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Synthesis and Characterization of Schiff Bases with Zn(II) and Ni(II) Complexes Derived From Benzaldehyde Derivatives

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Structured Abstract

Background: Schiff base ligands, with a double bond between carbon and nitrogen, are versatile in metal complex synthesis. They have antimicrobial and anticancer activities, finding applications in coordination chemistry and potential uses in medicine and biotechnology.

Methods: OPD and o-vanillin were refluxed in methanol for 5 hours to synthesize the Schiff base ligand. In a one-pot method, o-vanillin, OPD, and metal acetate were mixed in ethanol and refluxed for 6 hours to produce metal complexes (Zn(II) and Ni(II)).The ligand and metal complexes were characterized using melting points, CHNS analyses, FTIR, UV-Vis, and NMR spectroscopy.

Results: The experiment synthesized one ligand and two metal complexes with 68.7%, 73.24%, and 98% yields for Ligands 2, NiL2, and ZnL2. Ligand-metal ion complexation caused color shifts. Due to their size and bonds, metal complexes had higher melting points. Synthesis was confirmed by close agreement between estimated and experimental C, H, and N compositions. The peak for v(C=N) in ligand (L2) was observed at 1612 cm^{-1}, while for NiL2 and ZnL2, it was at 1607.1 cm^{-1} and 1613.23 cm^{-1}, respectively. The shift was due to n-backbonding. Complexes showed lowered v(C-O) frequencies. Metal complexes have new weak absorption bands at 534-584 cm^{-1} and 426-488 cm^{-1}. NMR showed coordination with metal centers. Due to hydrogen bonding, NiL2 had a downfield-shifted phenolic proton (-OH) signal, while ZnL2 did not. ZnL2's azomethine hydrogen peak was less shielded, indicating electronic environment changes upon coordination. Aromatic carbons were found in L2 and ZnL2 at 116-165 ppm. UV-visible spectra showed ligand π-π* and n-π* transitions at 279.90 and 330.38 nm, respectively. ZnL2 and NiL2 showed a red shift in electronic transitions after complexation, indicating weaker bonds. NiL2 had an extra LMCT peak at 485.64 nm, but ZnL2 did not, suggesting an energy gap mismatch between the ligand's HOMO and the metal center's LUMO, resulting in weak or missing LMCT transitions.

Conclusion: In conclusion, one ligand and two metal complexes were synthesized. Melting point, FTIR, NMR, UV-Visible and elemental analyses were characterised.

Keywords: Schiff base, azomethine, metal complexes, condensation method.

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