

Synthesis, physicochemical studies, fluorescence behavior, and anticancer properties of transition metal complexes with the pyridyl ligand

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A novel series of complexes with the formula $[MLCl]$ $[M = Co(II) (1), Ni(II) (2), Cu(II) (3), Zn(II) (4)]$ arising from Pyridyl ligand, N,N' -bis(1-(2-pyridyl)ethylidene)-2,2-dimethylpropane-1,3-diamine), ligand, L, was synthesized and investigated by elemental analyses, FT-IR, 1H and ^{13}C NMR, Powder XRD, and thermal analyses. TGA analysis indicated that all complexes degraded in three different steps, while the PXRD examination showed well-defined sharp crystalline peaks for the complexes, indicating significant crystallinity. The antiproliferative activity of the ligand and its complexes were also evaluated *in vitro* against the HeLa (Human Cervical Cancer Cells) and HCT116 (Colon Cancer Cells) cell lines. The findings suggested complex 4 to be potential anticancer agent against these cell lines. In addition, ligand and its complexes also exhibited considerable emission properties.

Keywords: Pyridyl ligand; metal complexes; anticancer activity.

INTRODUCTION

Schiff base ligands are one of the most prominent nitrogen donor ligands in the field of inorganic chemistry due to their ability to chelate metal ions by donating lone pair of electrons. In addition, Schiff base ligands are easy to synthesize, stable, and adaptable¹⁻⁵. Moreover, the Schiff base complexes are useful in a variety of contexts, including catalysis⁶, photochromism^{7, 8}, nonlinear optics⁹, magnetism¹⁰, coordination chemistry¹¹, and materials science^{12, 13}.

Pyridyl ligands have gained a lot of attention among the various Schiff base ligands used in coordination chemistry because of their effective chelating properties and ability to develop distinct coordination architectures^{12, 13}. The pyridyl functionality also improves electron delocalization and conformational rigidity after coordination to the metal ion, enhancing the luminescent, optical, catalytic, and medicinal properties of the complexes¹⁴⁻¹⁸. Over the years, cis-platin, a platinum-based drug, has been used to treat almost half of all cancer patients¹⁹. However, the use of cisplatin is restricted despite its therapeutic effectiveness in the treatment of cancer because it has serious toxic side effects such as nephrotoxicity, neurotoxicity, hematologic toxicity, and ototoxicity. In addition, cisplatin has poor water solubility and can cause acquired resistance in a variety of cancer types²⁰.

Keeping in mind the benefits and downsides of platinum-based anticancer medications, researchers are therefore seeking for new potential anticancer medicines with high efficacy across a wide spectrum of tumours and low harmful side effects. Nitrogen-containing ligands and their metal complexes have drawn a lot of attention over the years due to their extensive biological applications, particularly when it comes to developing complexes with anticancer properties²¹, which are attributed to electronic interactions between the metal center and the π -electrons in rings²²⁻²³. Therefore, taking into account the properties of nitrogen-containing ligands and their complexes, we study here a novel series of complexes of the first series of transition metal ions obtained from pyridyl ligand¹² and investigate their anticancer activity against HeLa (Human Cervical Cancer Cells) and HCT116 (Colon

Cancer Cells) cancer cell lines. In addition, we have also reported their fluorescence behavior.

EXPERIMENTAL

Materials and methods

All of the chemicals, including 2,2-Dimethyl-1,3-propanediamine, 2-acetylpyridene, were procured from Sigma-Aldrich and utilized exactly as received. FT-IR spectra were collected on a Perkin Elmer 621 infrared spectrophotometer with KBr pallet. 1H - and ^{13}C -NMR spectra in d_6 -DMSO, as well as CHN, were obtained using a JEOL-400 spectrometer and an Elementar Varrio EL analyzer, respectively. The RF-6000 Spectro Fluorophotometer was used to obtain fluorescence spectra in methanol. The Powder XRD analysis with XRD pattern was performed using $Cu K\alpha$ ($\lambda = 1.54059 \text{ \AA}$) radiation on Bruker D2 Phaser X-ray diffractometer.

Synthesis of Pyridyl ligand, (1E,1'E)-N,N'-(2,2-dimethylpropane-1,3-diyl)bis(1-(pyridin-2-yl)ethan-1-imine), L

A methanolic solution of 2,2-Dimethyl-1,3-propanediamine (100 mg, 0.98 mmol) was mixed with 2-acetylpyridene in a 1:2 molar proportion in the same solvent for 10 hours at ambient conditions, yielding crystalline solid after evaporation (Scheme 1). Unfortunately, we were unable to find a suitable crystal for diffraction.

Color, Yellow; Chemical Formula: $C_{19}H_{24}N_4$, Anal. Calc.: C, 73.99; H, 7.84; N, 18.17; Found: C, 73.79; H, 7.79; N, 18.10; 1H NMR (d_6 -DMSO, ppm): 8.58-7.38 (m, Ar-H, 8H), 3.39 (4H, N- CH_2), 2.26 (N=C- CH_3), 1.09 (6H, C- CH_3), ^{13}C -NMR (d_6 -DMSO, ppm): 165.3 (C=N), 148.1–157.0 (Ar-C), 36.5 (N-C- CH_3 - CH_2 -), 24.4 (- CH_3 -C- CH_3), 60.1 (- CH_3 -C- CH_3), IR (KBr, cm^{-1}): 1612

General procedure for the Synthesis of complexes

To the methanolic solution of ligand, L (50 mg, 0.162 mmol) was added metal salt in a 1:1 proportion followed by the vigorous stirring of the reaction mixture for 5 hours. Slight turbidity was obtained which was eliminated by filtration. The transparent and colored