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Synthesis, Characterization and in Vitro Studies of Cobalt Schiff Base Complex

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ABSTRACT: Schiff Bases play an important role in Inorganic chemistry due to formation of very stable complexes with various transition Metals. It has been extensively studied over past decades as Schiff bases provide potential sites for bio-chemically active compounds. This review is to summarize various Biological activities of Schiff Bases complexes as it has been recognized widely and Complexes may serve as biologically impertinence. Most of them show Biological activities such as antifungal, antibacterial, and antimicrobial activities

KEYWORDS: Antibacterial, Antifungal, cobalt nitrate, thiocyanate, Schiff Bases.

I. INTRODUCTION

Schiff Bases have been known since 1864 when Hugo Schiff reported the condensation of primary amines with carbonyls compounds [1]. Schiff Bases of aliphatic aldehyde are unstable in nature and readily get polymerized where as Schiff Bases with aromatic aldehyde are more stable due to conjugation system. Schiff Bases derived from amino acids are an important class of ligands that coordinate to metal ion by azomethine nitrogen. Ligands with heterocyclic molecules containing hetero atoms such as N, O, and in azomethine derivatives, C=N linkage is essential for biological activities. The presence of lone pair of electron in sp^2 hybridized orbital of nitrogen atom of the azomethine is of considerable chemical and biological importance. Schiff Bases are good chelating agents; generally bi- or tri- or tetra dentate ligands are more capable of forming very stable complexes with transition metals. Therefore Schiff bases metal complexes were widely investigated for their antifungal, antibacterial, antimicrobial, diuretic and antitumor, and enzymatic activities [2-3]. Cobalt complex with corrinoid ligands is also important biologically as cobalmins which is an essential part of vitamin B₁₂[4]. While cobalt is an indispensable smidgen element for humans, the metal is genotoxic and mutagenic at higher concentrations, especially to mammalian cells, and the reason for this genotoxicity is not yet very clear. Two probable mechanisms of venomousness have been indicated. (i) the inherent ability of cobalt to produce reactive oxygen species and (ii) the inactivation of the DNA restoration pathway due to the replacement of divalent metals in active Sites by cobalt. The collaboration of small molecules with DNA is presented an important area of investigation since it is widely accepted that DNA is the major intracellular target of anticancer, Anti-microbial and anti-viral metallo drugs[5-6].

II. EXPERIMENTAL

A. Reagents

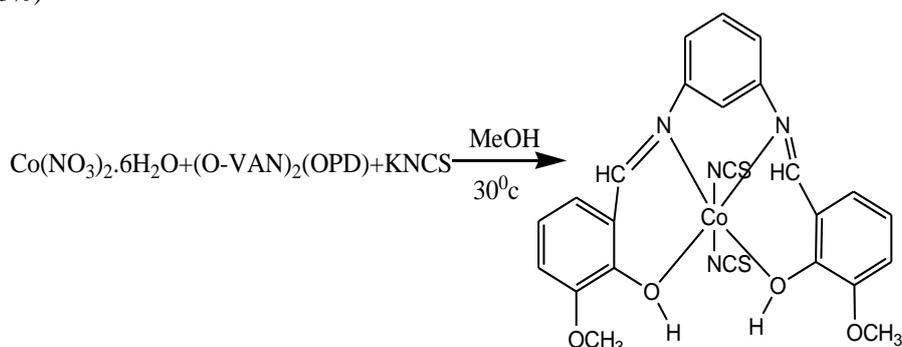
Chemicals are secured from prominent companies like sigma Aldrich, molyhemand used without further purification. Ethanol, methanol used for synthesis of metal complexes are A.R. grade and used as received for synthetic work. $Co(NO_3)_2 \cdot 6H_2O$ is procured from Alfa easer.

B. Synthesis of $[(Co)(O-VAN)_2(OPD)(NCS)_2]$

A Schiff's base solution (0.5mmol, 0.188gm) is dissolved in 10ml of hot methanol is added to a solution of cobalt nitrate (0.5mmol, 0.145gms) is liquefied in 10ml of water, immediately brown colored solution is appears. To this, a solution of potassium thiocyanate (0.5mmol, 0.485gms) is dissolved in 10ml of water is added, a crystalline dark brown colored hasty is obtained after one hour on constant stirring at room temperature. Anal. exptal. $C_{23}H_{31}N_4CoO_5S_2$ (M.Wt. 542) C, 54.22; H, 3.69; N, 8.54. Found. C, 55.82; H, 3.98; N, 8.66 Important IR absorptions (KBr disk, cm^{-1}). 3361, 3431, 1193, 1236, 1602, 426, 545. Mass peaks (m/z). 540, 432, 241, 149.

M.P; 340°C

Yield.0.445gm(55%)



Synthetic route and proposed structure of complex

C. Scheme of synthetic route and proposed structure of complex

The title mono nuclear cobalt complex, [(Co) (O-VAN)₂(OPD)(NCS)₂] has been synthesized. The cobalt ion in the complex has octahedral coordination geometry comprised of the adjacent two oxygen atoms of two ortho vanillin molecules, two nitrogen of two thiocyanate, and two nitrogen atoms of OPD ligands.

D. Physical measurements

An IR spectrum is obtained with a Bruker-alpha-T FT-IR spectrophotometer. UV spectrum is chronicled on systronics 2700R UV spectrophotometer. LC-MS Spectra is recorded on AGILANT-Triple Quad (LC-MS/MS) mass spectrometer. TG-DTA Spectra is recorded using Shimadzu-DTG-60H. NMR spectrum was recorded on Bruker-Ascend (400).

E. Electronic spectrum of [(Co)(O-VAN)₂(OPD)(NCS)₂]

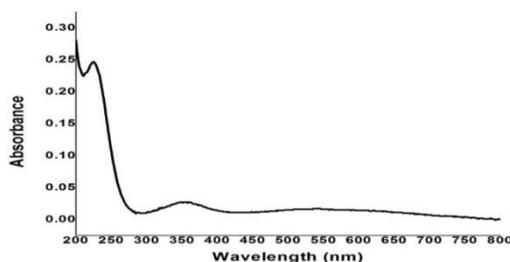


Fig 1; Electronic spectrum of complex

The Uv-visible spectra of metal complexes are recorded in DMF in the range 200 – 800 nm. The electronic spectrum of free Schiff base showed three bands around 240, 350 and 450 nm characteristic of $\pi-\pi^*$ and $n-\pi^*$ transitions. In the metal complexes, this band is shifted to a longer wave length with increasing intensity. This shift may be attributed to the donation of lone pair of electrons of oxygen of Schiff base to metal ion. The cobalt complexes exhibits bands around 255-300 nm, 350- 355 nm and 477-498 nm. The broad penetrating and ailing determined bands around 350-355 nm may be assigned to LMCT or MLCT. The high intensity band around 250 nm is of ligand origin assignable to $n-\pi^*$ or $\pi-\pi^*$ transition[7].The complexes showed shoulder broad bands in the range of 300-325 nm may be assigned to the d-d transition.

F. IR Spectrum of [(Co)(O-VAN)₂(OPD)(NCS)₂]

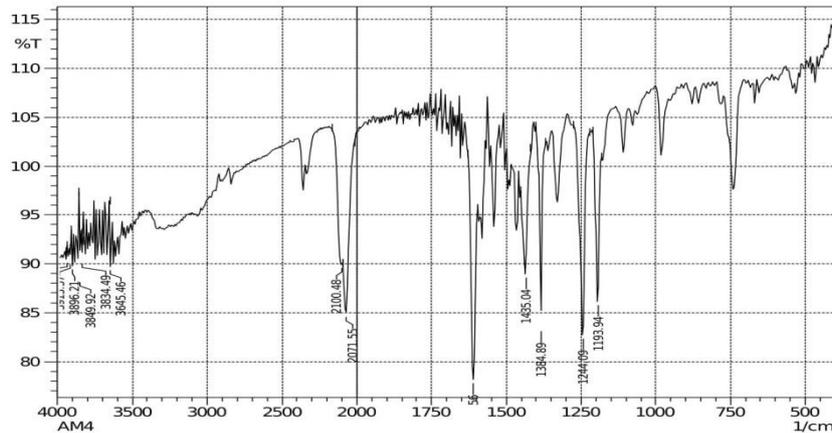


Fig:2 IR Spectrum of complex

In the IR spectrum of the Schiff bases ligand a sharp band observed at 1624 cm^{-1} is assigned to the $\nu(\text{C}=\text{N})$ mode of the azomethine group. This shifts to lower wave number, 1600 cm^{-1} in the complex suggesting the co-ordination of the azomethine nitrogen to the metal centre [8]. The characteristic phenolic $\nu(\text{OH})$ mode due to presence of a hydroxyl group at ortho position in the free Schiff base ligand is observed around $3246\text{--}3400\text{ cm}^{-1}$. The exterior of a new band around $500\text{--}540\text{ cm}^{-1}$ in the complex due to $\nu(\text{M}\text{--}\text{O})$ bond formation.[9]. A strong bond at 1253 cm^{-1} in the free ligand were due to phenolic $\nu(\text{C}\text{--}\text{O})$ stretching, on complex formation these bonds shifted to lower frequencies 1230 cm^{-1} indicating coordination through the phenolic oxygen[10]. This is further supported by the shifting of $\nu(\text{C}\text{--}\text{O})$ phenolic band to lower wave number 1240 cm^{-1} and in the metal complex. The $\nu(\text{CN})$ absorption at 2115 cm^{-1} as a single peak suggests the presence of N-coordinated terminal thiocyanate group, (NCS) appears at $2158\text{--}2102\text{ cm}^{-1}$ as a bridged peak indicating the presence of bridged thiocyanate ion coordination to the metal center.

F. H-NMR spectrum of $[(\text{Co})(\text{O}\text{--}\text{VAN})_2(\text{OPD})(\text{NCS})_2]$

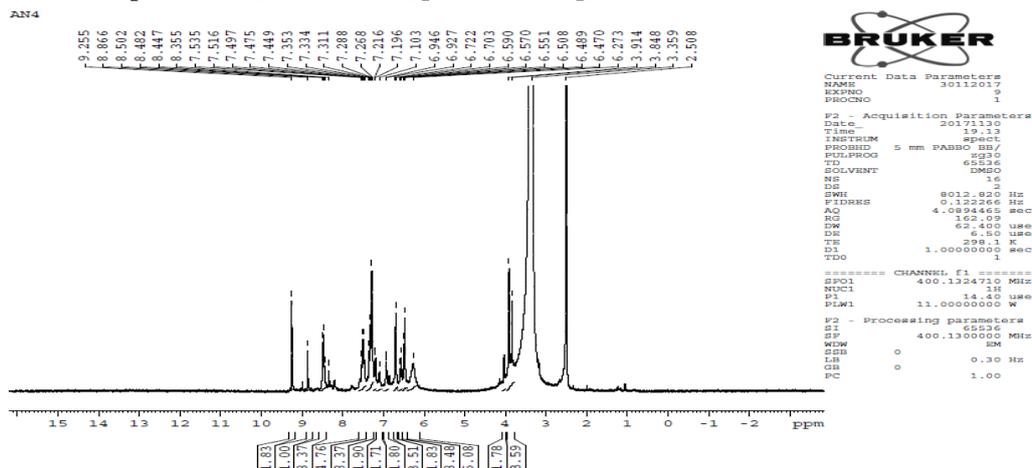


Fig:3 ^1H -NMR spectrum of Complex

A review of the literature revealed that NMR spectroscopy has been proven to be useful in establishing the nature and structure of many Schiff bases, as well as their complexes in solutions. The ^1NMR spectra of Schiff bases are recorded in dimethylsulfoxide (DMSO) solution, using tetramethylsilane (TMS) as internal standard. The NMR spectra of the Schiff bases, the spectra of the complexes are examined in comparison with those of the parent Schiff bases Upon examination it was found that the N-CH signal that appeared in the spectrum of the ligand at 10.2 ppm, signal shifts down fields in the spectrum of its Co (II) complex, this also confirms co- ordination by azomethine nitrogen. Signal at

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3.85 signifying methoxy group, moreover, signal observed at 12.9ppm indicating the phenolic OH in free Schiff base, the signal shifts down fields in the spectrum, this confirms the coordination of the phenolic (OH) proton.

G. Antimicrobial screening of [(Co)(O-VAN)₂(OPD)(NCS)₂]

The complex is screened in vitro for antibacterial activities against E.coli, S.aureus and antifungal activity against C.albicans by Agar-well diffusion method [11-15]. The antibacterial and antifungal activities of complex are listed in table.1



Figure 4 Inhibition zones for complex against S.aureus and E.coli



Figure 5. Inhibition zones for complex against C.albicans

Bacteria	Inhibition zone (mm)
E.coli	10
S.aureus	10
Fungi	Inhibition zone (mm)
C.albicans	Nil

Table 1 .Anti-microbial activities for Schiff’s base complex

According to above table the complex showed antibacterial activities against E.coli and S.aureus. The obtained inhibition zones are 10 and 10 mm and antifungal activity against C.albicans didn’t show any fungal activity.



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III. CONCLUSION

In this paper, we presented the results of synthesis and characterization studies for the Schiff's base transition metal complex involving Schiff's base and pseudo halide ligand. The adopted approaches for the synthesis of metal complex are self-assembly method. The IR spectra confirm the existence of functional groups and anionic ligand such as O-H (water), C=C, C=N, NCS, frequencies. The UV spectrum approves the complexation of metal and ligand with the increase in the absorbance value compared to the free ligand. The λ_{\max} values of a d-d band are detected to be in the range of 300 to 321 nm. The IR spectrum approves the coordination of pseudo halide bond in the complex molecule. In this paper the complex is $[(Co) (O-VAN)_2(OPD)(NCS)_2]$ is screened invitro for antimicrobial activity by disc diffusion method. The bacterial organisms used in this study are E.coli, S.aureus. The observed inhibition zones for these complexes are in the range of 10 mm for E.coli, 10 for S.aureus. The screened data in these reports are in good agreement with the previous data and the inhibition zone images are pictorially recorded. The fungal organisms used are C.albicans and the observed inhibition zones for complex shows nil activity against fungal organisms.

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