INTISARI

PEMBUATAN FILM ANTIBAKTERI NANOKOMPOSIT PERAK-KITOSAN DENGAN REDUKTOR GLUKOSA DAN AKSELERATOR NATRIUM HIDROKSIDA

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Telah dikaji pembuatan nanokomposit perak-kitosan yang ramah lingkungan menggunakan reduktor glukosa dan akselerator NaOH. Penelitian ini mengembangkan strategi baru pada pembuatan perak-kitosan nanokomposit yaitu melalui fase gel. Gel nanokomposit perak-kitosan ditransformasi menjadi koloidal dengan melarutkan ke dalam larutan kitosan dan selanjutnya diubah menjadi film dengan teknik *casting* pada suhu ruang. Sifat mekanik film ditingkatkan melalui penggunaan *plasticizer* gliserol. Kajian terhadap kestabilan koloidal dan film bertujuan untuk mengetahui kemungkinan arah aplikasinya. Gejala *localized surface plasmon resonance* (LSPR) nanopartikel perak pada koloidal dan film nanokomposit diselidiki menggunakan spektrofotometer UV-Vis. Bentuk dan ukuran perak nanopartikel dianalisis menggunakan TEM. Karakterisasi film meliputi LSPR (spektrofotometer UV-Vis), gugus fungsi (spektrofotometer FTIR), kristalinitas (XRD), sifat termal (DTA/TGA), morfologi film (SEM), sifat mekanik, *swelling*, WVP dan *leaching* partikel perak (AAS). Uji aktivitas film meliputi biodegradabilitas film dengan metode pemendaman dan aktivitas antibakteri film terhadap bakteri *E.coli* isolat klinis dan ATCC 25922, *S.aureus* isolat klinis dan ATCC 259213, MRSA dan ESBL dengan metode difusi cakram.

Terbentuknya perak nanopartikel pada pembuatan nanokomposit perak-kitosan koloidal melalui fase gel ditandai oleh munculnya puncak serapan LSPR pada 402,4 - 414,5 nm dan berdasar citra TEM partikel berbentuk bulat. Kondisi optimal pembentukan perak nanopartikel ditinjau dari jumlah dan ukuran partikel diperoleh pada penggunaan NaOH 5 mmol/25 mL larutan kitosan 1% (v/v) dengan rasio molar glukosa/$AgNO_3$ adalah 6:1 dan waktu reaksi 30 menit. Jumlah perak nanopartikel berbanding lurus dengan konsentrasi $AgNO_3$. Nanokomposit koloidal stabil selama penyimpanana 16 pekan pertama. Keberadaan perak nanopartikel meningkatkan kapasitas *swelling*, menurunkan WVP dan sifat mekanik pada film nanokomposit perak-kitosan. Penambahan *plasticizer* gliserol meningkatkan kapasitas *swelling* dan WVP serta memperbaiki sifat mekanik film nanokomposit perak-kitosan. Aktivitas antibakteri film nanokomposit perak-kitosan meningkat seiring dengan meningkatnya jumlah ion perak yang terdesolusi. Film nanokomposit perak-kitosan mudah teroksidasi selama penyimpanan di udara tetapi bersifat reversibel (dapat direduksi ulang). Berdasarkan kajian kestabilan, sifat fisik, mekanik dan aktivitasnya, maka film nanokomposit perak-kitosan berpotensi digunakan sebagai material *wound dressing* antibakteri untuk aplikasi medis.

Kata kunci: film, kitosan, perak, nanopartikel, nanokomposit, glukosa

ABSTRACT

PREPARATION OF ANTIBACTERIAL NANOCOMPOSITE SILVER-CHITOSAN FILMS USING GLUCOSE AS REDUCING AGENT AND SODIUM HYDROXIDE AS ACCELERATOR

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An environmentally friendly silver-chitosan nanocomposites preparation using glucose as reducing agent and NaOH as accelerator has been studied. It develops a new strategy on preparation of silver-chitosan nanocomposites through the gel phase. Silver-chitosan gels were transformed to colloidal nanocomposites by dissolution to chitosan solution and then converted into films by casting techniques at ambient temperature. The mechanical properties of the films were improved through the addition of glycerol as plasticizer. Study on stability of the colloidals and the films aims to determine possible perspective application. Localized surface plasmon resonance (LSPR) phenomenon of silver nanoparticles on colloidal nanocomposites and films were investigated using UV-Vis spectrophotometer. The shape and size of silver particles were analyzed using TEM. Characterization of the films included LSPR (UV-Vis spectrophotometer), functional groups (FTIR spektrophotometer), crystallinity (XRD), thermal properties (DTA/TGA), morphology (SEM), mechanical properties, swelling, WVP and leaching of silver particles (AAS). The biodegradability of films was tested using the burial method, while antibacterial activity of the films against E. coli clinical isolates, E. coli ATCC 25922, S. aureus clinical isolates, S. aureus ATCC 259213, MRSA and ESBL was tested by disc diffusion method.

The silver nanoparticles in colloidal silver-chitosan nanocomposite prepared through the gel phase were identified by the appearance of LSPR absorption peak at 402.4 to 414.5 nm and spherical shape based on TEM images. Based on the number and size of the particles, optimal conditions of silver nanoparticles formation obtained at NaOH of 5 mmol/25 mL solution of chitosan 1% (v/v) with a molar ratio of glucose to $AgNO_3$ is 6:1 and reaction time of 30 minutes. The amount of silver nanoparticles is directly proportional to the concentration of $AgNO_3$. All colloidal nanocomposites were stable up to the first 16 weeks of storage at ambient temperature. The existence of silver nanoparticles increases the swelling capacity and decreases WVP and mechanical properties of the chitosan-silver nanocomposite films. The addition of glycerol plasticizer increases swelling capacity and WVP and improves the mechanical properties of the silver-chitosan nanocomposite films. The antibacterial activity of silver-chitosan nanocomposite films increases with the number of silver ions. Silver-chitosan nanocomposite films were easily oxidized during storage in the air but the oxidized silver can be readily reduced again. Based on the study of the stability, physical properties, mechanical and activities, the silver-chitosan nanocomposite films can be used potentially as an antibacterial wound dressing material for medical applications.

Keywords: film, chitosan, silver, nanoparticles, nanocomposite, glucose