ISOLATION AND CHARACTERIZATION OF NANOCELLULOSE FROM EMPTY FRUIT BUNCH FIBER FOR NANOCOMPOSITE APPLICATION

NURUL SAADIAH BINTI LANI

UNIVERSITI TEKNOLOGI MALAYSIA

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NURUL SAADIAH BINTI LANI

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To my wonderful families especially to my beloved mother and father

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ABSTRACT

Nowadays, the demands for plastics materials are increasing rapidly. Nevertheless, most of these products are non-environmentally friendly and non-biodegradable. About 60 to 100 million gallons of petroleum are needed to produce plastics every year around the world. Therefore, there has been growing interest in developing bio–based products that can offer favorable environmental advantages. The purpose of this study is to isolate nanocellulose from empty fruit bunch (EFB) fiber and to investigate reinforcing effect of nanocellulose in poly(vinyl alcohol) (PVA)/starch blend films. The optimization of acid hydrolysis conditions for nanocellulose yield with response surface methodology (RSM) was also investigated. Cellulose and nanocellulose fibers were successfully extracted by using alkali treatment and acid hydrolysis, respectively. Subsequently, a series of PVA/starch film with different content of nanocellulose were prepared by solution casting method. The isolated nanocellulose displayed a relatively high crystallinity, which were around 73% that consisted of rod like nanoparticles with the diameter of 4 to 15 nm. Analysis of the RSM result revealed that high nanocellulose yield (83.42%) was obtained when the sulfuric acid concentration, hydrolysis time and reaction temperature were set at 58 wt%, 43 minutes and 35 °C, respectively. PVA/starch films reinforced with nanocellulose fiber possessed significantly improved properties compared to the film without reinforcement. From the results, PVA/starch films with the addition of 5% (v/v) of nanocellulose suspension exhibited the best combination of properties. This nanocomposite was found to have tensile strength about 5.694 MPa and the elongation at break about 481.85%. In addition, this nanocomposite had good water resistance (19.71%) and biodegradability (47.73%). It can be concluded that the nanocellulose obtained in this study can be an excellent reinforcing material in PVA/starch blend film.

ABSTRAK

Pada masa kini, permintaan untuk bahan plastik semakin meningkat dengan pantas. Walau bagaimanapun, kebanyakan produk ini tidak mesra alam dan tidak terurai. Kira–kira 60 hingga 100 juta gelen petroleum diperlukan untuk membuat plastik setiap tahun di seluruh dunia. Justeru itu, terdapat minat yang semakin meningkat dalam membangunkan penggunaan produk berasaskan bio yang mempunyai kebaikan untuk alam sekitar. Tujuan kajian ini adalah untuk mengasingkan nano selulosa dari serat tandan buah kosong dan mengkaji kesan pengukuhan mereka dalam filem polivinil alkohol (PVA)/kanji. Pengoptimuman keadaan hidrolisis asid untuk menghasilkan nano selulosa dengan menggunakan kaedah gerak balas permukaan (RSM) juga dilakukan. Serat selulosa dan nano selulosa telah berjaya diekstrak dengan menggunakan rawatan alkali dan hidrolisis asid. Selepas itu, satu siri filem PVA/kanji dengan kandungan nano selulosa yang berbeza disediakan dengan menggunakan kaedah tuangan larutan. Nano selulosa yang telah diasingkan meunujukkan penghabluran yang secara relatifnya tinggi, iaitu kira-kira 73% dan mempunyai bentuk seperti rod dengan diameter dari 4 hingga 15 nm. Analisis keputusan RSM mendedahkan bahawa hasil nano selulosa (83.42%) adalah tinggi apabila kepekatan asid sulfurik, masa hidrolisis dan suhu tindak balas diletak masing-masing pada 58 wt%, 43 minit dan 35 °C. Filem PVA/kanji yang diperkukuhkan dengan gentian nano selulosa mempunyai ciri-ciri penambahbaikan yang ketara berbanding filem tanpa pengukuh. Daripada keputusan, filem PVA/kanji dengan tambahan 5% (v/v) ampaian nano selulosa meunujukkan kombinasi ciri-ciri yang terbaik. Nano komposit ini didapati mempunyai kekuatan tegangan pada kira-kira 5.694 MPa dan pemanjangan pada takat putus adalah 481.85%. Sebagai tambahan, nano komposit ini mempunyai rintangan air (19.71%) dan biodegradasi (47.73%) yang baik. Kesimpulannya, nano selulosa yang diperoleh dalam kajian ini boleh menjadi bahan pengukuh yang sangat baik untuk filem adunan PVA/kanji.