BIOSORPTION OF GOLD(III), PALLADIUM(II) AND SILVER(I)
FROM AQUEOUS SOLUTION ONTO LOW–COST DURIO ZIBETHINUS HUSK

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M A H A N I

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ABSTRAK

Biopenjerapan adalah salah satu proses kos-rendah untuk menjerap ion logam berharga daripada larutan akueus. Kajian ini mengkaji biopenjerapan ion emas(III), palladium(II), dan perak(I) dari larutan akueus menggunakan Durio zibethinus husk (DZH) sebagai penjerap biojisim. DZH telah dicirikan dengan menggunakan spektroskopi FT-IR, menunjukkan bahawa ia mempunyai kumpulan hidroksil, karboksil dan fenol yang berupaya untuk menarik ion logam berharga dari larutan akueus. Keupayaan DZH untuk menjerap ion logam berharga itu telah dikaji dengan sistem biopenjerapan kelompok dibawah pelbagai paramater seperti masa sentuh, pH, dos penjerap, kepekatan awal logam dan suhu. Keadaan optimum telah dicapai untuk memberi peratus penjerapan masing-masing sebanyak 98.50, 93.88 dan 67.18 (%) untuk emas(III), palladium(II) dan perak(I), masing-masing. Data eksperimen masing-masing adalah memenuhi model kinetik tertib-kedua-pseudo untuk kedua-dua emas(III) dan palladium(II), dan tertib-pertama-pseudo untuk perak(I). Keputusan eksperimen juga telah dianalisis dengan persamaan isoterma Langmuir, Freundlich dan Dubinin-Reduskevich pada suhu yang berbeza. Data menunjukkan bahawa pejerapan gold(III), palladium(II) dan perak(I) mematuhi isoterma Langmuir dengan penjerapan maksimum yang diperolehi masing-masing adalah sebanyak 500.00, 30.30 and 3.66 mg g⁻¹. Fakta bahawa model Langmuir memenuhi data eksperimen dengan tepat menunjukkan bahawa permukaan DZH adalah homogen. Sifat termodinamik (ΔG°, ΔH° and ΔS°) juga telah dipelajari pada tiga suhu berlainan (30, 40 and 50°C). Nilai negatif ΔH° untuk emas(III) dan perak(I) mengesahkan proses penjerapan semulajadi eksotermik, manakala nilai positif bagi penjerapan palladium(II) menunjukkan sifat endotermik kesemulajadiannya. Tenaga pengaktifan (Ea) biopenjerapan telah dianggarkan dari persamaan Arrhenius adalah didapati sebanyak 15, 70.28 and 31.56 kJ mol⁻¹, masing-masing, dan menunjukkan bahawa semua logam yang dipelajari adalah dikawal oleh mekanisme kimia, memandangkan nilai dari tenaga pengaktifannya adalah lebih dari 4 kJ mol⁻¹. Pengesahan emas(III) yang terjerap telah dilakukan menggunakan mikroskop pengimbasan elektron pancaran medan dan analisis sinar-x sebaran tenaga (FESEM-EDX) menunjukkan bahawa peratus atom emas(III) telah dikenalpasti sebanyak 4.12 (%).
ABSTRACT

Biosorption is one of efficient low-cost process of precious metal ions recovery from aqueous solution. This study investigated the biosorption of gold(III), palladium(II) and silver(I) ions from aqueous solution using *Durio zibethinus* husk (DZH) as a biosorbent. The DZH characterized by FT-IR (Fourier transform infrared) spectroscopy, showed that it has hydroxyl, carboxyl and phenolic groups, which have possibility to adsorb precious metal ions from aqueous solution. The ability of DZH was investigated using batch biosorption system. Several parameters were studied such as contact time, pH, adsorbent dosages, initial metal concentration, and temperature. The optimum conditions were achieved to give the adsorption percentage of 98.50, 93.88 and 67.18 (%) for gold(III), palladium(II) and silver(I), respectively. The experimental data was fitted very well the pseudo-second-order kinetic model for both of gold(III) and palladium(II), and pseudo-first-order kinetic model for silver(I), respectively. Experimental results were also analyzed by the Langmuir, Freundlich and Dubinin-Reduskevich isotherm equations at different temperatures. The results shows that the biosorption of gold(III), palladium(II) and silver was follow Langmuir isotherm model for all temperatures with the maximum biosorption capacity was obtained to be 500.00, 30.30 and 3.66 mg g\(^{-1}\), respectively. The fact that the Langmuir model fits the experimental data very well shows that the surface of DZH was homogeneous. The thermodynamic properties \((\Delta G^\circ, \Delta H^\circ \text{ and } \Delta S^\circ)\) were also studied at three different temperatures (30, 40 and 50°C). Negative value of \(\Delta H^\circ\) for gold(III) and silver(I) confirmed the exothermic nature of adsorption processes, whereas the positive value of palladium(II) adsorption showed endothermic in nature. The activation energy \((E_a)\) of the biosorption of gold(III), palladium(II) and silver(I) were estimated from the Arrhenius equation and found to be 21.15, 70.28 and 31.56 kJ mol\(^{-1}\), respectively, shows that all the metal studied was controlled by chemical mechanism since the value of activation energy more than 4 kJ mol\(^{-1}\). The verification of adsorbed gold(III) on DZH surface was done by Field emission scanning electron microscopy-energy dispersive X-ray (FESEM-EDX), indicating that the atomic percentage of gold was detected by 4.12 (%).