

Spectroscopic and Antimicrobial study of Co (II) and Cu (II) Schiff base Metal Complexes

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ABSTRACT: Schiff base ligand N, N' (2 hydroxybenzaldehyde) diamino diphenyl ether [HL] and its Co (II) and Cu (II) metal complexes were synthesized. The ligand and metal complexes were characterized by UV-visible, FTIR and ¹H NMR spectroscopy. The ligand [HL] was synthesized by condensation of 2-hydroxybenzaldehyde and 4, 4'diaminodiphenyl ether. The ligand and metal (II) complexes were also screened for their antimicrobial activity against microorganisms *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

KEYWORDS: Transition metal complexes, 4, 4'diaminodiphenyl ether, Schiff base, and Antibacterial activity.

I. INTRODUCTION

Transition metal complexes with various donor groups have been used in organometallic chemistry [1]. A large number of Schiff base compounds have been synthesized and structurally characterized [2–6]. The various classes of Schiff bases that can be prepared by condensation of different types of amines and carbonyl compounds are very popular due to diverse chelating ability. Several transition metal complexes have been screened for their medicinal properties [7–19].

The Schiff base complexes are important as medicine and show a variety of interesting biological activities such as antibacterial and antifungal activity [20-21]. Transition metal complexes with various donor groups have been used in organometallic chemistry. A large number of Schiff base compounds have been synthesized and structurally characterized [22-23].

The various classes of Schiff bases that can be prepared by condensation of different types of amines and carbonyl compounds are very popular due to diverse chelating ability. Several transition metal complexes have been screened for their medicinal properties. The first row transition metals have attracted much attention due to their biological importance [24]. These factors prompted us to carry out a study on synthesis of Schiff base and its complexes with Co (II) and Cu (II) metal ions.

In this paper we report the synthesis of new Schiff base ligand N, N' (2 hydroxybenzaldehyde) diamino diphenyl ether [HL] and its legation behavior with Co (II) and Cu (II) metals. The synthesized ligand and metal complexes were characterized by elemental analysis, Uv-Visible, FTIR and ¹H NMR. They are also screened for their biological activities against the microorganism *Pseudomonas aeruginosa* and *Staphylococcus aureus*.

II. MATERIALS AND METHODS

All reagents used were pure AR grade such as 2 hydroxybenzaldehyde, 4, 4'diaminodiphenyl ether, Nickel chloride and Zinc chloride. The solvents used were ethanol and Dichloromethane. The synthesis of Schiff base ligand and metal complexes is shown in Scheme 1.

The 2 hydroxybenzaldehyde (4.88 g, 0.2 mol) and 4, 4'diaminodiphenyl ether (4.0 g, 0.1mol) were dissolved in ethanol (25 ml) separately in 2:1 molar ratio. The ethanolic solutions were mixed together. The mixture was refluxed on oil bath for 3 hrs. On cooling, a crystalline complex was separated by filtration and the crystals were washed with ethanol and anhydrous diethyl ether and dried over anhydrous CaCl₂ [25-28].

A ligand (0.408g, 0.01 mol) [HL] was dissolved in (25ml) Dichloromethane and added to a metal salt [cobalt chloride (0.474 g, 0.01 mol), and copper chloride (0.454 g, 0.01 mol)] ethanolic solution (25 ml). The metal-ligand molar ratio was (2:1). The mixture was refluxed for 2 hrs. On cooling, a crystalline complex was separated by filtration and the crystals were washed and dried.

III. RESULTS AND DISCUSSION

Analytical and physical data of the compounds studied is reported in Table 1. The ligand and the metal (II) complexes are soluble in common polar solvents like Chloroform, Dichloromethane and Dimethyl acetamide. The synthesized ligand and the metal complexes were characterized by spectral analysis. Biological activity of the ligand and the metal complexes were also studied.

The electronic spectra are very useful in the evaluation of results obtained by other methods of structural investigation. Information regarding the geometry of the complexes around the Co (II) and Cu (II) ions was obtained from electronic spectral studies. The electronic spectra of ligand and their metal complexes were recorded at room temperature using Dichloromethane as a solvent.

The electronic spectra of ligand show bands in the region of 234 nm and 278 nm but in the complexes they are slightly shifted to higher frequencies. The band between 375 nm can be assigned to $n \rightarrow \pi^*$ of transition of azomethine group. In the spectra of complexes the bands of azomethine chromophore $n \rightarrow \pi^*$ transition are shifted to lower frequencies indicates that imine nitrogen is involved in the co-ordination of metal ion. A very weak low intensity absorption band associated with d-d transition for Co (II) complexes at 465, 532 nm (typical octahedral transition) and for Cu (II) complexes at 470 nm (Charge transfer), 525nm [$^3A_{2g}(F) \rightarrow ^3T_{1g}(P)$], 985 nm [$^3A_{2g} \rightarrow ^3T_{1g}(F)$] respectively supports the octahedral geometry of metal complexes [29].

The IR spectral data of Schiff base [HL] and their metal complexes are presented in Table 2. The IR spectra of complexes are compared with those of ligand in order to determine the coordination sites that may be involved in chelation. A strong band observed at 1620 cm^{-1} in a ligand [HL] is a characteristic band of (HC=N) azomethine group. The shifting of this band towards lower frequency region by $10-15\text{ cm}^{-1}$ in complexes indicates involvement of azomethine nitrogen in coordination with metal ion [30-32]. The assignment of the proposed coordination sites is further supported by appearance of band at $521-544\text{ cm}^{-1}$ suggesting the ν (M-N) bond. The presence of ν (M-O) stretching vibration at $740-750\text{ cm}^{-1}$ supports the involvement of oxygen atom in complexation with metal ions. The ligand and metal complexes were characterized mainly using the azomethine and $-\text{OH}$ bands. In the complexes, the broad band in the range of $3357-3365\text{ cm}^{-1}$ is attributed to the presence of water molecules. Therefore, from the IR spectra, it is concluded, that the ligand coordinated to the metal ions via azomethine nitrogen and deprotonated oxygen atom from 2 hydroxybenzaldehyde.

The antibacterial activity of the Schiff bases and their metal complexes was tested on *Staphylococcus aureus*, *Pseudomonas aeruginosa*. The method used for antibacterial activity was Agar Well-Diffusion method [33]. The stock solution 1mg/ml was prepared and was used to prepare concentrations of 8, 6, 4 and $2\text{ }\mu\text{g/l}$. The bacteria and fungi were inoculated on the surface of Nutrient agar and Sabouraud's agar, respectively. The various concentrations of the compounds were inoculated in the wells prepared on the agar plates. The plates were incubated at room temperature for 24h. In order to clarify the effect of Dimethylformamide on the biological screening, separate studies were carried out with Dimethylformamide (DMF) and showed no activity against any bacteria. The results are as summarized in the Table 3.

IV. CONCLUSION

The Co and Cu complexes have octahedral geometry. The Copper ($\text{C}_{26}\text{H}_{20}\text{N}_2\text{O}_3\cdot 2\text{Cu}\cdot 4\text{H}_2\text{O}$) and the Cobalt complexes ($\text{C}_{26}\text{H}_{20}\text{N}_2\text{O}_3\cdot 2\text{Co}\cdot 4\text{H}_2\text{O}$) are moderately active against the *Staphylococcus aureus*. The highest activity is observed for Copper complex.

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Figure captions:

Scheme 1: Synthesis of Schiff base and metal complexes.

Figure 1: UV-Visible spectra of Schiff base ligand [HL]

Figure 2: FTIR spectra of Schiff base Ligand [HL]

Table captions:

Table 1 Analytical and Physical data of the compounds studied.

Table 2 FTIR spectral data.

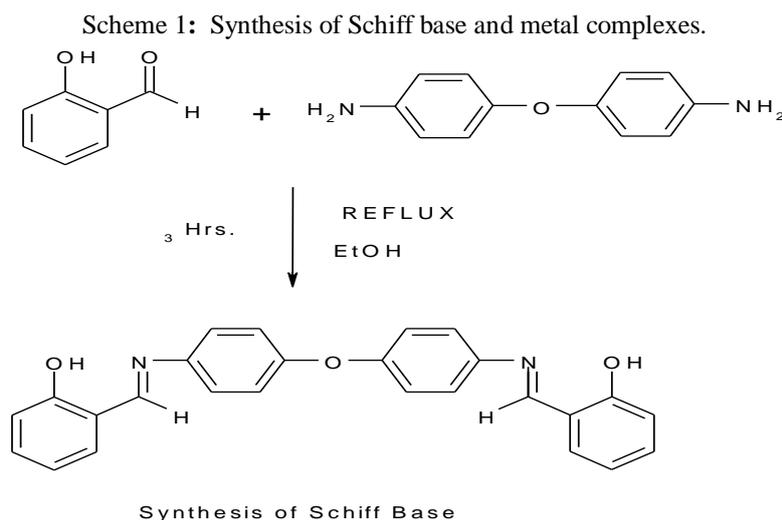


Table 1: Analytical and Physical data of the compounds studied.

Sr. No.	Compound	Mole. formula (Mol. wt)	Colour	M.P./ Decomposition temp. °C	Yield %
1	HL	C ₂₆ H ₂₀ N ₂ O ₃ (408)	Faint Yellow	215	95
2	HL-Co	C ₂₆ H ₂₀ N ₂ O ₃ ·2Co·4H ₂ O (870)	Yellowish Brown	>295	83
3	HL-Cu	C ₂₆ H ₂₀ N ₂ O ₃ ·2Cu·4H ₂ O (822)	Radish Brown	>295	85

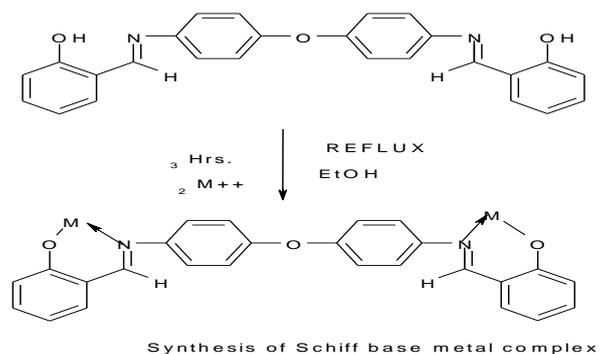


Table 2: FTIR spectral data.

Name of Compounds	$\nu_{(C=N)}$	$\nu_{(C-O)}$	$\nu_{(M-O)}$	$\nu_{(M-N)}$	$\nu_{(O-H)}$
HL	1620	1188	-	-	3380
HL -Co	1605	1148	460	521	3357
HL -Cu	1602	1145	465	544	3360

Table No-3 Biological activity and its Metal complexes

Name of compd.	Conc. $\mu\text{g / mL}$	<i>Staphylococcus Aureus</i>	<i>Pseudomonas Aeruginosa</i>
HL1	2	-	-
	4	+	-
	6	+	+
	8	+	+
HL-Co	2	+	-
	4	+	-
	6	+	+
	8	+	+
HL-Cu	2	++	+
	4	++	++
	6	++	++
	8	+++	++

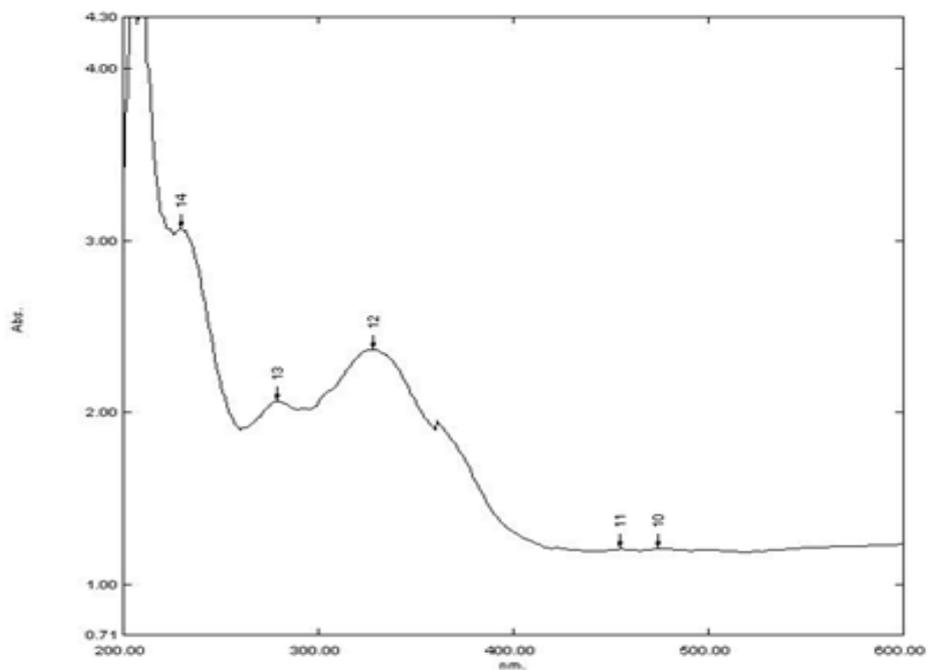
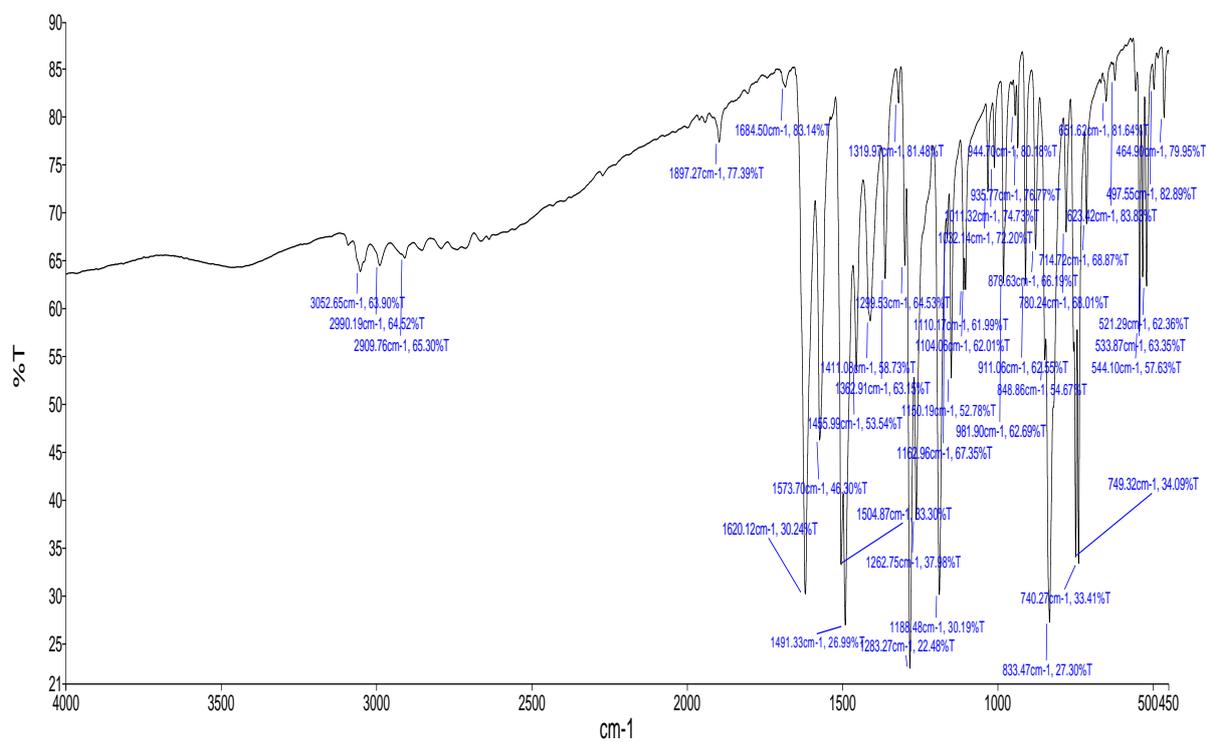


Figure 1 UV-Visible spectra of Schiff base ligand [HL]



Name Description
 MMJ-HL-1 Sample 069 By wcs Date Wednesday, February 06 2013

Figure 2 FTIR spectra of Schiff base Ligand [HL].