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Metal Complexes of Schiff Bases: Preparation, Characterization, and Biological Activity

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Abstract: Metal complexes of Schiff bases derived from 2-furancarboxaldehyde and o-phenylenediamine (L^1), and 2-thiophenecarboxaldehyde and 2-aminothiophenol (HL^2) are reported and characterized based on elemental analyses, IR ^1H NMR, solid reflectance, magnetic moment, molar conductance, and thermal analysis (TGA). The ligand dissociation, as well as the metal-ligand stability constants were calculated, pH-metrically, at 25 °C and ionic strength $\mu = 0.1$ (1 M NaCl). The complexes are found to have the formulae $[M(L^1)(H_2O)_2](Cl)_n$ \cdot yH_2O (where M = Fe(III), Ni(II), Cu(II); n = 2-3, y = 2-4); $[M(L^1)](X)_2$ \cdot yH_2O (where M = Co(II), Zn(II), UO_2(II), X = Cl, AcO or NO_3, y = 1-3); $[M(L^2)_2]$ \cdot yH_2O (where M = Co(II), Ni(II), Cu(II); X = Cl; y = 0-2 and Zn(II); X = AcO, y = 0); and $[Fe(L^2)_2]Cl$ \cdot $2H_2O$ and $[UO_2(HL^2)_2](NO_3)_2$. The molar conductance data reveal that all the metal chelates of the L^1 ligand, and Fe(III) and UO_2(II) chelates of HL^2 are electrolytes, while Co(II), Ni(II), Cu(II), and Zn(II) chelates of HL^2 are non-electrolytes. IR spectra show that L^1 is coordinated to the metal ions in a tetradentate manner, with ONNO donor sites of azomethine--N and furan-O, whereas the HL^2 ligand is coordinated to the metal ions in a terdentate manner with SNS donor sites of azomethine--N, thiophene-S, and thiol-S. From the magnetic and solid reflectance spectra, it is found that the geometrical structures of these complexes are octahedral and tetrahedral. The thermal behavior of these chelates shows that the hydrated complexes lose water molecules of hydration in the first step and is immediately followed by decomposition of the anions and ligand molecules in the subsequent steps. The activation thermodynamic parameters, such as E*, Δ H*, Δ S*, and Δ G*, are calculated from the DrTG curves using the Coats-Redfern method. The synthesized ligands, in comparison to their metal complexes, were also screened for their antibacterial activity against bacterial species, Escherichia coli, Pseudomonas aeruginosa, and Staphylococcus Pyogones, as well as fungi (Candida). The activity data show the metal complexes to be more potent antibacterials than the parent Schiff base ligand against one or more bacterial species.

Key Words: 2-thiophenecarboxaldehyde, 2-furancarboxaldehyde, 2-aminothiophenol, o-phenylenediamine, transition metal complexes, stability constants, IR, ^1H NMR, conductance, solid reflectance, magnetic moment, thermal analysis, biological activity

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