

**PRODUCTION OF POLY-L-LACTIC ACID FROM L-LACTIC ACID  
ISOLATED FROM KITCHEN WASTE FERMENTED USING  
*ENTEROCOCCUS GALLINARUM* EB1**

**By**

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**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
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Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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ISOLATED FROM KITCHEN WASTE FERMENTED USING  
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**March, 2006**

**Chairman: Professor Mohd. Ali Hassan, PhD**

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Lactic acid (LA) has potential applications in the chemical and biodegradable plastics industries. The L-form LA monomer can be polymerized to polylactate, a degradable polymer with potential to substitute certain environmentally recalcitrant plastics. In the previous work, a local bacterial strain, *Enterococcus gallinarum* EB1 was found to be a good L-lactic acid producer, with kitchen waste as the substrate. The fermentation of treated kitchen waste contained a mixture of organic acids with mainly lactic acid. The objectives of this study are, i) to produce, recover and purify L-lactic acid from treated kitchen waste by *E. gallinarum* EB1, and, ii) to produce poly-L-lactic acid (PLLA) from purified L-lactic acid. The fermentation was carried out in 90 L fermenter with a working volume of 60 L. The bacterium converted saccharified kitchen waste into organic acids with mainly lactic acid. The highest lactic acid concentration produced was 59 g/L, with an optical purity of L-lactic acid of 84%. The yield based on total sugar was 0.98 g LA/ g total sugar and the productivity was 0.308 g/L.h. In the recovery process, the concentrated broth was esterified in order to produce butyl lactate. The ester was then subjected to pre-

distillation and distillation for further purification of butyl lactate. After the separation and purification by distillation, the purity of butyl lactate increased from 40% to 98%. Butanol and lactic acid were produced by hydrolysis of the purified butyl lactate. The purity of lactic acid was 99.6% after hydrolysis. The purified lactic acid was then subjected to dehydration and oligomerization process in order to produce lactide. This lactide contains *meso*-, D- and L-lactide. Therefore, L-lactide was further purified using toluene in order to achieve 100% purity. Finally, poly-L-lactide (PLLA) was produced from L-lactide by ring-opening polymerization. The molecular weight ( $M_w$ ) of PLLA obtained from this polymerization was 6, 192 g/mol.

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

**PENGHASILAN POLI-L-LAKTAT DARIPADA L-ASID LAKTIK  
DIHASILKAN DARIPADA PROSES FERMENTASI DENGAN  
MENGUNAKAN RAWATAN SISA DAPUR DENGAN *ENTEROCOCCUS  
GALLINARUM* EB1**

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Asid laktik mempunyai potensi aplikasi dalam industri kimia dan polimer. Monomer L-asid laktik boleh dipolimersasikan ke poli-(laktat), iaitu polimer yang boleh diuraikan dengan potensi menggantikan plastik diperbuat daripada petrol kimia. Dalam hasil kaji yang sebelum, bakteria tempatan, *Enterococcus gallinarum* EB1 telah didapati mempunyai potensi untuk menghasilkan L-asid laktik dengan baik, dengan menggunakan sisa dapur rawatan sebagai substrak. Tujuan dalam penyelidikan ini ialah, i) untuk mengasing, memperoleh dan menuliskan L-asid laktik daripada sisa dapur yang terawat secara anaerobik, dan, ii) untuk menghasilkan poli(laktik) asid daripada L-asid laktik yang tulen. Fermentasi telah dijalankan dengan menggunakan 90 L fermenter dengan 60 L isipadu berfungsi. Bakteria ini boleh menukarkan sisa dapur rawatan kepada asid organik dengan utamanya asid laktik. Kepekatan asid laktik yang tertinggi dihasilkan ialah 59 g/L. Purata optikal L-asid laktik ialah 84%. Penghasilan asid laktik berdasar pada jumlah gula ialah 0.98 g asid laktik/g jumlah gula manakala kadar penghasilan asid laktik

ialah 0.308 g/L.h. Dalam proses perolehan, sup fermentasi telah dipisahkan untuk dijalankan proses esterifikasi supaya mendapatkan butyl laktat. Pra-penyulingan dan penyulingan ester telah dijalankan untuk memperoleh butyl laktat yang tulen. Selepas pengasingan dan penulenan dengan menggunakan penyulingan proses, ketulenan butyl laktat telah meningkat dari 40% ke 98%. Butanol dan asid laktik telah diasingkan dalam proses hidrolisis. Ketulenan asid laktik telah mencapai 99.6% selepas hidrolisis. Asid laktik yang tulen telah diteruskan ke proses oligomerisasi supaya mendapatkan laktide. Laktide yang dihasilkan mengandungi komponen *meso*-, D-, dan L-laktide. Oleh itu, penulenan menggunakan toluene telah dijalankan untuk mendapat L-laktide dengan ketulenan 100%. Selepas menjalankan proses pembukaan jaringan polimer, PLLA telah dapat dihasilkan dari L-laktide tulen dengan berat molekul (Mw) PLLA 6, 192 g/mol.

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I certify that an Examination Committee has met on 7<sup>th</sup> March 2006 to conduct the final examination of Ooi Kim Yng on her Master of Science thesis entitled “Production of Poly-L-Lactic Acid from L-Lactic Acid Isolated from Kitchen Waste Fermented using *Enterococcus gallinarum* EB1” 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 acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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**OOI KIM YNG**

Date:

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