AN INNOVATIVE SYNTHESIS OF NEW MANNICH BASE, ITS METAL COMPLEXES AND THEIR ANTIBACTERIAL STUDIES

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ABSTRACT

We reported synthesis of new mannich base and its transition metal complexes in green manner. The structure of synthesized compounds confirmed with help of UV, IR, $^1$HNMR, $^{13}$CNMR spectroscopic techniques and their analytical data. The antibacterial activity of ligand and complexes examined against selective gram positive and gram negative bacteria where metal complexes showed good activity than the free ligand was observed.

Keywords: Mannich base, disc diffusion method, antibacterial activity, green manner.

1. INTRODUCTION

Mannich base is a three-component condensation product of active hydrogen containing compound, aldehyde and secondary amine. The formation of mannich base product depends on the nucleophilicity of substrate and pH of the reaction medium. The electrochemical behavior and catalytic activity of various mannich bases were reported in literature. The metal complexes of mannich bases have been studied extensively in recent years due to the selectivity and sensitivity of the ligands towards various metal ions. The organic chelating agents containing amide moiety as a functional group have strong ability to form metal complexes and exhibit a variety of biological activities such as antibacterial, antifungal, anti TB activity, anti HIV activity, antiviral, antiulcer and anti- hypertensive. The number of studies have been done in the various mannich base complexes formed by the condensation reaction of secondary amines with different aldehyde and amides. In the present work, we reported synthesis, characterization, antibacterial studies of new mannich base and its transition metal complexes.

2. MATERIAL AND METHODS

2.1 General

All the chemicals used were reagent grade and used without further purification. The molar conductance was measured in DMSO solvents at room temperature and magnetic moment was measured on a Gouy balance by using CuSO4 as standard. The UV-Vis spectra were recorded in DMSO solvent on Shmazdu UV mini-1240 spectrophotometer and IR spectra were recorded on Perkin-Elmer FT-IR spectrophotometer using KBR pellet. The antibacterial activity of synthesized ligand and its metal complexes were studied by disc diffusion method.

2.2 Synthesis of ligand

The aqueous mixture of salicylaldehyde (2 equivalent) and thioacetamide (2 equivalent) at room temperature was neutralized with liquid ammonia. To the above mixture, piperazine (1 equivalent) was added slowly with constant stirring at room temperature. This reaction mixture was stirred 15 minutes, the yellow color solid product formed was filtered and washed with water. The progress of the reaction was monitored by TLC using hexane and ethyl acetate 7:3 solvents. Yield: 70%, Mp: 100-105°C.
2.3 Synthesis of complexes
Hot ethanolic solution of ligand (1 equivalent) was slowly mixed with hot ethanolic solution of the metal chloride (2 equivalent) under reflux condition with constant stirring. The mixture was refluxed for 1-2 hours and after that it was cooled under ice cold condition, the colored solid complex separated out in each case. It was filtered, washed with 50% ethanol and finally dried.

3. RESULTS AND DISCUSSION
3.1 Molar conductance and Magnetic moment
The complexes prepared are various colored, powder like, air stable, soluble in dimethylformamide (DMF) and dimethylsulfoxide (DMSO). The analytical data and some physical properties of the metal complexes were listed in table 1 and synthetic scheme of complex is given in scheme 1. The molar conductivities values showed that all the complexes are non-electrolytes nature with \( \lambda m = 30.45 \Omega^{-1} \text{cm}^2 \text{mol}^{-1} \text{in} \) DMSO solutions at room temperature. The \( \mu_{eff} (1.6) \) value of the Cu(II) complex represented octahedral geometry with one unpaired electron. The observed \( \mu_{eff} (2.57) \) value of the Ni (II) complex confirmed octahedral geometry with two unpaired electron and Zn (II) complex is diamagnetic as expected with zero unpaired electron.

3.2 UV-Visible and IR-Spectroscopy
The Cu (II) complex under the present study exhibit a broad band in the region 27200 cm\(^{-1}\) due to transition between \( ^{2}E_g \rightarrow ^{2}T_g \) which indicated octahedral geometry. The Ni (II) complex showed broad signals at 26334 and 28420 cm\(^{-1}\) which is assigned to \( ^{3}A_{2g} \rightarrow ^{3}T_{1g} \) and \( ^{3}A_{2g} \rightarrow ^{3}T_{2g} \) transition respectively which further confirmed the octahedral geometry of the complex. The spectra of Zn (II) complex exhibited band at 25100cm\(^{-1}\) assigned to L \( \rightarrow \) M charge transfer and not for d-d transition. The infrared bands of ligand observed at 3202, 1145 and 757 cm\(^{-1}\) have been assigned to vN-H, C-N-C of piperazine group and C=S group respectively. In IR spectra of all the complexes, the vN-H band appeared its specific region indicated that the secondary nitrogen was not involved in coordination. A band due to vC=N–C and C=S in all the complexes shifted towards lower frequency clearly indicated that nitrogen, sulphur involved coordination with metal ion. The above said coordination site was further confirmed by appearance of band in between 1649-1633 cm\(^{-1}\) in all the complexes due to existence of C=N group during complexation (see table-2). The new bands at 530-526 cm\(^{-1}\) and 435-427 cm\(^{-1}\) in the spectra of the metal complexes were assigned to vM=N and vM=S stretching vibrations. The presence of coordinated water molecule in Cu (II) and Ni(II) complex is determined by appearance of bands in between 3514-3405 cm\(^{-1}\) and 857-898 cm\(^{-1}\) assignable to the OH stretching and bending mode of vibration. The presence of phenolic OH group in all the complexes in between 3432-3340 cm\(^{-1}\) indicated that which was not involved in coordination.

3.3 \(^{1}H\)-NMR and \(^{13}C\)-NMR spectra
The \(^{1}H\)-NMR spectrum of the ligand showed the following resonance signals: Signals due to aromatic protons appear in between 6.77-7.65 \( \delta ppm \) as many multipletes. The N-H proton chemical shift occurred at 8.74-8.73 \( \delta ppm \) as weak doublet and CH methine proton appeared as doublet at 5.17-5.5.24 \( \delta ppm \). The piperazine protons signal occur at 2.76 \( \delta ppm \) as singlet and methyl protons appeared as singlet at 2.50 \( \delta ppm \). The signal at 10.25 \( \delta ppm \) was due to the phenolic –OH group present in molecule. The \(^{13}C\)-NMR spectrum of the ligand showed the following signal at 170.13(C=S), 157.16(C-OH), 129.80, 126.96, 122.13, 119.85, 117.61, 116.89 (6Ar-Carbons), 70.31(CH), 48.95(N-CH\(_2\)), 24.04(CH\(_3\)) well supported for our expected structure.

4 Antimicrobial activity
The antibacterial activities of ligand (L) and its metal complexes were studied by usual agar agar disc diffusion method. The bacterial species used in the screening were staphylococcus aureus, staphylococcus epidermidis (gram positive) Escherichia coli and Pseudomonas aeruginosa (gram negative). The presence of clear zones around the wells indicated that the compound is active and diameter of the zone inhibition was deducted in millimeters by using zone diameter. The results of bactericidal screening showed that the chelating tends to make the ligand act as more powerful and potent bactericidal agents, thus killing more of the bacteria than the free ligand. The detailed data of all the synthesized compounds against gram positive and gram negative bacteria given in table-3.
Scheme - 1: Synthesis of the ligand and its complexes

Table 1: Physical data of ligand and its complexes

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Yield(%)</th>
<th>Mp(°C)</th>
<th>Colour</th>
<th>μeff (BM)</th>
<th>M. conductance (Ω−1cm2mol−1in 10−3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMB-L</td>
<td>70</td>
<td>170-172</td>
<td>Light yellow</td>
<td>----</td>
<td>-----</td>
</tr>
<tr>
<td>BMB-Cu</td>
<td>50</td>
<td>240-242</td>
<td>Brown</td>
<td>1.6</td>
<td>45</td>
</tr>
<tr>
<td>BMB-Ni</td>
<td>56</td>
<td>198-200</td>
<td>green</td>
<td>2.5</td>
<td>32</td>
</tr>
<tr>
<td>BMB-Zn</td>
<td>40</td>
<td>260-262</td>
<td>white</td>
<td>Diamagnetic</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 2: IR-Spectral data of ligand and its complexes

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Vibration frequency of various functional groups ( in cm−1)</th>
</tr>
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<tr>
<td></td>
<td>-OH</td>
</tr>
<tr>
<td>BMB-L</td>
<td>3402</td>
</tr>
<tr>
<td>BMB-Cu</td>
<td>3432</td>
</tr>
<tr>
<td>BMB-Ni</td>
<td>3450</td>
</tr>
<tr>
<td>BMB-Zn</td>
<td>3447</td>
</tr>
</tbody>
</table>

Table 3: Antibacterial activity

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Bacteria</th>
<th>Standard Antibiotic Disk(streptomycin)</th>
<th>Zone of inhibition mm in diameter (10µg/disc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BMB - L</td>
<td>BMB - Cu</td>
</tr>
<tr>
<td>1</td>
<td>Staphylococcus aureus</td>
<td>18</td>
<td>08</td>
</tr>
<tr>
<td>2</td>
<td>Staphylococcus epidermidis</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Escherichia coli</td>
<td>24</td>
<td>08</td>
</tr>
<tr>
<td>4</td>
<td>Pseudomonas aeruginosa</td>
<td>25</td>
<td>08</td>
</tr>
</tbody>
</table>
Fig. 1: FT-IR Spectra of ligand using KBr pellets

Fig. 2: 1H-NMR Spectra of ligand in DMSO-D6 solvent
5. CONCLUSION
It may be concluded that the ligand behaves as bidentate chelating agent and the spectroscopic techniques were well supported to our proposed structure. The metal complexes showed good microbial activity than the ligand was observed.

6. ACKNOWLEDGEMENTS
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REFERENCES
3. Michael K. Ainooson, Ilia A. Guzei and Lara C. Spencer. Pyrazolylimine iron and


