PREPARATION, CHARACTERIZATION AND APPLICATION OF LIGNIN AND LIGNIN ESTERS FROM GMELINA WOOD AS BIOADSORBENT IN THE TREATMENT OF GOLD MINING EFFLUENTS

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A THESIS IN THE DEPARTMENT OF CHEMISTRY, FACULTY OF SCIENCE

SUBMITTED TO

THE POSTGRADUATE SCHOOL, UNIVERSITY OF UYO, UYO, AKWA IBOM STATE, NIGERIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY (PhD) DEGREE IN INDUSTRIAL CHEMISTRY

MARCH 2023

ABSTRACT

Lignin is a non-carbohydrate major component of wood usually released in large quantity as a waste material during wood pulping. In this research, lignin was extracted from *Gmelina arborea* wood using Soda and Kraft pulping processes. It was modified into lignin esters using succinic and maleic anhydride respectively. Lignin, succinylated Kraft lignin (SKL), maleated Kraft lignin (MKL), succinylated Soda lignin (SSL) and maleated Soda lignin (MSL) were characterized using Fourier Transformed Infrared Spectroscopy (FTIR), UV/visible spectrophotometer, Scanning Electron Microscope (SEM), Electrospray Ionization-Mass Spectroscopy (ESI-MS) and potentiometric titration. These bioadsorbents were applied in the adsorption of Pb^{2+} and Cd^{2+} from simulated mining effluent. Effect of contact time (30-150 min), adsorbent dosage (50-250 mg), adsorbate concentration (10 – 50 mg/L), adsorbate pH (2– 6), isotherm and kinetics models of each adsorption process were evaluated. The results were analyzed using independent t-test at $\alpha < 0.05$. The bioadsorbents were also applied in the adsorption of Pb^{2+}, Cd^{2+}, As^{2+}, Au^{2+} and Hg^{2+} from gold mining effluents obtained from Osun State. FTIR results of lignins and their ester derivatives showed a broad absorption band of free hydroxyl group at 3500 – 3000 cm^{-1}. Lignin esters showed a carbonyl peak at 1710 -1703 cm^{-1}. Maleated derivatives showed a carbon – carbon double bond peaks at 1648 – 1630 cm^{-1}. UV/visible spectroscopy results revealed a bathochromic shift and hypochromic effect in Kraft lignin derivatives and hypsochromic shift in Soda lignin derivatives. Hypochromic and hyperchromic effects occurred in SSL and MSL respectively. ESI-MS spectra revealed that lignin monomers were higher in Kraft lignin while dimers were higher in the Soda lignin. The surface morphology of all the bioadsorbents were heterogeneous. Potentiometric titration indicated a surface area ranges from 45.40 – 399.00 m^2/g. In all the adsorption processes, adsorption efficiency increased with increase in adsorbent dosage, contact time and pH, but decreased with increase in the adsorbate concentration. Most of the adsorption processes followed Langmuir isotherm and second order kinetics. Statistical analysis revealed a significant difference in the adsorption efficiency of lignin and its ester derivatives. Also, there was no significant difference in the adsorption in single metal and binary metal systems. However, lignin esters adsorbed over 80% of the heavy metals in simulated effluents and over 60% in the gold mining effluents. The results indicate that lignin which is presently discarded as waste material could be modified into lignin esters and applied as bioadsorbent in the adsorption of heavy metals from gold mining effluent.