UNIVERSITI PUTRA MALAYSIA

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MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA

2010

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By

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Thesis Submitted to the School Of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master Science

September 2010

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master Science

COMPOSTING OF EMPTY FRUIT BUNCHES BY MICROBIAL INOCULAR

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YEOH CHUI YEN

September 2010

Chair: Ir. Chin Nyuk Ling, PhD

Faculty: Engineering

The increment of palm oil production increases its by-product wastes such as the empty fruit bunch (EFB) and palm oil mill effluent (POME). To recycle the wastes, large-scale windrow composting system is established. However, the duration of compost production from two months to one-year is not compatible to the daily output of the palm oil mill wastes. Thus, accelerating of EFB composting by using inoculums, urea and a smaller substrate size were investigated. Parameters such as moisture content, temperature, pH, electrical conductivity and turning frequency were used to monitor the composting process of EFB and POME. The carbon-nitrogen ratio, UV-vis spectrophotometer test, microorganisms enumeration and germination test were used to assess the maturity of compost.

Two pilot scale tests were conducted in an industrial compost plant. The first pilot scale test aims to verify the effectiveness of inoculums and urea addition in 30 tonne of EFB compost piles. Four heaps of EFB with different treatments *i.e.* addition of 0.03%, 0.3% of commercial inocular, 200 kg urea, and control without any additives were investigated. The result disclosed that the 0.03% of inocular had positively affected the composting performance by decreasing the C/N ratio to 15.04 compared to the control, which had the final C/N of 21.39. The EFB heap with addition of urea also had its C/N decreased to 15.62, thus urea may be a second option for accelerating the composting process.

In the second pilot scale trial, four heaps of composts were used. Daily turning was done on a heap containing commercial inocular, a heap added with laboratory inocular consisting 15 types of functional microbes and the control heap. Another heap with the laboratory inocular was scheduled turning once in every two days. This trial revealed that the moisture loss and degradation rate were not significantly different between composts with different turning frequencies. With similar decreasing rate of the C/N ratio and microbes population, the laboratory and commercial inoculars were found similar in assisting composting. Both the inoculars have an enhancing effect on the EFB composting as the C/N of both inoculated composts dropped below 20 at 14 days earlier than control.

In the third trial, three composts of 20 kg of EFB each were evaluated for the time efficiency of laboratory inocular in smaller particle size of substrate. Composts with

4 cm and 2 cm particle sizes of EFB were inoculated, and a control with 4 cm fibres was without inocular. The C/N of inoculated composts with 2 cm fibres dropped to 18.31, whereas the control was 20.65. The UV-vis ratio of the 2 cm fibre became constant earlier than the control by at least 3 weeks. Observations on the germination test and microbe enumeration suggested that 2 cm inoculated compost matured earlier, *i.e.* in 35 days compared to the 4 cm fibre at 49 days and the control not mature even at 60 days. In conclusion, the laboratory inoculars can be useful in speeding up the composting process of EFB, particularly for those with smaller substrate sizes. (499)

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PROSES KOMPOS TANDAN BUAH KELAPA SAWIT DENGAN PENAMBAHAN MICROB

Oleh

YEOH CHUI YEN

September 2010

Pengerusi: Ir. Chin Nyuk Ling,PhD

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Minyak kelapa sawit merupakan komoditi pertanian yang utama di Malaysia. Peningkatan hasil minyak kelapa sawit menyebabkan pertambahan bahan buangannya seperti tandan buah kosong (EFB) dan air sisa kilang kelapa sawit (POME). Untuk mengitar semula bahan buangan itu, sistem kompos yang berskala besar telah dibina. Walaubagaimanapun, tempoh masa untuk menghasilkan baja kompos antara dua bulan hingga setahun tidak sesuai dengan bahan buangan yang dihasilkan setiap hari. Oleh itu, keupayaan mempercepatkan proses kompos EFB dengan menggunakan inokulam, urea dan bahan yang bersaiz kecil telah diuji. Parameter seperti kandungan air, suhu, pH, pengaliran elektik and kekerapan pusingan digunakan untuk memantau proses kompos EFB. Nisbah karbon kepada nitrogen, UV-vis ujian spektrometer, pengiraan mikroorganisma dan ujian percambahan telah diguna untuk menentukan kematangan kompos.

Dua ujian berskala loji pandu dilakukan di kilang perusahaan kompos. Skala loji pandu yang pertama bertujuan memastikan keberkesanan penambahan inokulam dan urea ke dalam 30 tonne timbunan kompos EFB. Empat longgok EFB dengan rawatan yang berlainan i.e penambahan 0.03%, 0.3% inokulum komersial, 200 kg urea, dan kawalan yang tanpa bahan tambahan. Keputusan menunjukan bahawa penambahan 0.03% inokulum mempunyai kesan yang positif ke atas prestasi proses kompos dengan menurunnya nisbah C/N kepada 15.04 berbanding dengan kawalan yang mempunyai nisbah C/N terakhir 21.39. Longgokan EFB yang ditambah urea juga mempunyai C/N yang berkurang kepada 15.62, maka urea mungkin dijadikan pilihan kedua untuk mempercepatkan proses kompos.

Semasa menjalankan ujian kedua yang berskala loji pandu, empat longgok kompos digunakan. Longgohan yang dipusing setiap hari adalah longgohan yang mengandungi inokulam komersil, longgokan dengan pertambahan inokulam makmal yang mengandungi 15 jenis mikrob yang berfungsi dan longgokan kawalan. Longgokan yang lagi satu yang mengandungi inokulam makmal dijadualkan untuk dipusingkan sekali dalam setiap dua hari. Ujian ini menunjukan bahawa tiada perbezaan bagi kehilangan air dan kadar reput antara kompos yang mempunyai kekerapan pusingan yang berlainan adalah tiada perbezaan. Dengan kesamaan kadar penurunan nisbah C/N dan populasi mikrob, inokulam makmal dan inokulam komersil didapati sama dalam membantu proses kompos. Kedua-dua inokulam mempunyai kesan mempercepatkan proses kompos EFB kerana C/N bagi kedua-dua kompos berinokulasi berkurang sehingga bawah 20 dalam 14 hari lebih awal daripada kawalan.

Dalam ujian ketiga, tiga kompos yang terdiri dari 20 kg EFB setiap satu telah dikaji keberkesanan masa untuk inokulam makmal dalam saiz bahan yang lebih kecil. Kompos dengan saiz EFBnya 4 cm dan 2 cm ditambah dengan inokulam, dan kawalan yang mempunyai saiz serabut 4 cm adalah tanpa inokulam. C/N bagi kompos berinokulasi dengan saiz serabutnya 2 cm bekurang kepada 18.31, manakala kawalan mempunyai C/N 20.65. Nisbah UV-vis bagi kompos yang mempunyai saiz serabut 2 cm menjadi tetap lebih awal daripada kawalan sekurang-kurangnya 21 hari. Pemerhatian ke atas ujian percambahan dan pengiraan mikrob mencadangkan bahawa kompos berinokulasi yang bersaiz 2 cm matang lebih awal, *i.e*, dalam 35 hari berbanding dengan kompos yang mempunyai saiz serabut 4 cm pada 49 dari dan kawalan pada 60 hari. Kesimpulannya, inokulam makmal boleh digunakan untuk mempercepatkan proses kompos EFB, terutamanya bagi bahan yang bersaiz lebih kecil. (485)

ACKNOWLEDGEMENTS

Throughout the project, I was fortunate to have the support and expertise of the project supervisors, course-mates, UPM staff, family and friends. It meant a great deal to me. It was also indispensable in allowing me to create this resource for understanding the challenges of composting palm oil wastes. The supervisors contributed insight and knowledge from their own fields, consulted on highly specialized part of research, provided laboratory space, reviewed drafts, and earned my deep gratitude. Members included Ir. Dr. Chin Nyuk Ling, Dr. Farah Saleena Taip and Dr. Ing. Mohd Noriznan Mokhtar. It all started with Ir. Jason Ooi and Dr. Tan Chong Seng, who brought us together in the field of composting research. They provided useful materials for this research. They also offered thoughtful reviews of the proposal and the manuscript. Thank you to Graduate School of UPM, for being involved in organizing the research supplemental courses that assure the postgraduates worked to the effective technical research skills. Library of Universiti Putra Malaysia provided rigorous international databases, scientific publication on many facets of composting research. The knowledgeable staff of UPM provided training that led to greater clarity of particular experiment. I thank my family and friends for their supports and patience. My friends Sam Foo, Cindy Yeap and Christy Wong had contributed to grammar correction of thesis. As this project is a combination of composting researches synthesis and my experimental efforts, I benefited greatly from the commitment of many scientists I have not met. I developed a renewed and deeper appreciation for the challenges involve in developing the issue topic.

I certify that an Examination Committee has met on 23rd September 2010 to conduct the final examination of YEOH CHUI YEN on her thesis entitled "Composting of Empty Fruit Bunches by Microbial Inicular" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master Science.

The members of the supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

YEOH CHUI YEN

Date: 23 September 2010

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