

Synthesis and Biological Evaluation of New Schiff Base Transition Metal Complexes

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Abstract : Schiff Base Complexes Derived From Dfmpm And Glutamic Acid With Co(II), Ni(II) And Cu(II) Were Synthesized And Characterized By IR, UV-Vis, Elemental Analysis, Molar Conductance, Powder Xrd And SEM. The Antimicrobial Activity Of The Synthesized Ligand And Its Complexes Were Screened By Disc Diffusion Method. The Nuclease Activity Of The Ligand And Its Complexes Were Assayed On Lambda- Dna Using Gel Electrophoresis In The Presence Of H₂O₂. The In-Vitro Anticancer Studies Reveal That The Cu(II) Complex Had The Moderate Anticancer Activity Against Ht-29 (Colon Carcinoma) Cell With IC₅₀ Value Of 72.07 μM.

Key Words : Dfmpm, Glutamicacid, Xrd, Sem, Dna Cleavage, Ht-29 (Colon Carcinoma)

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I Introduction

The Chemistry Of The Schiff Base Ligands And Their Metal Complexes Has Expanded Enormously And Encompasses A Vast Area Of Organometallic Compounds And Various Aspects Of Bioinorganic Chemistry. Schiff Base Ligands Are Considered 'Privileged Ligands' Because They Are Mainly Prepared By Condensation Between Aldehydes And Primary Amines[1]. These Ligands Are Able To Coordinate Many Different Metals And To Stabilize Them In Various Oxidation States. They Are Used Also As Pigments And Dyes, Catalysts, Intermediates In Organic Synthesis, And As Polymer Stabilizers. Large Numbers Of Schiff Bases Have Also Been Shown To Exhibit A Broad Properties. Following All These Observations And As A Part Of Our Continuing Research On The Coordination Chemistry Of Multidentate Ligands.

II EXPERIMENTAL

2.1 Synthesis Of Schiff Base Ligand

The Synthesis Of Schiff Base Ligand Was Carried Out By Reported Methods[2]. Ethanolic Solution Of DFMPM And Glutamicacid In KOH Were Taken In RB Flask In 1:2 Molar Ratios And Refluxed For An Hour. The Reaction Mixture Was Poured In Ice, An Yellow Compound Of Schiff Base Ligands Was Obtained. The Precipitated Yellow Compound Was Filtered, Washed With Water And Dried Over Anhydrous Calcium Chloride. The Crude Sample Was Recrystallised From 50% Absolute Alcohol. Yield = 58%, Melting Point = 225°C.

2.2 Synthesis Of Schiff Base Metal Complexes

The Metal Complexes Were Prepared By Adding Ethanolic Solution Of Cu(II) Nitrate, Ni(II) Nitrate And Co(II) Nitrate To The Ligand In Ethanol In 1:1 Molar Ratio And Refluxed For About Twelve Hours At 80°C[2]. The Precipitated Solids Were Filtered, Washed With Ethanol, Diethyl Ether And Hot Water And Finally Dried Under Vacuum At 90°C. Yield = 60 – 64%.

III Results And Discussion

All The Metal Complexes Are Coloured Solids, Stable Towards Air And Have High Melting Points (Above 250°C). The Complexes Are Insoluble In Water And Common Organic Solvents, But Are Soluble In DMF, CdCl₃ And DMSO.

3.1 Elemental Analysis

The Analytical Data Suggest That All The Complexes Are Mono Nuclear With The Ligands Coordinated To The Central Metal Atom. The Metal To Ligand Ratio In All Complexes Was 1:1 And Their Formulae Have Been Computed And Given In Table 1. Conductivities Of Solution Of The

Complexes In DMF Showed That All The Complexes Are Non-Electrolytes Because Their Conductivity Values Were Low. However, The Conductivity Value Is Higher Than Expected For Non-Electrolytes Probably Due To Partial Solvolysis Of Complexes In DMF Medium.

TABLE : 1 PHYSICAL CHARACTERISTICS AND ANALYTICAL DATA OF THE COMPLEXES

Compound	Yield %	Colour	Mol. Formula	Mol.Wt	Melting Point	Elemental Analysis			Molar Conductance $\Omega\text{cm}^2\text{Mol}^{-1}$
						C	H	N	
$\text{C}_{57}\text{H}_{86}\text{N}_2\text{O}_1$	58	Brown	$\text{C}_{57}\text{H}_{86}\text{N}_2\text{O}_{10}$	958	225	71.42 (71.39)	8.70 (8.97)	2.10 (2.92)	-
CoL	60	Purple	$\text{CoC}_{57}\text{H}_{82}\text{N}_2\text{O}_{10}$	1012.93	>250	67.43 (67.52)	8.18 (8.09)	2.54 (2.76)	10
NiL	64	Pale Green	$\text{NiC}_{57}\text{H}_{82}\text{N}_2\text{O}_{10}$	1012.71	>250	67.32 (67.54)	8.90 (8.09)	2.45 (2.76)	12
CuL	64	Green	$\text{CuC}_{57}\text{H}_{84}\text{N}_2\text{O}_{10}$	1019.55	>250	67.67 (67.08)	8.12 (8.23)	2.72 (2.74)	13

3.2 IR Spectra

Selected IR Spectral Bands For The Ligand And Its Complexes Are Given In Table 2. The IR Spectrum Of The Free Ligand Is Characterized Mainly By The Strong Bands At 2925 cm^{-1} , 2855 cm^{-1} , 1690 cm^{-1} , 1595 cm^{-1} And 1452 cm^{-1} Which Are Attributed To The Stretching Frequencies Of C – H, O – C, >C=N (Azomethine), Asym coo^- And Sym coo^- Respectively [2] (Fig. 1). The IR Spectrum Of The Free Ligands Was Compared With The Spectra Of Metal Complexes. The Characterization Absorption Bands 3429 cm^{-1} , 3412 cm^{-1} And 3540 cm^{-1} Range Were Attributed To – OH Group Of The Lattice Water Or The Coordinated Water. The Absorption Bands In The Range 2986 cm^{-1} , 2925 cm^{-1} And 2925 cm^{-1} Were Assigned To C – H Stretching Frequencies. The Absorption Bands In The Range 2885 cm^{-1} , 2885 cm^{-1} And 2854 cm^{-1} Were Assigned To O – C Stretching Frequencies. The Absorption Bands In The Range 1625 cm^{-1} , 1680 cm^{-1} And 1637 cm^{-1} Were Assigned To >C=N Stretching Frequencies. The Imine Peak In The Metal Complexes Showed Change In Shifts Compared To The Ligand Indicating Coordination Of The Imine Nitrogen Atom To The Metal Ion Due To Coordination. The Absorption Bands In The Range 1594 cm^{-1} , 1600 cm^{-1} And 1383 cm^{-1} , 1492 cm^{-1} & 1424 cm^{-1} Were Assigned To Asym coo^- And Sym coo^- Stretching Frequencies. Another Absorption Bands At 700 cm^{-1} , 750 cm^{-1} & 779 cm^{-1} Were Assigned To M – N Bond And 545 cm^{-1} , 474 cm^{-1} & 425 cm^{-1} Were Assigned To M – O Bond [4] (Fig2-4).

TABLE : 2 SELECTED UV AND FTIR FREQUENCIES (Cm^{-1}) OF THE LIGAND AND COMPLEXES

Ligand/Complex	$\nu_{\text{O-H}}$	$\nu_{\text{C-H}}$	$\nu_{\text{O-C}}$	$\nu_{\text{C=N}}$	$\nu_{\text{asy coo-}}$	$\nu_{\text{sym coo-}}$	M-N	M-O	λ_{max} (nm)		
									241	264	324
L		2925	2855	1690	1595	1452			241	264	324
CoL	3429	2986	2885	1625	1594	1383	700	545	234	823	908
NiL	3412	2925	2855	1680	1600	1492	750	474	312	352	1010
CuL	3540	2925	2854	1637	-	1424	779	425	235	238	448

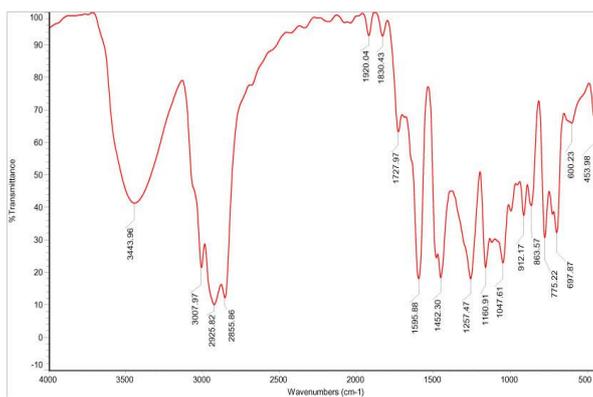


FIG. 1 : FTIR SPECTRUM OF SCHIFF BASE LIGAND

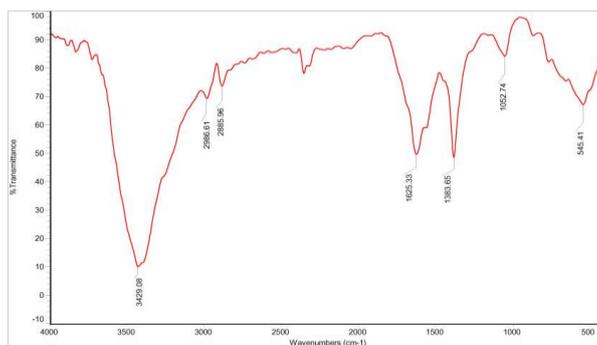


FIG. 2 : FTIR SPECTRUM OF Co(II) COMPLEX

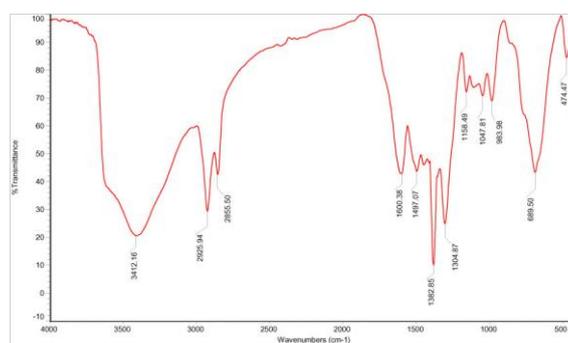


FIG. 3 : FTIR SPECTRUM OF Ni(II) COMPLEX

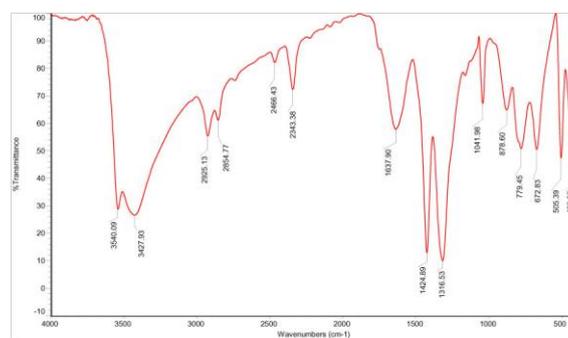


FIG. 4 : FTIR SPECTRUM OF Cu(II) COMPLEX

3.3 Electronic Spectra

The Electronic Spectrum Of Ligand Shows A Broad Band At 241 nm Which Is Assigned To $\pi \rightarrow \pi^*$ Transition Of The Chromophore. In The Octahedral Environment Of The Ligand Fields, D-Orbitals Of The Co(II) Shows $4t_{1g}(F) \rightarrow 4t_{2g}(F)$ With The Absorption Bands At 908nm, Which Is The Characteristic Of Octahedral Geometry. The Electronic Spectrum Of Ni(II) Complex Shows An Intense Band At 352nm. This Corresponds To The Transition $3a_{2g}(F) \rightarrow 3t_{2g}(P)$ (400 – 300 nm), Which Is The Characteristic Of Octahedral Geometry. The Electronic Spectrum Of Cu(II) Complex Shows An Intense Band At 448nm. This Corresponds To The Transition $2b_{1g}(F) \rightarrow 2e_{1g}(P)$ (470 – 450 nm) Which Is The Characteristic Of Tetragonally Distorted Octahedral Environment[3]. Based On The Present Study The Structure Of The Ligand And Complexes May Be Given As Follows (Scheme 1-3)

SCHEME 1 : STRUCTURE SCHIFF BASE

SCHEME 2 : STRUCTURE OF SCHIFF BASE COMPLEXES OF Co(II) OR Ni(II)

SCHEME 3 : STRUCTURE OF SCHIFF BASE COMPLEX OF Cu(II)

3.4 SEM Analysis

Scanning Electron Micrography Is Used To Evaluate Morphology Of The Schiff Base Metal Complexes . The SEM Picture Of Co(II) Complex Is Shown In Fig. 6. From The Fig. 5 Pitted And Rough Surface Is Observed In The Complex. The Particle Size Of The Co(II) Complex Was In The Diameter Range Of Few Microns[4].

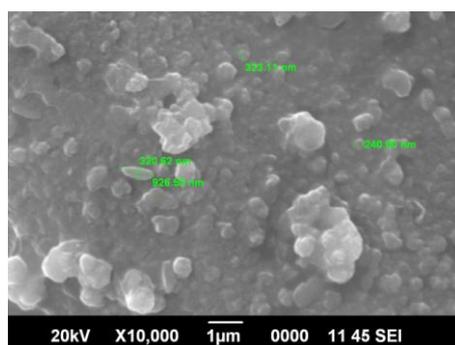


FIG. 5 : SEM IMAGE OF SCHIFF BASE COMPLEX OF Co(II)

3.5 XRD Analysis

The XRD Pattern Of Co(II) Complex Shows Well Defined Crystalline Peaks Indicating That The Samples Are Crystalline In Nature . The Above Complexes Have Specific 'D' Values Which Can Be Used For Its Characterization . The Crystallite Size Of The Complexes D_{xrd} Could Be Estimated From XRD Patterns By The Scherrer's Formula. XRD Shows That Co(II) Complex Has The Average Crystallite Size Of 4.1 Nm Suggesting The Complexes To Be Nano Crystalline (Fig : 7)[4].

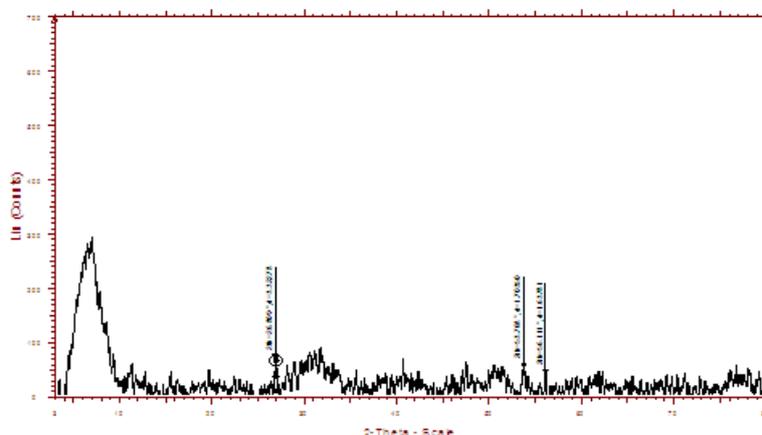


FIG. 6 :XRD SPECTRUM OF Co(II) COMPLEX

3.6 Antimicrobial Study

The Biological Activities Of Synthesized Schiff Base And Its Metal Complexes Have Been Studied For Their Antibacterial And Antifungal Activities By Disc Diffusion Method , And The Stock Solution (0.001 Mol) Was Prepared By Dissolving The Compounds In DMSO And The Antimicrobial Activity Was Estimated Based On The Size Of Inhibition Zone In The Discs [5,6].

Four Bacterial Stains Klebsiella Sps , E.Coli, P.Aeruginosa , S.Aureus Were Incubated For 24h At 37° c And Fungal Stains Candida Sps , Aspergillus Sps Were Incubated For 48h At 37° c.

TABLE : 3 ANTIMICROBIAL ACTIVITY FOR BACTERIA

S.No	Samples	Media	Zone Of Inhibition (Mm)			
			Klebsiella Sps	E.Coli	P.Aeruginosa	S.Aureus
1	C ₅₇ H ₈₆ N ₂ O ₁₀	Mueller Hinton Agar	6.0	6.0	6.0	6.0
2	[Co]		8.0	11.0	6.0	10.0
3	[Ni]		9.0	6.0	6.0	6.0
4	[Cu]		6.0	6.0	10.0	6.0
5	PC (Chloramphenicol)		25.0	26.0	24.0	25.0
6	NC		6.0	6.0	6.0	6.0

TABLE: 4 ANTIMICROBIAL ACTIVITY FOR FUNGI

S.No	Samples	Media	Zone Of Inhibition (Mm)	
			Candida Sps	Aspergillus Sps
1	C ₅₇ H ₈₆ N ₂ O ₁₀	Mueller Hinton Agar	6.0	6.0
2	[Co]		6.0	14.0
3	[Ni]		15.0	6.0
4	[Cu]		6.0	6.0
5	PC (Chloramphenicol)		25	26
6	NC		6	6

The Antimicrobial Activity Results (Table 3 & 4) Reveal That , The Higher The Activity Of The Metal Complexes May Be Owing To The Effect Of Metal Ions On The Normal Cell Membrane. Metal Chelates Bear Polar And Nonpolar Properties Together ; This Makes Them Suitable For Permeation To The Cells And Tissues . In Addition , Chelation May Enhance Or Suppress The Biochemical Potential Of Bioactive Organic Species . Further, Lipophilicity , Which Controls The Rate Of Entry Of Molecules Into The Cell , Is Modified By Coordination , So The Metal Complex Can Become More Active Than The Free Ligand . Therefore , The Metal Complexes

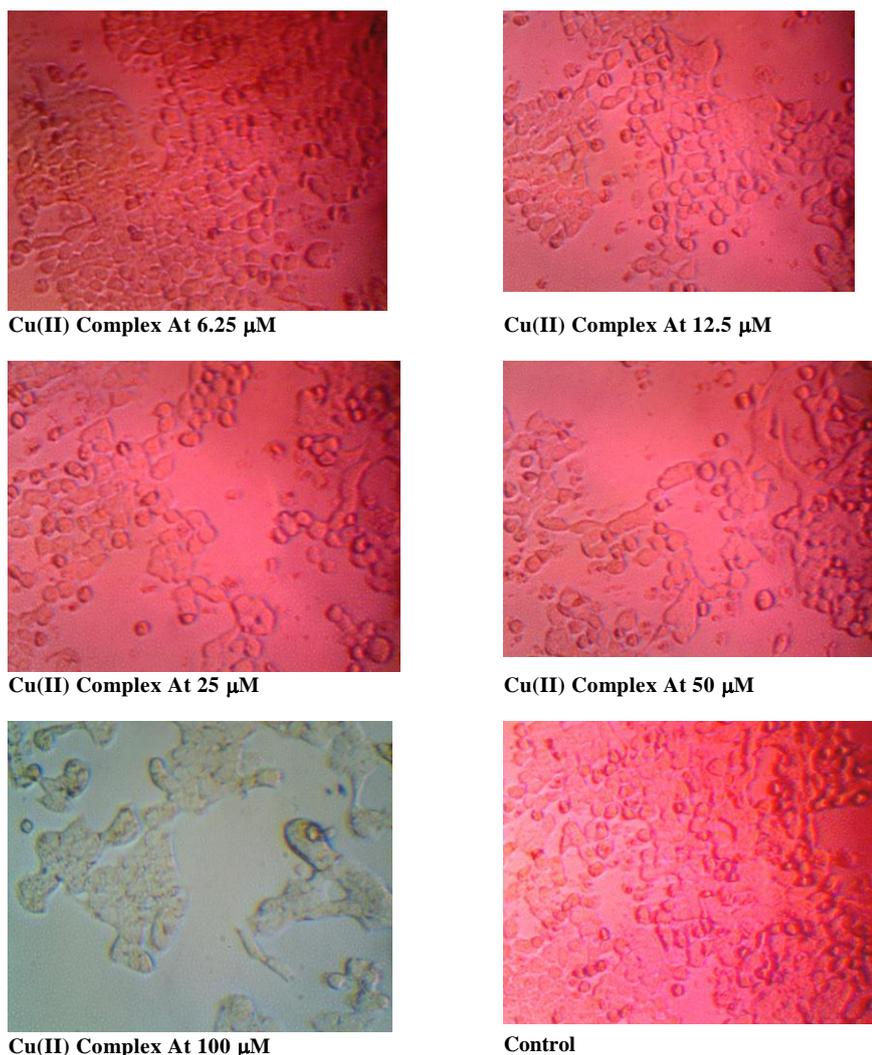


FIG. 8 : MICROSCOPIC OBSERVATION OF ANTICANCER ACTIVITY FOR Cu(II) COMPLEX OF SCHIFF BASE

IV CONCLUSION

Schiff Base Complexes Of Co(II), Ni(II) And Cu(II) With DFMPM And Glutamicacid Were Synthesized And Characterized. The UV-Visible And IR Revealed The Geometry Of The Complexes Of Which Co(II) And Ni(II) Complexes Are Hexa Coordinated. Cu(II) Complexes Is Tetra Coordinated. The Antimicrobial Activity Results Show That The Metal Complexes Were Found To Be More Active Than The Ligand. The DNA Cleavage Activity Of Complexes Is In The Order Co(II) > Cu(II) > Ni (II). The In-Vitro Anticancer Studies Reveal That The Cu(II) Complex Had The Moderate Anticancer Activity Against HT-29 (Colon Carcinoma) Cell With IC₅₀ Value Of 72.07 μ M.

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