompos yang terhasil menunjukkan keputusan yang memuaskan.
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I certify that an Examination Committee met on 28th June 2004 to conduct the final examination of Abdul Rahman bin Abdul Razak on his Master of Science thesis entitled “Bioreactor Co-Composting of Sewage Sludge and Restaurant Waste” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

ABDUL RAHMAN BIN ABDUL RAZAK

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