UNIVERSITI PUTRA MALAYSIA

PREPARATION AND CHARACTERIZATION OF BIODEGRADABLE POLY(LACTIC ACID)/TAPIOCA STARCH COMPOSITES

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PREPARATION AND CHARACTERIZATION OF BIODEGRADABLE POLY(LACTIC ACID)/TAPIOCA STARCH COMPOSITES

By

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Thesis Submitted to the School of Graduates Studies
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Abstract of thesis to the Senate of Universiti Putra Malaysia in Fulfilment of requirement for the degree of Master of Science

PREPARATION AND CHARACTERIZATION OF BIODEGRADABLE POLY(LACTIC ACID)/TAPIOCA STARCH COMPOSITES

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Chairman: Nor Azowa Ibrahim, PhD

Faculty: Science

Biodegradable composites of poly(lactic acid) (PLA) and dried tapioca starch were prepared by using melt blending technique with a Haake mixer at 100/0, 90/10, 80/20, 70/30, 60/40 and 50/50 blend ratios. The study on the effect of adding of 1, 3, 5, 8 and 10 wt.% triacetin on the properties of 70/30 PLA/starch was also investigated in order to study the plasticization effect of the triacetin. The mechanical and thermal properties of composites were investigated by using Instron Universal Testing Machine, Fourier Transform Infrared Spectroscopy (FTIR), Differential Scanning Calorimetry (DSC), and Thermogravimetry Analysis (TGA). The morphology of the composites were analysed by Scanning Electron Microscopy (SEM). The tensile strength of PLA/starch composites decreased with the increased of the starch loading. The tensile modulus and the elongation at break results reveal that the composites are stiff and brittle. However, addition of triacetin to the 70/30 PLA/starch composites improve the flexibility of the composites, indicating by the increase in tensile strength and elongation at break at 5

and 8 wt.% respectively. The FTIR spectra of composites showed that there is shifting to lower wavenumber (1750 to 1748 cm^{-1}) for C=O indicating that some interaction occurs between PLA/starch composites with addition of triacetin. The starting decomposition temperature was shifted to lower values as starch and plasticizer were increased in the composites. The glass transition temperature (T_g), cold crystallization temperature (T_{cc}) and melting point (T_m) of the PLA/starch composites were shifted to lower temperature with the increasing amount of plasticizer. The micrographs show the PLA phase becoming discontinuous as the starch loading increases. The addition of triacetin improves interfacial adhesion between PLA and starch and the composites become more homogenous. The dependence of water uptake on the absorption characteristics of PLA/starch composites was evaluated by immersion in distilled water with respect to starch and triacetin loading. Water absorption increased with increasing of starch loading due to the hyrdophilicity nature of starch. The composites with addition of triacetin give significant change on the water absorption with the increase in the amount of plasticizer. The biodegradability of composites was evaluated by the soil-burial test in 3 months. The rate of degradation increased with the increased amount of starch.

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

PENYEDIAAN DAN PENCIRIAN KOMPOSIT TERBIODEGRASI DARI POLI(LAKTIK ASID)/KANJI UBI KAYU

Oleh

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Komposit terbiodegrasi daripada poli(laktik asid) (PLA) dan kanji ubi kayu telah disediakan melalui adunan lebur menggunakan pencampur Haake pada nisbah 100/0, 90/10, 80/20, 70/30, 60/40 dan 50/50. Untuk mengkaji kesan pemplastik, penambahan 1, 3, 5, 8 dan 10 peratus berat triasetin kepada komposit 70/30 PLA/kanji turut dilakukan. Sifat mekanikal dan terma komposit telah dikaji dengan menggunakan mesin ujian universal Instron, spektroskopi infra merah penjelmaan fourier (FTIR), kalorimetri pengimbasan pembezaan (DSC) dan analisis thermogravimetri. Morfologi komposit telah dikaji menggunakan mikroskop imbasan elektron (SEM). Sifat tegangan untuk komposit PLA/kanji menurun apabila kanji semakin banyak dalam sesuatu komposit. Keputusan ujian modulus tensil dan pemanjangan takat putus menunjukkan komposit yang dihasilkan keras dan rapuh. Sebaliknya, dengan penambahan triasetin pada komposit nisbah 70/30 PLA/kanji, peningkatan kelenturan komposit dilihat melalui kekuatan regangan dan pemanjangan takat putus masing-masing pada 5 dan 8 wt.%.

Sepktrum FTIR mendapati bahawa terdapat anjakan puncak ke nombor gelombang lebih rendah (1750 kepada 1748 cm^{-1}) berlaku pada kumpulan berfungsi C=O yang menunjukkan berlaku sedikit interaksi antara PLA dan kanji dengan penambahan triasetin. Suhu permulaan penguraian telah bertukar ke nilai yang lebih rendah jika kanji dan pemplastik ditingkatkan pada komposit. Suhu peralihan kaca (T_g), suhu penghabluran sejuk (T_{cc}) dan takat lebur (T_m) komposit PLA/kanji beralih kepada suhu yang lebih rendah apabila sukatan pemplastik kedalam komposit semakin meningkat. Mikrograf menunjukkan fasa PLA menjadi tidak berterusan apabila peningkatan kanji kedalam komposit. Dengan penambahan triasetin, komposit PLA/kanji memberikan perekatan antara-muka yang baik dan komposit menjadi lebih homogen. Pengambilan air melalui proses serapan oleh komposit PLA/kanji dilakukan dengan merendam komposit didalam air suling mengikut penambahan nisbah kanji dan triasetin pada adunan komposit. Kajian menunjukkan serapan air meningkat dengan penambahan amaun kanji yang dipengaruhi oleh sifat hidrofilik kanji yang semulajadi. Penambahan triasetin kepada komposit memberikan kesan ketara kepda ujian serapan air. Biodegradasi komposit pula telah dinilai melalui penanaman di dalam tanah selama tiga bulan. Kadar biodegradasi meningkat dengan penambahan amaun kanji.

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I certify that an Examination Committee has met on **2010** to conduct the final examination of Mohd Khairulniza Bin Mansor on his Master of Science thesis entitled "**Preparation and Characterization of Biodegradable Poly(Lactic Acid)/Tapioca Starch Composites**" 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 are as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of Supervisory Committee were 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 and is not concurrently submitted for any other degree at Universiti Putra Malaysia or any other institutions.

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MOHD KHAIRULNIZA MANSOR

Date: 16 August 2010

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