INTRODUCTION

If a ligand combines with the metal ions contains two or more donor groups forming one or more rings with the metals the resulting compound is called a chelate compound and the ligand itself is said to be chelating agent [1]. Metal chelates play significant role in physiological processes of biological system as they participate in the form of metalloprotein in respiratory, photosynthetic, nitrogen fixation, biosynthetic and metabolic process which are essential to the foundation of life in living being [2-4]. The function of metal chelates in physiological system could be understood in the light of chelation theory. Metal chelates play specific role, particularly in the activation of enzymes, though, the role played by the metal ion chelates in an enzymic reaction is often difficult to elucidation due to the complex nature of protein structure, model studies with relatively simple metal chelates of known structures. They generally provides important information giving the clues to the roles of the metal ions in several enzymic reactions [5,6]. Nucleotides as co-enzymes in enzymic reactions function only in the form of metal chelates [7]. Chelation of a biomolecules with metal ions gives some important properties to the drug, which are helpful in their biological activities. The properties of the metal chelates like dissociation constant, reduction in the polarity of the metal ion in chelates, special redox potential, electron distribution, etc. have mark effect on the solubility of drugs in lipid. It facillitates the drug action and their pharmacological transport mechanism. The low polarity of metal ion in metal chelates increases its hydrophobic character which favours it permeation through the lipid layer of microorganism, which enhances the antibacterial activities of metal chelates [8-12].

Recently considerable attention has been focussed on the chelation chemistry of Schiff bases, because of their ease of preparation, structural varieties and varied denticities [13-15]. The transition metal complexes of Schiff base ligands have a broad spectrum of applications like catalyst, magnetic materials, porous materials, luminous materials, electronic and optoelectronic devices and moulding biological process [16-22]. The development of field of bioinorganic chemistry has increased the interest in Schiff base complexes, since it has been recognized that many of these complexes may serve as models for bioinorganic important species [23]. A particular interest has been those involving higher valent metal ions since they reveals amazing molecular diversity not only in coordination geometry but in more suitable changes in the ligands [24,25]. Keeping in view the above importance of Schiff base complexes of trans-

Keywords: Transition metal(II) complexes, Chelation, 1-Phenylbutane-1,3-dione, Anthranilic acid.
EXPERIMENTAL

All the chemicals used were of AnalaR grade and used as received. 1-Phenylbutane-1,3-dione was procured from Merck and anthranilic acid was purchased from Lupin. The Schiff base ligand 1-benzoyl-2-(2'-carboxylphenyl)iminopropane (BIPH) has been prepared by the condensation of 1-phenylbutane-1,3-dione and anthranilic acid taken in equimolar ratio in ethanolic solution by refluxing in the presence of few drops of conc. H2SO4 for 3.5 h. On cooling the solution, a dull yellow solid appeared which was filtered and recrystallized in acetone where by a bright yellow crystalline solid was obtained (Scheme-I). The obtained Schiff base was used for the complexation with Co(II), Ni(II) and Zn(II).

The elemental analyses of the ligand and its metal complexes were determined by Perkin-Elmer 2400 CHN elemental analyser. The IR spectra of the ligand and complexes have been recorded on Shimadzu UV-visible spectrophotometer (UV-160). Thermogravimetric analysis (TGA) were recorded in static nitrogen atmosphere with heating rate of 10 °C/min using Perkin-Elmer Diamond TGA/DTA analyser.

RESULTS AND DISCUSSION

The physico-chemical composition of ligand as well as complexes is shown in Table-1. On the basis of percentage composition and molar conductivity the complexes have been formulated as (ML₃X₂) where M = Co(II), Ni(II) and Zn(II), while L = 1-benzoyl-2-(2'-carboxylphenyl)iminopropane (BIPH) and X = H₂O, pyridine and α-picoline. The molar conductivity value of complexes lies between 8.4 to 9.6 Ω⁻¹ cm² mol⁻¹ which indicates their non-electrolytic nature [26,27].

IR studies: The IR spectra of ligand and its metal complexes are very cumbersome as shown in Figs.1-4 and hence only important bands have been discussed. The broad band appearing at 3350 cm⁻¹ is assigned to H-bonded OH [28-30]. A band at 1655 cm⁻¹ due to ν(C=O) and another at 1620 cm⁻¹ due to ν(C=O) and another at 1655 cm⁻¹ due to ν(C=O). The medium band appearing at 1720 cm⁻¹ is assigned for anthranilic acid [31-33]. A band at 1655 cm⁻¹ gets disappeared in all the complexes, which shows that -OH group has undergone deprotonation and coordination has occurred through the deprotonated oxygen. The medium band appearing at 1720 cm⁻¹ is assigned for anthranilic acid [34,35]. This band remains almost intact in the IR spectra of complexes indicating its non-involvement in coordination. The strong band at 1640 cm⁻¹ in the spectra of free ligand is fairly assigned to ν(C=N),

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Colour</th>
<th>Yield (%)</th>
<th>m.p.  (°C)</th>
<th>Conc.</th>
<th>Elemental analysis (%)</th>
<th>Found (calcd.)</th>
<th>λ (ohm⁻¹ cm² mol⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ligand (BIPH)</td>
<td>Yellow</td>
<td>67</td>
<td>234</td>
<td></td>
<td>72.83 (72.60) 5.16 (5.33) 4.72 (4.98)</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>[Co(BIPH)₂(H₂O)₃]</td>
<td>Dull pink</td>
<td>64</td>
<td>281</td>
<td></td>
<td>62.80 (62.30) 4.67 (4.88) 4.20 (4.30) 8.86 (9.00)</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>[Co(BIPH)₂(Py)₂]</td>
<td>Light pink</td>
<td>65</td>
<td>289</td>
<td></td>
<td>78.41 (67.95) 4.53 (4.90) 7.00 (7.20) 7.24 (7.60)</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>[Co(BIPH)₂(α-picoline)₂]</td>
<td>Pink</td>
<td>64</td>
<td>279</td>
<td></td>
<td>68.86 (68.60) 5.00 (5.21) 6.81 (6.95) 7.14 (7.32)</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>[Ni(BIPH)₂(H₂O)₃]</td>
<td>Brilliant green</td>
<td>58</td>
<td>287</td>
<td></td>
<td>62.57 (62.38) 4.62 (4.89) 4.08 (4.28) 8.56 (8.86)</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>[Ni(BIPH)₂(Py)₂]</td>
<td>Greenish</td>
<td>61</td>
<td>294</td>
<td></td>
<td>68.33 (68.04) 4.58 (4.89) 7.10 (7.21) 7.21 (7.47)</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>[Ni(BIPH)₂(α-picoline)₂]</td>
<td>Green</td>
<td>60</td>
<td>297</td>
<td></td>
<td>68.82 (68.65) 5.11 (5.22) 6.78 (6.96) 7.00 (7.21)</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>[Zn(BIPH)₂(H₂O)₃]</td>
<td>Dull brown</td>
<td>76</td>
<td>268</td>
<td></td>
<td>61.97 (61.72) 4.38 (4.84) 4.16 (4.23) 9.62 (9.83)</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td>[Zn(BIPH)₂(Py)₂]</td>
<td>Brown</td>
<td>77</td>
<td>270</td>
<td></td>
<td>67.72 (67.43) 4.46 (4.85) 7.00 (7.15) 8.16 (8.30)</td>
<td>9.4</td>
<td></td>
</tr>
<tr>
<td>[Zn(BIPH)₂(α-picoline)₂]</td>
<td>Brown</td>
<td>77</td>
<td>274</td>
<td></td>
<td>68.32 (68.06) 4.91 (5.17) 6.69 (6.90) 7.89 (8.01)</td>
<td>8.7</td>
<td></td>
</tr>
</tbody>
</table>
azomethine group stretching vibration [36,37]. In the spectra of all the metal complexes, this band gets shifted to 1615-1605 cm⁻¹ which shows azomethine nitrogen is involved in coordination to metal ion [38,39]. The coordination through deprotonated oxygen and azomethine nitrogen is further confirmed by the appearance of new bands in the far infrared region of IR spectra of complexes. The new band at 515-510 cm⁻¹ is assigned ν(M–O) while other at 450-445 cm⁻¹ is assigned to ν(M–N) vibration [40,41]. The new broad band appearing at 2910 cm⁻¹ with a strong band at 850 cm⁻¹ is the signature of presence of coordinated H₂O in some complexes [42]. The appearance of new bands at 750 and 800 cm⁻¹ suggest the presence of coordinated pyridine and α-picoline, respectively [43,44] in coordination sphere of these complexes.

**Magnetic moment and electronic spectra:** Cobalt(II) complexes records magnetic moment 5.1-5.2 B.M. and their electronic spectra display three bands due to spin-allowed transitions ⁴T₁g(F) → ⁴T₂g(v₁), ⁴T₁g → ⁴A₂g(v₂) and ⁴T₁g → ⁴T₁g(P)(ν₃). The value of ν₂/ν₁ = 2.13-2.34 correspond to 10 Dq values 9354.6, 9446.2 and 9365 cm⁻¹. The value of Racah parameter B decreases from 971 cm⁻¹ in free Co(II) ion to 780-748 cm⁻¹ in complexes. These crystal field parameter values undoubtedly indicate the octahedral symmetry of Co(II) complexes [45-47]. The magnetic moment of Ni(II) complexes has been found 3.0-3.1 B.M., which is slightly higher than two unpaired electrons of d⁸-system which may be due to spin-orbit coupling effect [48]. The electronic spectra of Ni(II) complexes display four bands which may be assigned to ³B₁g → ³E₂g(a), ³B₁g → ³E₁g(a), ³B₁g → ³A₁g and ³B₁g → ³E₂g(b) [49,50]. On the basis of spectral bands the various crystal field parameters have been derived and their values are given in Table-2.

<table>
<thead>
<tr>
<th>TABLE-2</th>
<th>VALUES OF DIFFERENT CRYSTAL FIELD PARAMETER OF Ni(II) COMPLEXES (cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex</td>
<td>Dq(xy)</td>
</tr>
<tr>
<td>[Ni(BIP)₂(H₂O)₂]</td>
<td>1177.0</td>
</tr>
<tr>
<td>[Ni(BIP)₂(Py)₂]</td>
<td>1176.0</td>
</tr>
<tr>
<td>[Ni(BIP)₂(α-picolo)₂]</td>
<td>1172.5</td>
</tr>
</tbody>
</table>

From the value of D₅, it is obvious that there is definite deviation from octahedral symmetry. The less value of Dq(z) indicates tetragonal elongation along z-axis [51,52]. Zn(II) complexes are diamagnetic and exhibited no band in their electronic spectra. However, on the basis of microanalytical data the complexes found to be six coordinated, for which octahedral symmetry is the most preferred symmetry [53-55].

**Thermogravimetric studies:** The thermogram of the synthesized complex [ML₂(H₂O)₂] doesn’t show any considerable weight loss up to 145 ºC. The first step decomposition of complexes with weight loss of 5.35 to 5.55 % (calculated value 5.44-5.50 %) starts at 145 ºC and completes at 200 ºC due to loss of two coordinated water molecules from the coordination sphere. It confirms the presence of two coordinated water molecules in the complexes [56]. The second decomposition was found to have occurred between 260 ºC to 390 ºC corresponds to weight loss of 31.38 to 31.85 % (calculated value 31.47 to 31.98 %) due to loss of C₁₃H₁₀O₂ moiety. The third and last decomposition occurs between 445 ºC to 560 ºC correspond to weight loss of 18.9 to 19.35 % (calculated value 19.0 to 19.47 %) due to loss of the remaining part of the ligand.
The complexes finally convert into a constant composition of metal oxides above 600 °C (Fig. 5).

In case of [ML₂(H₂O)₂] complexes, the decomposition occurs in three steps. The first weight loss of 20 to 23 % (calculated value 20.33 to 23.33 %) occurs at 170 °C and ends at 215 °C. The second decomposition occurs between 265 to 390 °C with the weight loss of 24 to 25 % (calculated value 24.05 to 25.62 %) due to loss of C₆H₁₀O₂ moiety. The rest part of the ligand gets decomposed between 450 °C to 560 °C with the weight loss of 37 to 37.8 % (calculated value 37.7 to 38.22 %) due to loss of C₁₃H₁₀O₂ moiety. The rest part of the ligand gets decomposed between 450 °C to 560 °C with the weight loss of 37 to 37.8 % (calculated value 37.7 to 38.22 %) due to loss of C₁₃H₁₀O₂ moiety. The rest part of the ligand gets decomposed between 450 °C to 560 °C with the weight loss of 37 to 37.8 % (calculated value 37.7 to 38.22 %). The complexes finally convert into a constant composition of metal oxides above 600 °C (Fig. 5).

The complexes finally convert into a constant composition of metal oxides above 600 °C (Fig. 5).

In case of [ML₂(py)₂] complexes, the decomposition occurs in three steps. The first weight loss of 20 to 23 % (calculated value 20.33 to 23.33 %) occurs at 170 °C and ends at 215 °C. The second decomposition occurs between 265 to 390 °C with the weight loss of 24 to 25 % (calculated value 25.0 to 25.62 %). The rest part of the ligand gets decomposed between 450 °C to 560 °C with the weight loss of 37 to 37.8 % (calculated value 37.7 to 38.22 %). The complexes [ML₂(α-pic-o)₂] also show the similar pattern of thermal decomposition (Fig. 6). Thus, it is clear from thermogravimetric analyses that water, pyridine and α-picoline are attached to metal ion along axial position with slightly greater distance in respect of planer donar atoms.

**Conclusion**

On the basis of IR spectral analyses of complexes in comparison to that of free ligand, 1-benzoyl-2-(2'-carboxylphenyl)-iminopropane has been found to have acted as bidentate mononionic ligand coordinated through deprotonated hydroxyl oxygen and azomethine nitrogen. The molar conductivity, magnetic moment and electronic results suggest the following tentative structure of the metal complexes.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

REFERENCES


