NANOPARTIKEL ALGINAT–KITOSAN SEBAGAI ADSORBEN ION LOGAM Ag(I) DAN UJI AKTIVITASNYA TERHADAP BAKTERI *ESCHERICHIA COLI DAN STAPHYLOCOCCUS AUREUS*

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INTISARI

Penelitian tentang adsorpsi ion logam Ag(I) dengan nanopartikel alginat–kitosan dan uji aktivitasnya terhadap bakteri *Escherichia coli* dan *Staphylococcus aureus* telah dilakukan. Penelitian ini bertujuan untuk membuat nanopartikel alginat–kitosan untuk mengadsorp ion logam Ag(I), mempelajari kinetika adsorpsi dan isoterm adsorpsi, kemudian dilakukan uji antibakteri kepada nanopartikel alginat–kitosan sebelum dan setelah adsorpsi.

Penelitian ini dilakukan dengan metode mikroemulsi menggunakan pengikat silang natrium tripolifosfat dan kalsium klorida. Nanopartikel alginat–kitosan dikarakterisasi menggunakan FTIR, SEM-EDX, dan TEM. Kajian adsorpsi Ag(I) dilakukan dengan metode *batch* melalui penentuan kondisi optimum untuk parameter pH, massa adsorben, waktu kontak, dan konsentrasi awal ion logam. Nanopartikel alginat–kitosan dan hasil adsorpsi kemudian diuji aktivitasnya terhadap bakteri Gram negatif berupa *Escherichia coli* dan Gram positif berupa *Staphylococcus aureus* melalui metode difusi sumuran.

Hasil dari penelitian ini adalah nanopartikel alginat–kitosan yang telah berhasil disintesis dengan wujud serbuk padatan kasar dan berwarna putih gading, serta terbukti melalui spektra FTIR. Citra SEM menunjukkan bahwa material nanopartikel tersebut berpori dan setelah proses adsorpsi menunjukkan adanya unsur C, N, O, Ca, dan Ag yang ditunjukkan dari spektra EDX. Citra TEM menunjukkan rata-rata ukuran nanopartikel adalah sebesar 8,31 nm. Kondisi optimum adsorpsi Ag(I) oleh nanopartikel alginat–kitosan didapatkan pada pH 6, massa adsorben 0,07 g, waktu kontak selama 120 menit dan konsentrasi awal ion logam 14 mg L^{-1}. Studi kinetika adsorpsi Ag(I) oleh nanopartikel alginat–kitosan mengikuti orde kedua-semu (Ho–McKay) dengan konstanta laju adsorpsi 1,92 g mg^{-1} $menit^{-1}$. Studi isoterm adsorpsi Ag(I) oleh nanopartikel alginat–kitosan mengikuti model isoterm Dubinin-Radushkevich dengan energi bebas sebesar 1,581 kJ mol^{-1}. Nanopartikel lginat–kitosan setelah adsorpsi Ag(I) memiliki sifat bakteriostatik yang memberikan efek penghambatan pertumbuhan bakteri. Nanopartikel alginat–kitosan setelah adsorpsi Ag(I) memiliki aktivitas penghambatan pertumbuhan yang lebih baik pada bakteri Gram negatif *Escherichia coli* dengan diameter zona hambal parsial 15,3 mm daripada Gram positif *Staphylococcus aureus* dengan diameter zona hambat parsial 3,65 mm.

Kata kunci: adsorpsi, alginat, antibakteri, Ag(I), kitosan

ALGINATE–CHITOSAN NANOPARTICLES AS AN Ag(I) METAL ION ADSORBENT AND ITS ACTIVITY TESTS ON *ESCHERICHIA COLI AND STAPHYLOCOCCUS AUREUS* BACTERIA

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ABSTRACT

The adsorption research of Ag(I) metals ions on Alginate–chitosan nanoparticles and its activity test against bacteria have been carried out. This research aimed to synthesize Alginate–chitosan nanoparticles as an adsorbent for Ag(I) metal, analyze the kinetics and adsorption isotherm, then analyze the activity against *Escherichia coli* and *Staphylococcus aureus* bacteria.

This research was carried out by microemulsion method using sodium tripolyphosphate and calcium chloride as crosslinkers. The nanoparticles were characterized using FTIR, SEM, and TEM characterization. The adsorption study of Ag(I) was carried out by batch method by determining the optimum conditions for the parameters of pH, adsorbent mass, contact time, and initial concentration of metal ions. The alginate–chitosan nanoparticles and the adsorption results were tested for their activity against *Escherichia coli* and *Staphylococcus aureus* through the well-diffusion method.

The results showed that alginate–chitosan nanoparticles had been successfully synthesized by producing nanoparticle material in coarsesolid powder and ivory white. The FTIR spectra were confirmed as the Alginate–chitosan nanoparticles. The SEM image shows a porous nanoparticlematerial and, after the adsorption process, shows C, N, O, Ca, and Ag elements based on EDX spectra. The TEM image shows an average nanoparticle size of 8.31 nm. The optimum conditions for Ag(I) adsorption by Alginate–chitosan nanoparticles were obtained at pH 6, adsorbent mass of 0.07 g, contact time at 120 minutes, and initial concentration of metal ions 14 mg L^{-1}. The kinetic study of Ag(I) adsorption by alginate–chitosan nanoparticles followed a pseudo-second-order (Ho–McKay) with an adsorption rate constant of 1.92 g mg^{-1} min^{-1}. The isotherm study of the Ag(I) adsorption by alginate–chitosan nanoparticles followed the Dubinin-Radushkevich isotherm model with a free energy of 1.581 kJ mol^{-1}. Alginate–chitosan-Ag nanoparticles have bacteriostatic properties thathave an inhibitory effect on bacterial growth. Alginate–chitosan-Ag nanoparticles had better growth inhibition activity on Gram-negative *Escherichia coli* with a diameter of 15.3 partial inhibition zone than Gram-positive *Staphylococcus aureus* with a diameter of 3.65 mm partial inhibition zone.

Keywords: adsorption, alginate, antibacterial, chitosan, Ag(I)