

Synthesis and antimicrobial activity of Cu (III) schiff base complex

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Abstract

The study report the synthesis of the Cu(III), with Isonicotinic acid hydrazide and 2-acetylnaphthalene and their characterization using FTIR and Magnetic susceptibility studies. Our studies reveal the presence of different mode of linkages of the ligand with Cu(III), The comparison of the IR spectra of the ligand imply that the ligand is bidentate with the amide group and azomethine –nitrogen as the two coordination sites. The complexes exhibit an identical pattern suggesting them to be isostructural with six coordinated spin free octahedral complexes. The complexes have been screened for their antibacterial and antifungal activity. The results of this study shows that the Cu(III), complex is effective against fungal pathogen than the bacterial pathogens.

INTRODUCTION

Chemists have reported on the chemical, structural and biological properties of Schiff bases. Schiff Bases are characterized by the $-N=CH-$ (imine) group which imports in elucidating the mechanism of transamination and rasemination reaction in biological system (1,2). Schiff bases are active against a wide range of organisms for example; *Candida Albicans*, *Escherichia coli* *Staphylococcus aureus*, *Bacillus polymxa*, *Trychophyton gypseum*, *Mycobacteria*, *Erysiphe graminis* and *Plasmopora viticola*.

Antibacterial activity has been studied more than antifungal activity. Because bacteria can achieve resistance to antibiotics through biochemical and morphological modifications (3,4).

Bacteria are several types of microscopic or ultra-microscopic single-celled organisms occurring in enormous numbers everywhere in nature, not only in land, sea and air, but also on or in many parts of the tissues of plants and animals, and forming one of the main biologically interdependent groups of organisms in virtue of the chemical changes which many of them bring about, e.g. all forms of decay and the building up of nitrogen compounds in the soil . Review of literature shows that there is no report of Schiff base complexes of Cu (III) formed from Isonicotinic acid hydrazide (1NH) and 2-acetyl naphthalene. Hence an attempt was made to the synthesis of Cu(III) Schiff base

complexes with Isonicotinic acid hydrazide and 2-acetyl naphthalene.

MATERIALS AND METHODS

PREPARATION OF LIGAND

Isonicotinic acid hydrazide (1mmol) and 2-acetylnaphthalene (1mmol) were refluxed together for 3 hours in the presence of a drop of concentrated HCl. The volume of the mixture was reduced to half. It was then cooled in a refrigerator when light yellow crystals separated .It was filtered, washed several times with cold ethanol and dried.

The ligand(16) gave the following data IR (KBr)

$$\nu_{\max} = 1612\text{cm}^{-1}$$

$$= 1664\text{cm}^{-1}$$

$$= 761\text{cm}^{-1}$$

SYNTHESIS OF COPPER (III) COMPLEX

The complex was prepared by carrying out the insitu reaction of amine (INH) 2- acetyl naphthalene and the metal salt copper chloride. Isonicotinic acid hydrazide (1mmol) and 2 acetylnaphthalene (1mmol) were taken together in ethanol (30ml) and refluxed for an hour after which copper chloride (1mmol) in ethanol was added and reflux continued for another 3hours. Upon cooling microcrystalline copper

complexes precipitated. It was filtered, washed thoroughly with ethanol and dried. The yield was quantitative.

The complex gave the following IR spectral data

$\nu_{\max} = 1600 \text{ cm}^{-1}$

$= 1733 \text{ cm}^{-1}$

$= 761 \text{ cm}^{-1}$

CHARACTERIZATION OF CU(III) COMPLEX

IR spectra were recorded in KBr medium on a Perkin–Elmer 783 spectrophotometer. UV-Vis spectra of complex was recorded in DMSO on a Shimadzu UV-1601 spectrophotometer. The magnetic property of the metal complex was studied by Magnetometer.

ANTIMICROBIAL ACTIVITY

ANTIBACTERIAL ASSAY

Mueller Hinton agar (Beef extract 0.2 g, Peptone 1.75 g, Starch 0.15 g, Agar 2.0 g, Distilled water 100 ml, pH 7.5) prepared with lawn culture using desired test organisms. The inoculated plates were kept aside for few minutes. Using well cutter 2 wells are made in those plates at required distance. In each step of well cutting, the well cutter was thoroughly wiped with alcohol. Using sterilized micropipette, 20 μl of different solvents with selected chemical extract was added in to one well and in another well the same volume of corresponding controls (solvent without chemical extract) were added. After diffusion, the Mueller Hinton agar plates were incubated at 37 $^{\circ}\text{C}$, 24 hours for antibacterial analysis. After incubation, the zone of inhibition was analyzed and recorded.

ANTIFUNGAL ASSAY

The sterilized Sabouraud's dextrose agar medium (Dextrose 4.0 g, Mycological peptone 1.0 g, Agar 2.0 g, pH 5.0, Distilled water 100 ml) was poured to a Petri dish in a uniform thickness and kept aside for solidification. Using sterilized swabs, even distribution of lawn culture was prepared using desired fungi such as *A.niger*, *Pen.notatum*, *C.albicans*, *C.tropicalis*, in SDA plates. The inoculated plates were kept aside for few minutes. Using well cutter 2 wells are made in those plates at required distance. In each step of well cutting, the well cutter was thoroughly wiped with alcohol using sterilized micropipette, 20 μl of different solvents with compound was added in to one well and in another well the same volume of corresponding controls (solvent without compound) were added. After diffusion, the plates were

incubated at room temperature for 24–48 hours. After incubation, the inhibition of growth was analyzed and results were recorded.

DETERMINATION OF MINIMUM INHIBITORY CONCENTRATION

One ml of extract (1 mg/ml) was incorporated into one ml of nutrient broth and Sabouraud's dextrose broth and serially diluted to obtain concentration of 1000 $\mu\text{g/ml}$, 500 $\mu\text{g/ml}$, 125 $\mu\text{g/ml}$, 62.5 $\mu\text{g/ml}$, 31.25 $\mu\text{g/ml}$ respectively. 20 μl of the bacterial, fungal inoculum was added to each of the test tubes. The tube without the extract served as control. The tubes were incubated at room temperature and readings were recorded after a period of 24 hrs for bacteria and 3 days for fungi. MIC was recorded as the lowest concentration of the extract at which no visible growth of the bacterial and fungal occurred after a period of seven days incubation.

RESULTS AND DISCUSSION

REACTION OF ISONICOTINIC ACID HYDRAZIDE AND 2-ACETYL NAPHTHALENE

Reaction of Salicylaldehyde with 2-acetyl naphthalene in ethanol showed a new spot after refluxing for four hours. After usual workup a yellow solid showed the following special features.

IR(KBR)

The ligands are expected to be bidentate, the possible coordination sites being the azomethine-nitrogen and the amide group. The NH stretching absorption (34) in the free ligands occurs at 3330 cm^{-1} . The ligand band due to $\text{C}=\text{O}$ appears at 1664 cm^{-1} . The band due to $\text{C}=\text{N}$ mode appears at 1612 cm^{-1} .

REACTION OF THE LIGAND AND CU (III)

Reaction of the ligand and Cu(III) in ethanol gave yellowish green solid. The IR and magnetic susceptibility measurement of the complex showed the following spectral features.

IR: The band due to $\text{C}=\text{N}$ mode undergo a shift to lower frequency and is observed as a strong peak in the region 1600 cm^{-1} , suggesting participation of exocyclic azomethine nitrogen in the complex formation.

MAGNETIC SUSCEPTIBILITY:

The room temperature magnetic moment of Cu(III) chelates is found to be 2.70 BM indicating paramagnetic, low spin d^9 complex with ground state term $2D$. The magnetic moment value can be calculated as follows (Table 1).

Figure 1

$$\mu_{\text{eff}} = 2.828 \sqrt{\chi_m \times T}$$

$$\chi_m = \frac{\text{MW}}{\text{SW}} \times \text{slope} = \frac{1.1128 \times 10^{-21}}{0.9273 \times 10^{-21}} \text{ BM}$$

$$= 930.54 \times 0.00071 \times 0.11200 \times 10^{-3} \text{ BM}$$

$$0.026$$

$$= 35790 \times 8.52 \times 10^{-8} \text{ BM}$$

$$= 3.0493 \times 10^{-3} \text{ BM}$$

$$\mu_{\text{eff}} = 2.828 \times 3.0493 \times 10^{-3} \times 298$$

$$= 2.828 \times 0.9533$$

$$= 2.70 \text{ BM}$$

Where, MW = Molecular weight of the complex

SW = Weight of the substance

Figure 2

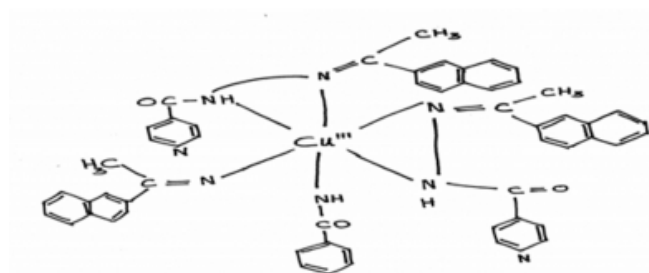
Table.1 Vibrating Sample Magnetometer Data of Cu (III) complex

Magnetic Field in Kilogauss	Magnetic Moment (in emu)
2	-0.00
4	-0.003
6	-0.004
8	-0.006
10	-0.007

The IR and magnetic susceptibility studies of the complex indicates that it is an octahedral complex of the type CuL₃ and the structure of the complex is assigned in Fig 1.

Figure 3

Fig.2. Structure of Cu (III) schiff base complex



ANTIMICROBIAL ACTIVITY

The Cu(III) metal complexes were effective against all the test organisms, both in Ethanol and methanol extract form.

The methanol extract was more active against the test organisms than the ethanol extract. The antimicrobial activity of ethanol extract of selected complexes in well method was performed and was found to be effective. (Table, 2)

Figure 4

Table.2 Antimicrobial activity of methanol extract of Cu (III) complex (Zone of inhibition in mm)

S.no	Name of the pathogens	Cu (III)	Ligand
1	<i>S. aureus</i>	16	11
2	<i>S. typhi</i>	13	12
3	<i>E. coli</i>	10	No Zone
4	<i>P. aeruginosa</i>	No Zone	13
5	<i>S. dysenteriae</i>	14	11
6	<i>Aspergillus niger</i>	12	14
7	<i>Penicillium sp.</i>	15	16
8	<i>C. albicans</i>	15	10
9	<i>C. tropicalis</i>	10	14

The minimal inhibitory concentration of Ethanol extract of Cu(III) against Staphylococcus aureus was 500 µg/ml, for Salmonella typhi was 1000µg/ml, for Escherichia coli 1000µg/ml Pseudomonas aeruginosa was 1000 µg/ml, Shigella dysenteriae was 500µg/ml, for Aspergillus niger 1000 µg/ml Penicillium notatum was 1000µg/ml for Candida albicans was 500µg/ml, and for Candida tropicalis was 500µg/ml.(Table, 3)

Figure 5

Table.3 Minimum inhibitory concentration of ethanol extract of Cu(III) on selected bacteria and fungi

S. No.	Name of the Organisms	Minimum Inhibitory Concentration (µg/ml)					
		1000	500	250	125	62.5	31.25
1	<i>Staphylococcus aureus</i>	+	+	-	-	-	-
2	<i>Salmonella typhi</i>	+	-	-	-	-	-
3	<i>Escherichia coli</i>	+	-	-	-	-	-
4	<i>P. aeruginosa</i>	+	-	-	-	-	-
5	<i>Shigella dysenteriae</i>	+	+	-	-	-	-
6	<i>Aspergillus niger</i>	+	-	-	-	-	-
7	<i>Penicillium sp.</i>	+	-	-	-	-	-
8	<i>Candida albicans</i>	+	+	-	-	-	-
9	<i>Candida tropicalis</i>	+	+	-	-	-	-

Various studies (5) have shown a relationship between the metal ions and their metal complexes as antitumour (6) and antibacterial agents, which is a subject of great interest. The inorganic pharmacology started to be an important field with more than 25 inorganic compounds being used in therapy as

antibacterial, antiviral and anticancer drugs (7). It was seen that the biological active compounds become more bacteriostatic and carcinostatic upon chelation with metal ions. Schiff bases have also attracted considerable attention in terms with their chelating abilities and analytical applications (8,9).

Thus the present study showed the significant antimicrobial activity to *Staphylococcus aureus* and *Candida albicans*. The further study is need for the identification of active site is essential because the predication of lead molecule and drug like property at the onset of drug design will helps in drug development.

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