

CHAPTER V

Synthesis, structural characterization and exploration of antibacterial activities of Co(II), Ni(II) and Cu(II) complexes derived from an ionic liquid-supported Schiff base: 1-{2-(2-hydroxy-5-nitrobenzylideneamino)ethyl}-3-ethylimidazolium tetrafluoroborate

5.1. Introduction

Ionic liquids (ILs) may be defined as “ionic materials”, with low melting points (below 100 °C) generally composed of inorganic or organic anions paired with large, usually asymmetric organic cations. ILs pose a plethora of unique physicochemical and solvation characteristics that can be tuned for specific applications and often producing interesting results when employed instead of traditional molecular solvents [1, 2]. In addition, most ILs show negligible vapor pressure³ as well as high thermal stability [4-6]. Due to these attractive features they are termed as neoteric solvents or green solvents. In recent years, ILs were extensively studied for their wide electrochemical window, high ionic conductivity [7] and a broad temperature range of the liquid state. Moreover, the physical properties of ILs including density, melting point, polarity, Lewis acidity, viscosity and enthalpy of vaporization can all be tuned by changing their cation and anion pairing [8]. IL-based solvent system typically exhibits enhanced reaction kinetics resulting in the efficient use of time and energy [1]. Due to these properties, ILs are treated as a new generation of solvents for catalysis, ecofriendly reaction media for organic synthesis and a successful replacement for conventional media in chemical processes [1,9]. Recently, many researchers have focused on the synthesis of new ionic liquids called functionalized ionic liquids (FILs) with different functional groups in the cationic moiety [10-15]. Such functionalization of the cation can easily be done in a single reaction step and thus both the cationic and anionic moieties of the FILs can be altered as required for specific applications like increased catalytic stability and reduced catalyst leaching etc [16,17].

Of note Schiff base being a salient class of multidentate ligand has played a key role in coordination chemistry. They exhibit varied denticities, chelating

capability [18-20], functionalities [21] and diverse range of biological, pharmacological and antitumor activities. Schiff-bases containing hetero-atom such as N, O, and S are drawn special interest for their varied ways of coordination with different transition metal ions and having unusual configurations [22-24]. The present chapter describes the syntheses and physico-chemical characterizations of an IL-supported Schiff base, 1-{2-(2-hydroxy-5-nitrobenzylideneamino) ethyl}-3-ethylimidazolium tetrafluoroborate and its Co(II), Ni(II) and Cu(II) complexes. The ligand and its metal complexes were screened for their *in vitro* antibacterial activities against gram negative bacteria *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Enterobacter aerogenes* and gram positive bacteria *Staphylococcus aureus* and *Bacillus cereus*. The complexes and the ligand were found most effective against the tested gram negative/positive bacteria.

5.2. Experimental Section

5.2.1. Materials and Methods

Analytical grade chemicals were used for synthesis without further purification. 1-ethyl imidazole, 2-bromoethylamine hydrobromide, 5-nitro-2-hydroxybenzaldehyde and NaBF₄ (sodium tetrafluoroborate) were purchased from Sigma Aldrich, Germany. Metal acetates and other reagents were used as obtained from SD Fine Chemicals, India. CH₃OH, petroleum ether, CHCl₃, DMF and DMSO were used after purification by standard methods described in the literature. The FIL, 1-(2-aminoethyl)-3-ethylimidazolium tetrafluoroborate, [2-aeem]BF₄ (**1c**) was synthesized by following a literature procedure [25]. The synthesis and structural characterization of the [2-aeem]BF₄ (**1c**) have been earlier described in chapter II.

FT-IR spectra were recorded by KBr pellets on a Perkin-Elmer Spectrum FT-IR spectrometer (RX-1). ¹H-NMR spectra were recorded on a FT-NMR (Bruker Avance-II 400 MHz) spectrometer by using D₂O and DMSO-*d*₆ as solvents. Powder X-ray diffraction (XRD) data were obtained on INEL XRD Model Equinox 1000 using Cu K α radiation ($2\theta=0-90^\circ$). Elemental microanalysis (CHN analysis) was performed on Perkin-Elmer (Model 240C) analyzer. Metal content was obtained from AAS (Varian, SpectraAA 50B) by using standard metal solutions procured from Sigma-Aldrich, Germany. Mass spectra were obtained on a JMS-T100LC spectrometer. The purity of the synthesized products was confirmed by thin layer

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chromatography (TLC) Merck 60 F254 silica gel plates (layer thickness 0.25 mm) and the spots were visualized using UV-light. The UV-Visible spectra were obtained from JascoV-530 double beam Spectrophotometer using CH₃OH as solvent. Specific conductance was measured at (298.15 ± 0.01) K with a Systronic conductivity TDS-308 metre. Magnetic susceptibility was measured with a Sherwood Scientific Ltd magnetic susceptibility balance (Magway MSB Mk1) at ambient temperature. The melting point of synthesized compounds was determined by open capillary method. Antibacterial activity (*in vitro*) of the synthesized ligand and complexes were evaluated by well diffusion method against six bacterial strains (Two gram positive and four gram negative). The bacterial strains were obtained from MTCC, Chandigarh, India.

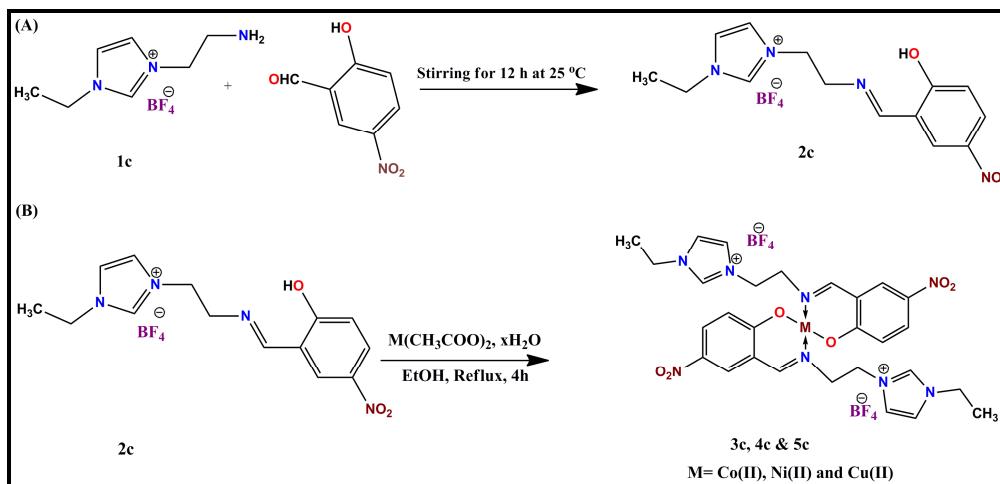
5.2.2. Synthesis of imidazolium ionic liquid-supported Schiff base, LH (2c)

Following literature procedure [26] 5-nitro-2-hydroxybenzaldehyde (1.67 g, 10 mmol) and [2-aaeim]BF₄ (2.27 g, 10 mmol) were taken in round bottomed flask and dissolved in methanol. The reaction mixture was stirred at 25 °C for 4 h. After completion of reaction, the product diluted using ethanol. The precipitate was filtered, washed with cold EtOH and dried properly to collect the expected ligand as a yellowish brown solid. 2.85 g (yield, 75 %). M. p. 95-97 °C. Anal. Calc. for C₁₄H₁₇N₄O₃BF₄ (376): C, 44.71; H, 4.56; N, 14.90. Found: C, 44.64; H, 4.49; N, 14.83 %. FT-IR (KBr, cm⁻¹) 3448 (O-H), 3071, 1664 (C=N), 1343 (N-O), 1293 (C-O), 1095 (B-F). ¹H NMR: (400 MHz, DMSO-d₆): δ 3.36 (q, 2H, N-CH₂), 3.60 (s, 3H, CH₃), 3.92 (t, 2H, N-CH₂), 4.60 (t, 2H, N-CH₂), 7.44 (s, 1H, NCH), 7.52 (s, 1H, NCH), 7.53 (s, 1H, N=CH), 7.61-7.59 (m, 3H, Ar-H), 8.65 (s, 1H, N(H)CN), 8.88 (s, 1H, OH). ¹³C NMR: (400 MHz, DMSO-d₆): δ 159.76, 138.43, 134.08, 130.47, 130.31, 123.89, 119.80, 118.65, 110.65, 39.86, 39.65, 39.24, 39.03 and 38.82. UV-Vis (Methanol, λmax): 206, 234, 306 nm; ESI-MS (CH₃OH, m/z): 289 ([M-BF₄]⁺, M=[C₁₄H₁₇N₄O₃]⁺).

5.2.3. Synthesis of the metal complexes (3c, 4c and 5c)

To an ethanolic solution of ligand, LH (2c) (0.376 g, 1 mmol) in round bottomed flask, Metal acetate salt Co(II), Ni(II) and Cu(II)), *viz.*, (0.5 mmol) dissolved in ethanol was added and the reaction mixture was refluxed for 12 h until the starting materials were completely consumed as monitored by TLC. On

completion of the reaction, solvents were evaporated and the reaction mixture was cooled to room temperature. The precipitate was collected by filtration, washed successively with cold ethanol ($10\text{ mL} \times 3$). Finally it was dried in vacuum desiccators to obtain the solid product. The complexes were soluble in *N,N*-dimethylformamide, dimethylsulphoxide, acetonitrile, methanol and water. The reactions are given in Scheme 5.1.



Scheme 5.1. Synthesis of the ionic liquid-supported Schiff base, 1-{2-(2-hydroxy-5-nitrobenzylideneamino)ethyl}-3-ethylimidazolium tetrafluoroborate (**2c**), and its M(II) complexes (**3c**, **4c** and **5c**) from (**2c**).

5.2.2.1. Co(II) complex (3c): Brown solid; 0.54 g (yield, 67 %), decomposes at $\sim 293^\circ\text{C}$. Anal. Calc. for $\text{C}_{28}\text{H}_{36}\text{CoB}_2\text{F}_8\text{N}_8\text{O}_8$ (809): 41.56; H, 3.99; N, 13.85, Co, 7.28. Found: C, 41.36; H, 3.71; N, 13.55, Co, 7.12 %. FT-IR (KBr, cm^{-1}): 3386 (O-H), 1648 (C=N), 1332 (N-O), 1177 (C-O), 1106 (B-F), 651 (M-O), 510 (M-N). UV-Vis (Methanol, $\lambda_{\text{max}}/\text{nm}$): 227, 246, 358. ESI-MS (CH_3OH , m/z): 635 ($[\text{M}-2\text{BF}_4]^+$, $\text{M} = [(\text{C}_{28}\text{H}_{32}\text{CoN}_8\text{O}_6)]^+$).

5.2.2.2. Ni(II) complex (4c): Light green solid; 0.56 g (yield, 69 %), decomposes at $\sim 291^\circ\text{C}$. Anal. Calc. for $\text{C}_{28}\text{H}_{36}\text{NiB}_2\text{F}_8\text{N}_8\text{O}_8$ (809): C, 41.57; H, 3.99; N, 13.85; Ni, 7.26. Found: C, 41.22; H, 3.63; N, 13.46, Ni, 7.11 %. FT-IR (KBr, cm^{-1}): 3396 (O-H), 1637 (C=N), 1330 (N-O), 1172 (C-O), 1102 (B-F), 646 (M-O), 526(M-N). UV-Vis (Methanol, $\lambda_{\text{max}}/\text{nm}$): 220, 340, 400. ESI-MS (CH_3OH , m/z): 634 ($[\text{M}-2\text{BF}_4]^+$, $\text{M} = [(\text{C}_{28}\text{H}_{32}\text{NiN}_8\text{O}_6)]^+$).

5.2.2.3. Cu(II) complex (5c**):** Dark green solid; 0.57 g (yield, 70 %), decomposes at ~ 295 °C. Anal. Calc. for $C_{28}H_{36}CuB_2F_8N_8O_8$ (813.76): C, 41.33; H, 3.96; N, 13.77; Cu, 7.81. Found: C, 41.12; H, 3.61; N, 13.46, Cu, 7.61 %. FT-IR (KBr, cm^{-1}): 3429 (O-H), 1656 (C=N), 1334 (N-O), 1175 (C-O), 1103 (B-F), 633 (M-O), 471 (M-N). UV-Vis (Methanol, λ_{max}/nm): 226, 244, 354. ESI-MS (CH₃OH, m/z): 639 ([M-2BF₄]⁺, M= [(C₂₈H₃₂CuN₈O₆]⁺).

5.4.4. Antibacterial assay

The synthesized ligand (**2c**) and complexes (**3c**, **4c** and **5c**) were screened against the gram negative bacteria (*E. coli*, *P. aeruginosa*, *P. vulgaris* and *E. aerogenes*) and gram positive bacteria (*S. aureus* and *B. cereus*) strains. The tests were performed using agar disc diffusion method [27]. The nutrient agar (Hi-Media Laboratories Limited, Mumbai, India) was put in an autoclave at 121 °C and 1 atm for 15-20 minutes. The sterile nutrient medium was kept at 45-50 °C and then 100 µL of bacterial suspension containing 10⁸ colony-forming units (CFU)/mL was mixed with sterile liquid nutrient agar and poured into the sterile Petri dishes. All the stock solutions were made by dissolving the compounds in dimethyl sulphoxide (DMSO). The concentrations of the tested compounds were 10, 20, 30, 40 and 50 µg/mL. The tested microorganisms were grown on nutrient agar medium in Petri dishes. The samples were soaked in a filter paper disk of 1 mm thickness and 5 mm diameter. The discs were kept on Petri plates and incubated for 24 hours at 37°C. The diameter of the inhibition zone (including disc diameter of 5 mm) was measured. Each experiment was carried out three times to minimize the error and the mean values were accepted.

5.3. Results and Discussion

All the isolated compounds were stable at room temperature to be characterized by different analytical and spectroscopic methods.

5.3.1. FT-IR spectral studies

The assignments of the IR bands of the synthesized Co(II), Ni(II) and Cu(II) complexes had been made by comparing with the bands of ligand (LH) to determine the coordination sites involved in chelation. FT-IR spectra of LH (**2c**) showed a strong broad band at 3448-3071 cm^{-1} ; which was due to the hydrogen bonded phenolic group (-OH) with H-C(=N) group in the ligand (OH...N=C) [28, 29]. The broad band appeared at 3386-3429 cm^{-1} for the metal complexes (**3c**, **4c** and **5c**) suggested the

presence of the solvated water molecules (probably for the presence of $-NO_2$ group in the ligand and intrinsic property of the anion tetrafluoroborate) [30-32]. The band corresponding to the azomethine group ($-C=N$) of the ligand was found at 1664 cm^{-1} . This band gets shifted in the range $1637\text{-}1656\text{ cm}^{-1}$ because of coordination of N atom of azomethine linkage to the Co^{+2} , Ni^{+2} and Cu^{+2} ions respectively [33]. The band for phenolic C-O of free ligand was observed at 1293 cm^{-1} which moved to lower wave number $1172\text{-}1177\text{ cm}^{-1}$ for the complexes (**3c**, **4c** and **5c**) upon complexation. This fact established the bonding of ligand (**2c**) to the metal atoms through the N atom of azomethine and O atom of phenolic group [34]. The bands appeared in the region of $1102\text{-}1107\text{ cm}^{-1}$ for the metal complexes were assigned for B-F stretching frequency. FT-IR spectra of the LH (**2c**) and its complexes showed strong bands at $1330\text{-}1343\text{ cm}^{-1}$ which were assigned for the NO_2 group [35]. The spectra of the metal complexes exhibited bands at $633\text{-}651$ and $471\text{-}526\text{ cm}^{-1}$ were attributed to M-O and M-N stretching vibrations, respectively [36]. FT-IR spectra of the Schiff base and its metal complexes are given in Figs 5.1-5.4.

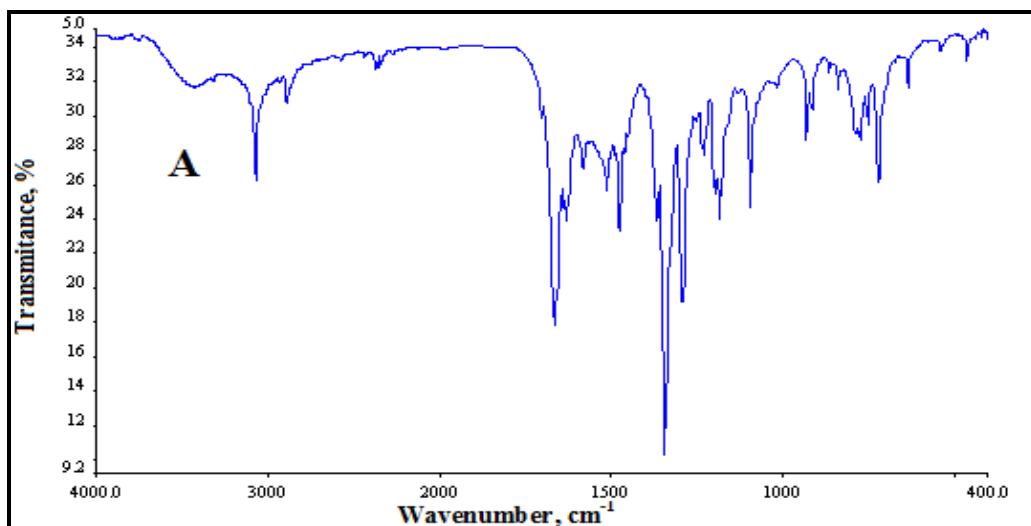


Fig 5.1. FT-IR spectrum of LH (**2c**).

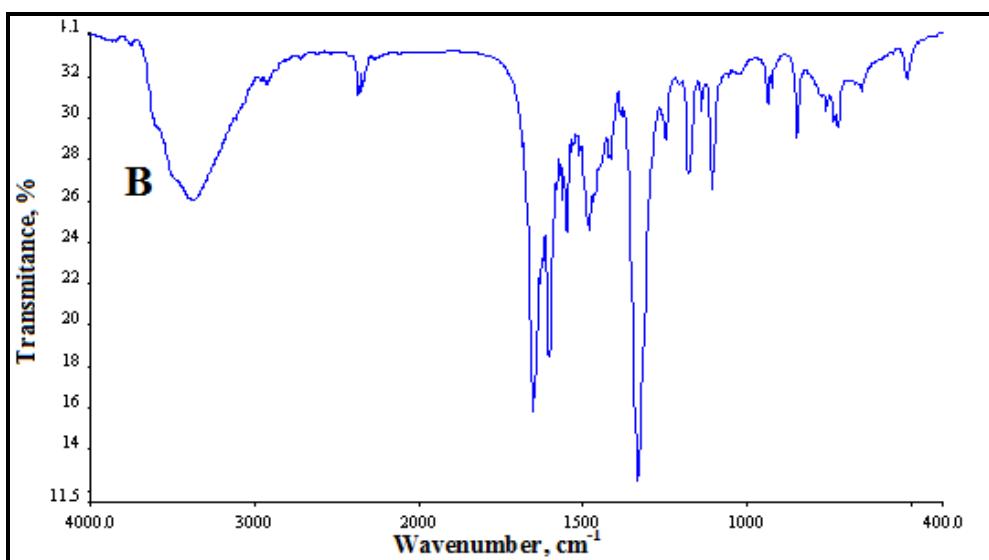


Fig 5.2. FT-IR spectrum of Co(II) complex (3c).

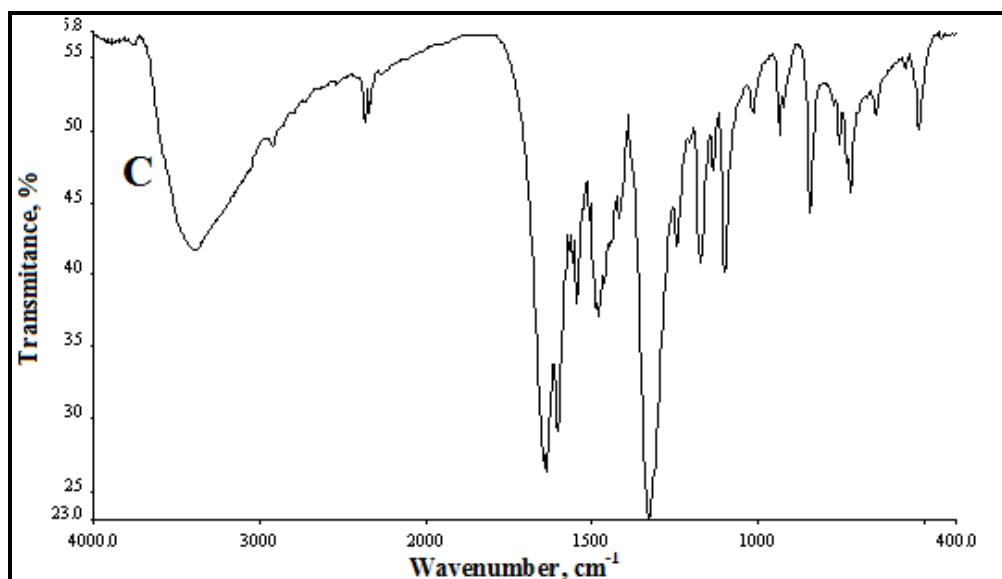


Fig 5.3. FT-IR spectrum of Ni(II) complex (4c).

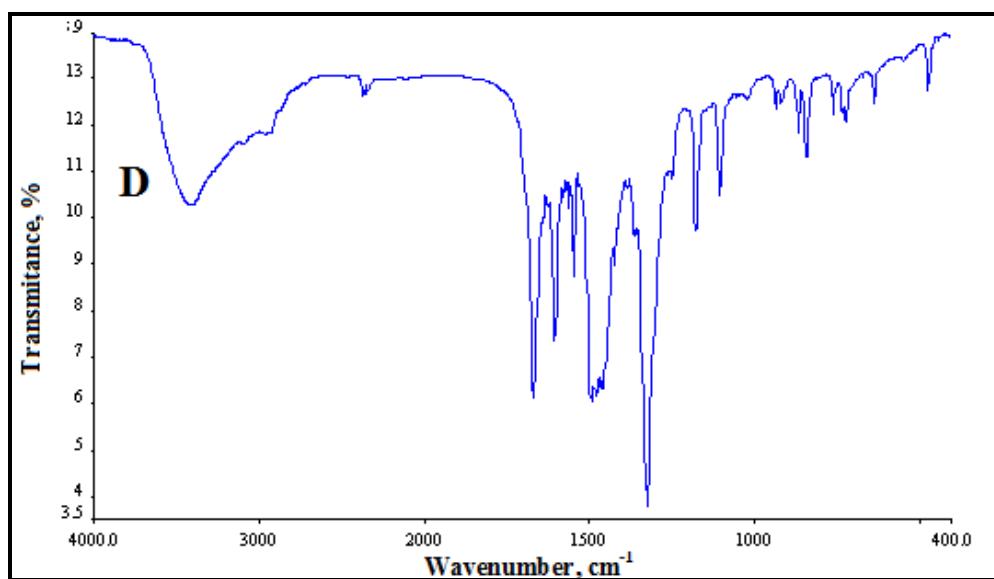


Fig 5.4. FT-IR spectrum of Cu(II) complex (**5c**).

5.3.2. Mass spectral studies

To get information regarding the structure of the synthesized compounds at the molecular level, electrospray ionization (ESI) mass spectrometry was performed using methanol as solvent. Mass-spectra of the LH (**2c**) had a molecular ion peaks at m/z 289, that corresponds to $[\text{M}-\text{BF}_4]^+$, $[\text{M}= \text{C}_{14}\text{H}_{17}\text{N}_4\text{O}_2]^+$. The metal complexes (**3c**, **4c** and **5c**) exhibited molecular ion peaks (*m/z*) at 635 ($\text{M}= [\text{C}_{28}\text{H}_{32}\text{CoN}_8\text{O}_6]^+$), at 634 ($\text{M}= [\text{C}_{28}\text{H}_{32}\text{CuN}_8\text{O}_6]^+$) and at 639 ($\text{M}= [\text{C}_{28}\text{H}_{32}\text{CuN}_8\text{O}_6]^+$) which confirmed their stoichiometry as Co(L)₂, Ni(L)₂ and Cu(L)₂ respectively. The mass spectra of the ligand and complexes were in good agreement with the respective structures as revealed by the elemental and other spectral analyses. The ESI-MS spectra of the ligand and complexes are shown in Figs 5.5-5.8.

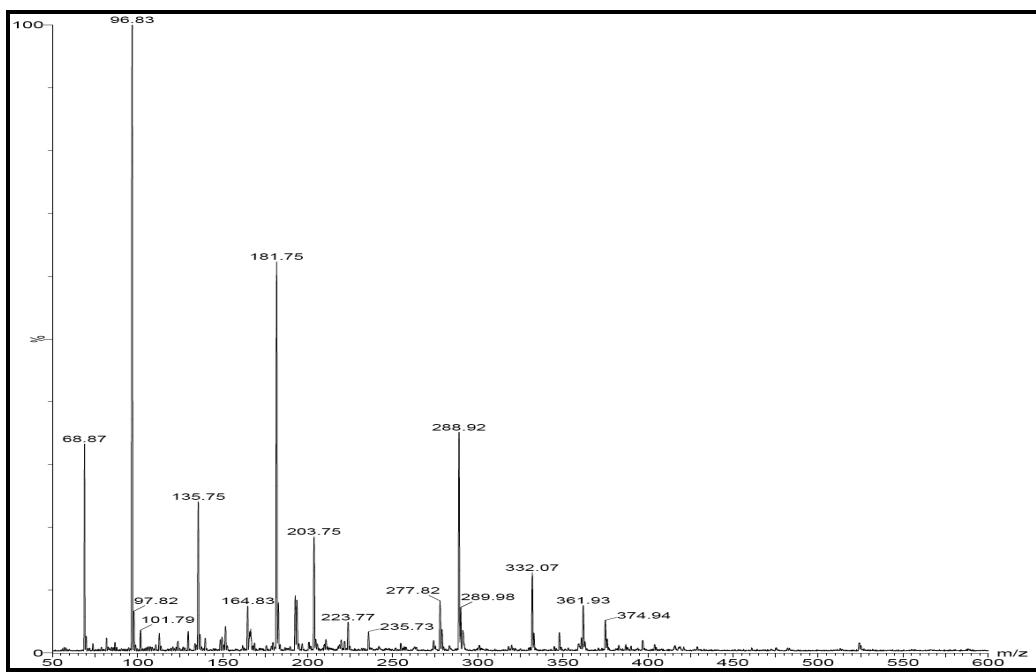


Fig 5.5. ESI-MS spectrum of LH (2c).

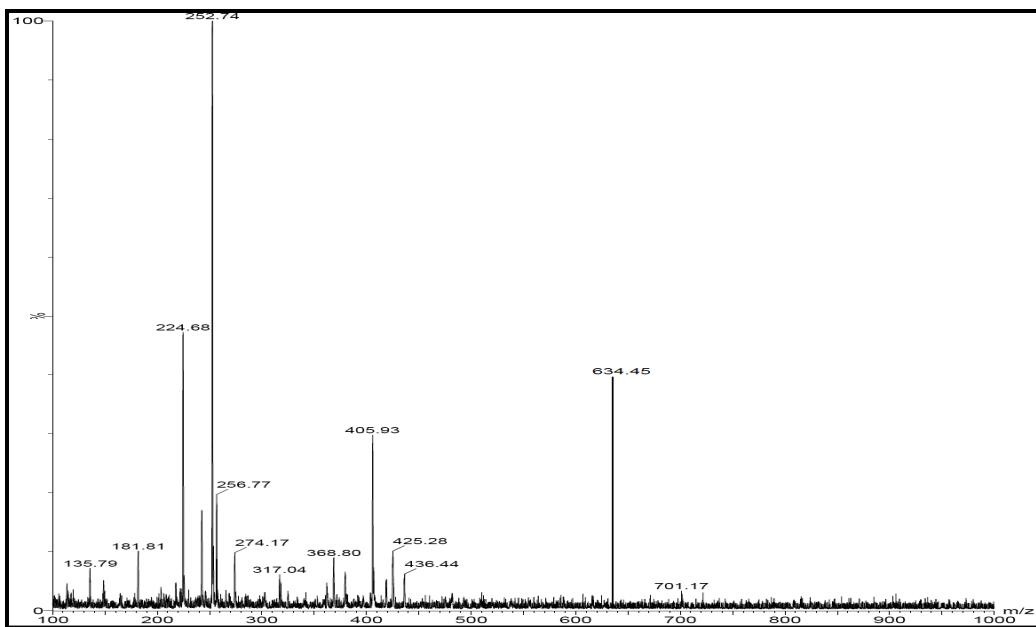


Fig 5.6. ESI-MS spectrum of Co(II) complex (3c).

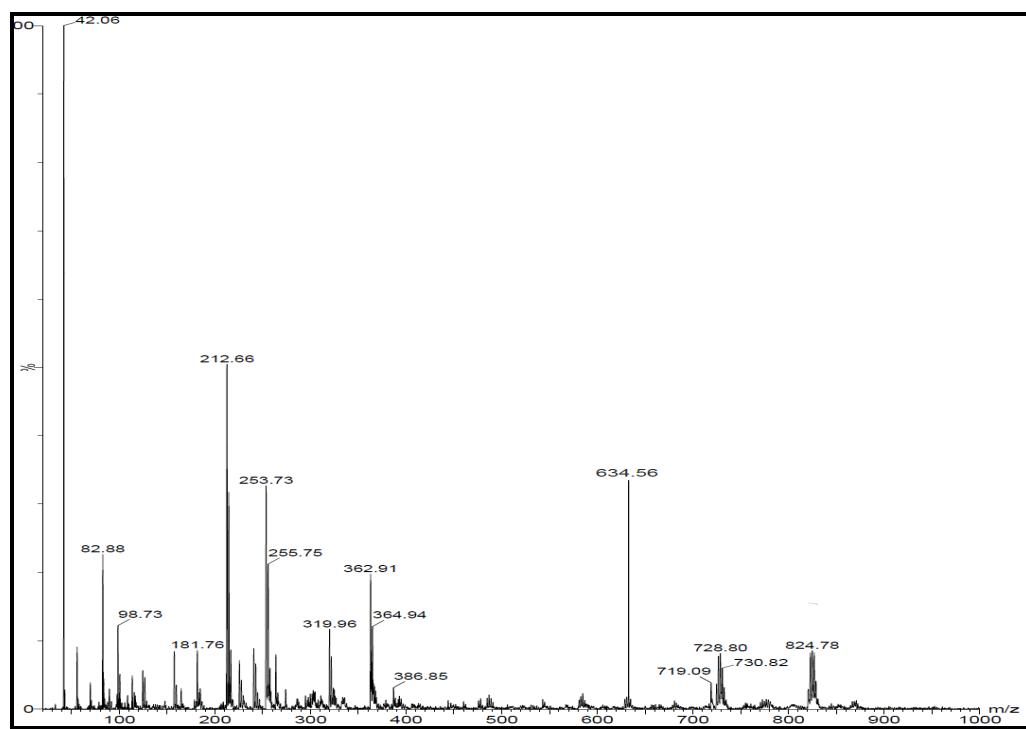


Fig 5.7. ESI-MS spectrum of Ni(II) complex (4c).

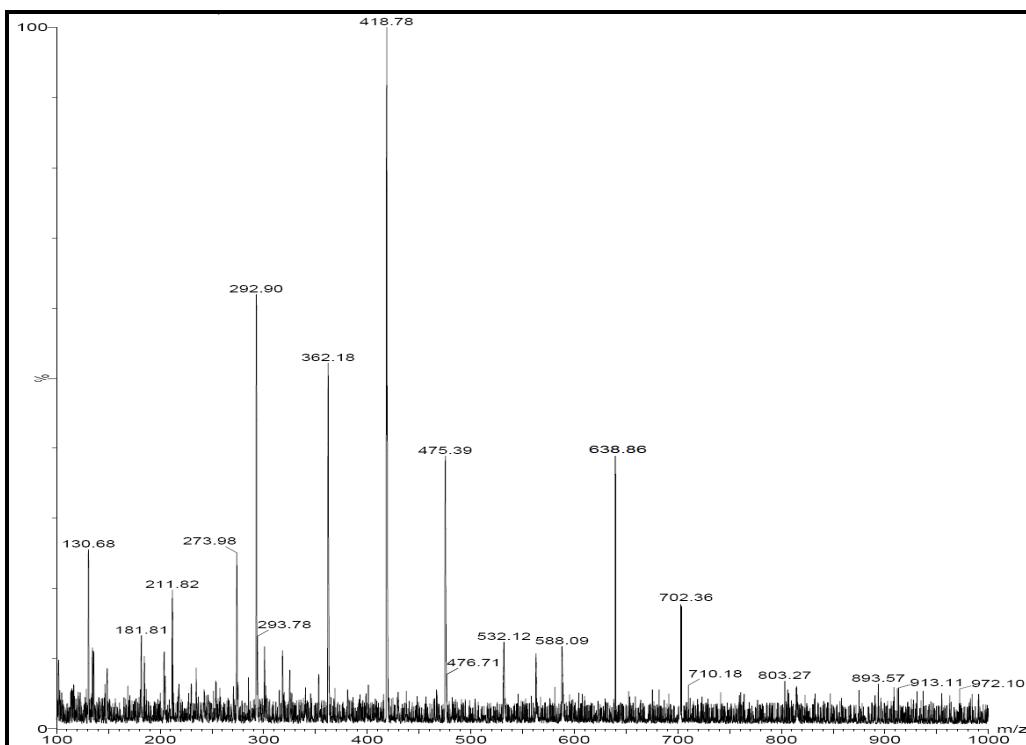


Fig 5.8. ESI-MS spectrum of Cu(II) complex (5c).

5.3.3. 1H and ^{13}C -NMR spectral studies

¹H-NMR and ¹³C-NMR spectra of Schiff base were recorded in DMSO-*d*₆ (Shown in Fig 5.9 and Fig 5.10). ¹H-NMR spectra of the ligand showed singlet at 7.60 ppm which was assignable to proton of the azomethine linkage (-CH=N-) might be because of the effect of the *ortho*-hydroxyl group in the aromatic ring. A singlet at 8.88 ppm was assigned to hydroxyl proton (-OH). The downfield shift of the phenolic (-OH) proton was observed due to intramolecular (O-H...N) hydrogen bonding in the ligand [37]. ¹³C-NMR spectra of ligand exhibited peaks at δ 159.76 and 138.43 which were detected for the phenolic (C-O) and imino (-CH=N) carbon atoms (due to Keto-imine tautomerism). The aromatic carbons showed peaks at δ 134.08, 130.47, 130.31, 123.89, 119.80 and 118.65.

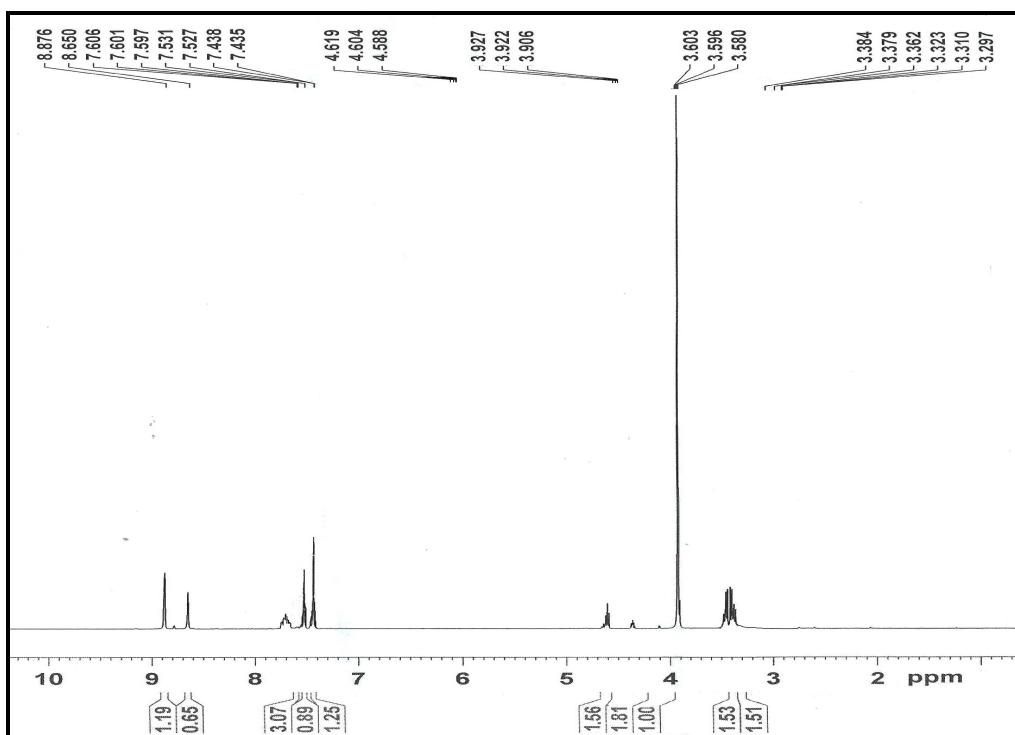


Fig 5.9. ^1H -NMR spectrum of LH (**2c**).

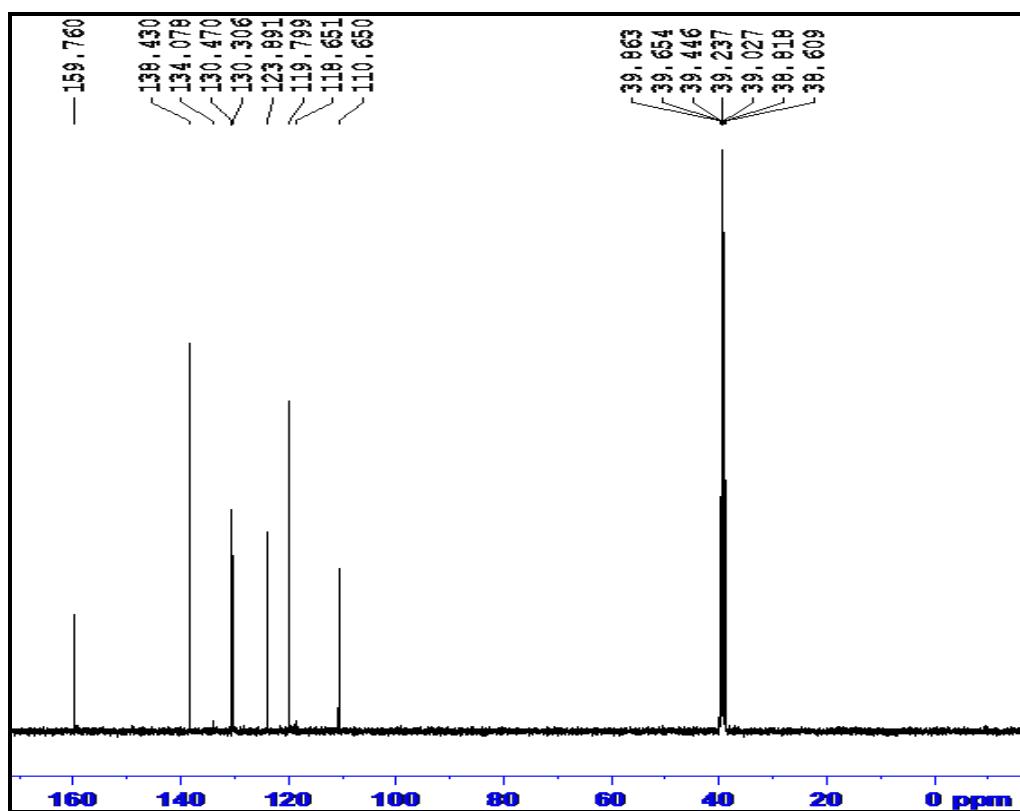


Fig. 5.10. ^{13}C -NMR spectrum of LH (**2c**).

5.3.4. Powder X-ray diffraction analysis

The PXRD analysis of the synthesized compounds was carried out to find whether the particle nature of the samples was amorphous or crystalline. The PXRD spectrum of ligand (LH) exhibited sharp peaks because of their crystalline nature although the spectra of the two complexes didn't show such peaks for their amorphous nature (Shown in Figs 5.11-5.14). The crystalline sizes were calculated using Debye Scherer's equation: $D = 0.9 \lambda / \beta \cos\theta$, where constant 0.9 is the shape factor, λ is the X-ray wavelength (1.5406 Å), β is the full width at half maximum (FWHM) and θ is the Bragg diffraction angle. The experimental average grain sizes of LH and its metal complexes were found to be 31.71 nm (**2c**), 7.76 nm (**3c**), 3.26 nm (**4c**) and 4.52 nm (**5c**).

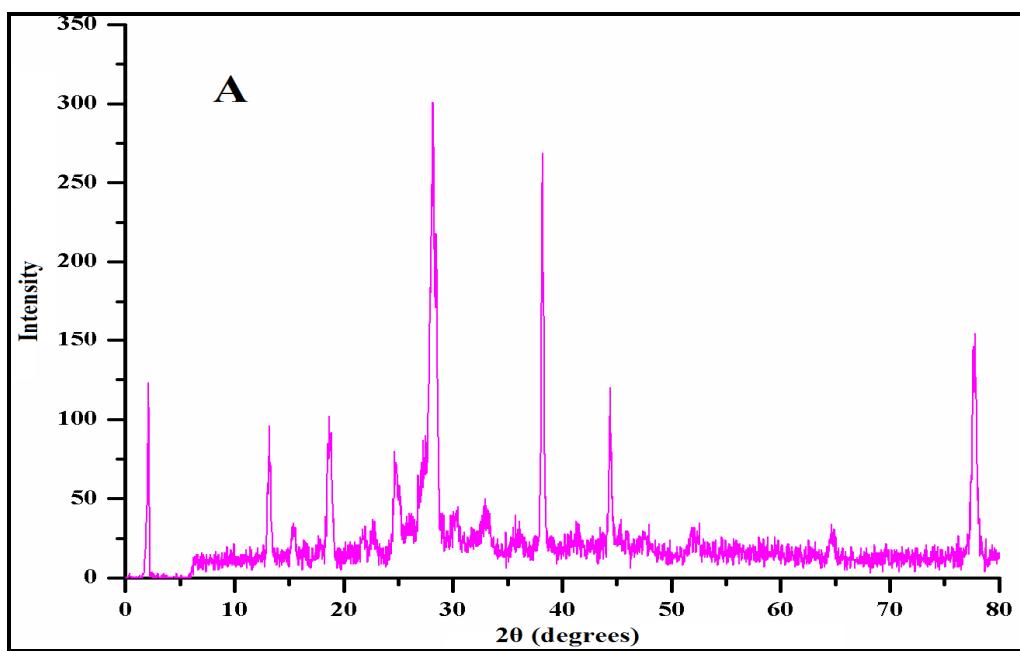


Fig 5.11. PXRD patterns of LH (**2c**).

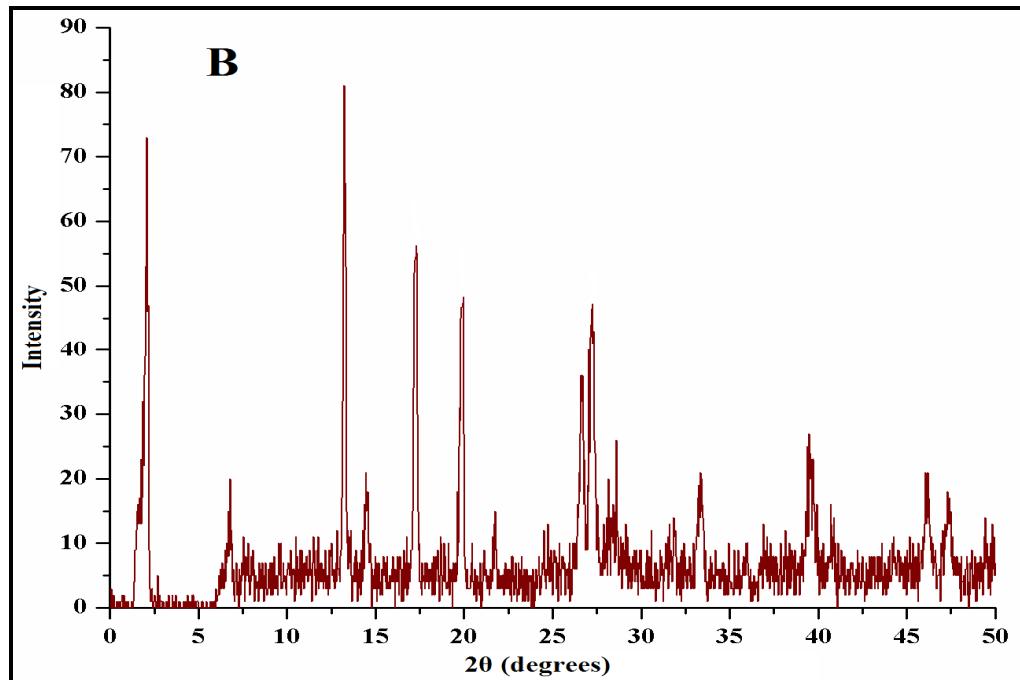


Fig 5.12. PXRD patterns of Co(II) complex(**3c**).

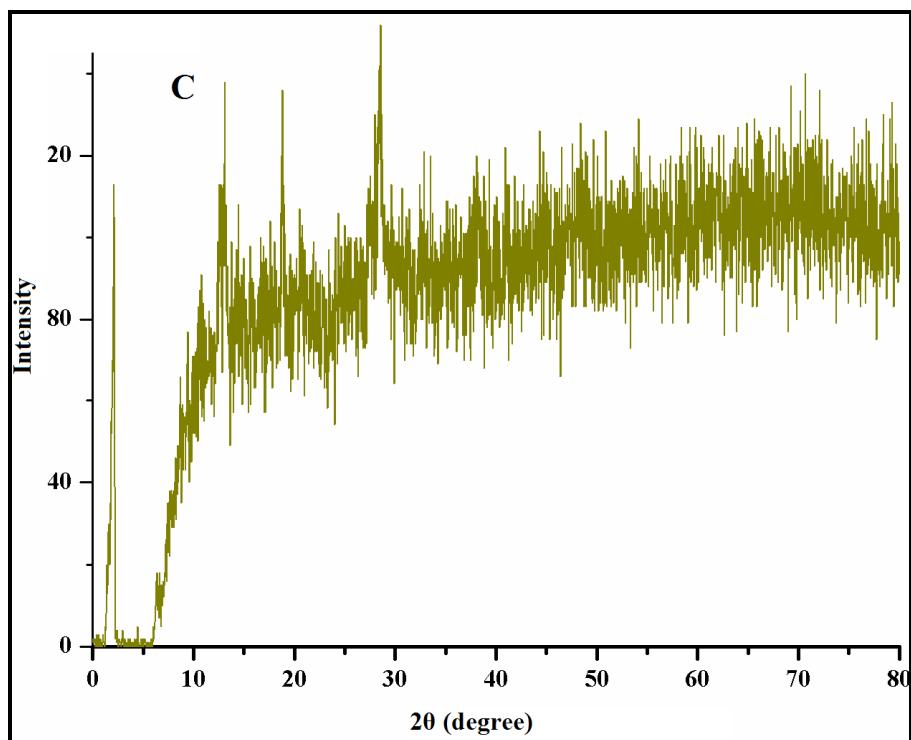


Fig 5.13. PXRD patterns of Ni(II) complex (**4c**).

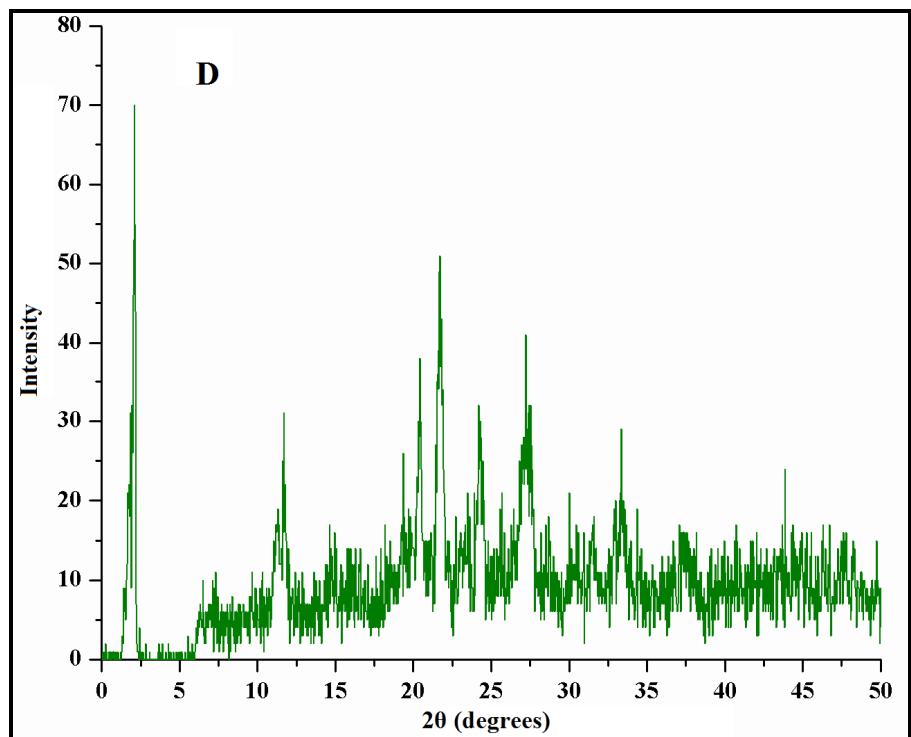


Fig 5.14. PXRD patterns of Cu(II) complex (**5c**).

5.3.5. Molar conductance measurements

The molar conductance (Λ_m) of the complexes (**3c**, **4c** and **5c**) was determined by applying the relation $\Lambda_m = 1000 \times \kappa/c$, where κ and c stands for the specific conductance and molar concentration of metal complexes respectively. The complexes (1×10^{-3} M) were dissolved in DMF and their specific conductance was measured at (298.15 ± 0.01) K. The molar conductance data was observed as 123, 128 and $131\text{ S cm}^{-1}\text{mol}^{-1}$ for the metal complexes **3c**, **4c** and **5c** respectively indicating their 1:2 electrolytic natures.

5.3.6. Electronic absorption spectral and magnetic moment studies

The UV-Visible spectra of the Schiff base and its metal complexes (as depicted in Fig 5.15.) were recorded at room temperature using methanol as solvent. The LH (**2c**) exhibited three absorption bands at 306, 234 and 206 nm due to $n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$ and transitions involved with the imidazolium moiety, respectively [38, 39]. For the complexes, the bands that appeared below 350 nm were ligand centred transitions ($n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$). The Co(II) complex (**3c**) displayed a band at 354 nm which could be attributed to the combination of ${}^2\text{B}_{1g} \rightarrow {}^1\text{A}_{1g}$ and ${}^1\text{B}_{1g} \rightarrow {}^2\text{E}_g$ transitions and supporting square planar geometry [40, 41]. The complex (**3c**) showed magnetic moment of 2.30 B.M. due to one unpaired electron. The Ni(II) complex (**4c**) was diamagnetic and the band appeared at around 400 nm due to ${}^1\text{A}_{1g} \rightarrow {}^1\text{B}_{1g}$ transition is consistent with low spin square planar environment [42]. UV-visible spectra of Cu(II) complex (**5c**) exhibited $d \rightarrow \pi^*$ metal-ligand charge transfer transition (MLCT) at the region 358 nm had been assigned to the combination of ${}^2\text{B}_{1g} \rightarrow {}^2\text{E}_g$ and ${}^2\text{B}_{1g} \rightarrow {}^2\text{B}_{2g}$ transitions in a distorted square planar geometry [43, 44]. The experimental magnetic moment value for **5c** was 1.84 B.M. consistent with the presence of an unpaired electron [45].

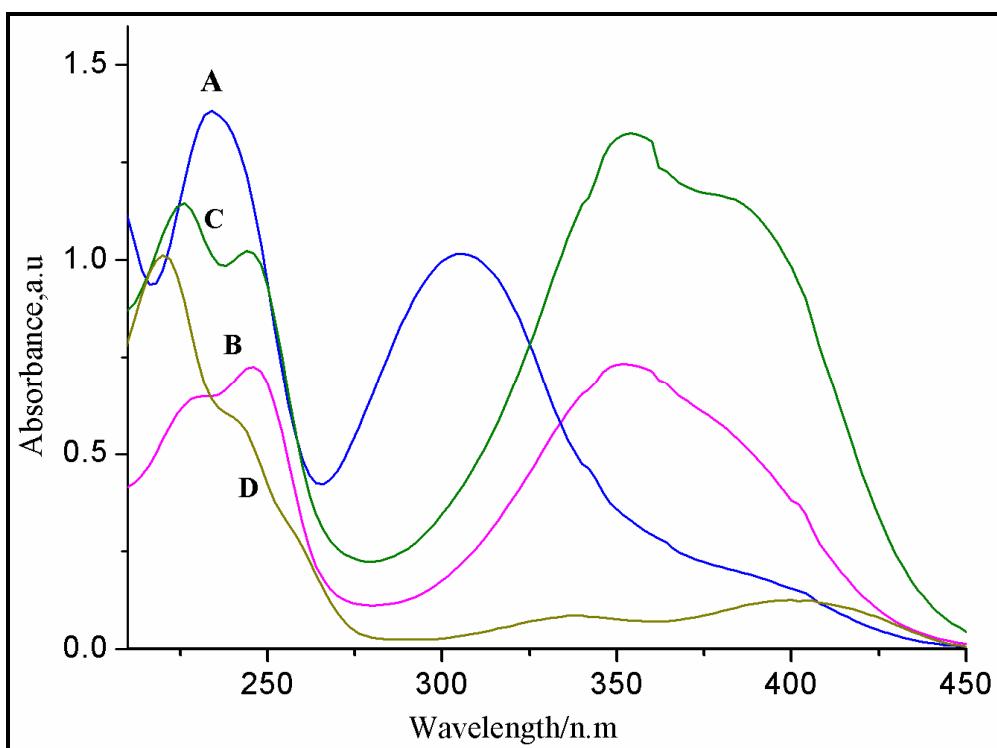


Fig 5.15. UV-visible spectra in methanol (concentration of the solutions 1×10^{-4} M): (A) LH (**2c**); (B) Co(II) complex (**3c**); (C) Ni(II) complex (**4c**) and (D) Cu(II) complex (**5c**).

5.3.6. Antibacterial activities

Antibacterial study of LH (**2c**) and its complexes (**3c**, **4c** and **5c**) was carried out *in vitro* against the gram negative/positive bacterial strains and the results were displayed in Table 5.1, Table 5.2 and also in Fig 5.16. Minimum inhibitory concentration (MIC) was measured by Broth Micro dilution susceptibility method. No inhibition zone was found for the solvent control (DMSO) for each bacterial suspension. A serial dilution of sample extracts was made in nutrient broth medium. Then 1 mL of standard (*0.5 Mc Farland*) bacterial suspension was inoculated into each of these tubes. A similar nutrient broth tube without sample extract was also inoculated and used as control. The samples under investigation have shown promising results against the tested bacterial strains. The LH (**2c**) was most effective against *S. aureus* only. The Co(II) complex (**3c**) showed most effectiveness against *S. aureus*, *E. aerogenes*. The Ni(II) complex (**4c**) showed higher acitivity against *E. aerogenes*. Although in other cases it showed moderate activity. It was found that

Table 5.1. Antibacterial activity data of Schiff base (**2c**) and its metal complexes (**3c**, **4c** and **5c**) against *E. Coli*, *S. aureus* and *B.cereus*.

Specimen	Concentration (µg/mL)														
	<i>E. coli</i>					<i>S. aureus</i>					<i>B.cereus</i>				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
LH (2c)	-	6	7	8	12	7	9	10	10	12	-	-	6	8	12
Co(II) complex (3c)	-	-	6	7	8	6	7	7	9	10	-	6	6	8	10
Ni(II) complex (4c)	6	7	8	9	9	-	-	7	8	10	-	-	6	8	10
Cu(II) complex (5c)	8	9	14	15	18	6	8	10	17	17	-	-	-	-	7

Table 5.2. Antibacterial activity data of Schiff base (**2c**) and its metal complexes (**3c**, **4c** and **5c**) against *P. aeruginosa*, *P. vulgaris* and *E. aerogenes*.

Specimen	Concentration (µg/mL)														
	<i>P. aeruginosa</i>					<i>P. vulgaris</i>					<i>E. aerogenes</i>				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
LH (2c)	-	6	9	15	16	-	6	9	10	14	-	6	8	10	13
Co(II) complex (3c)	-	7	9	10	13	-	-	-	6	7	8	10	13	15	17
Ni(II) complex (4c)	-	-	6	7	9	-	-	6	7	8	8	10	12	12	16
Cu(II) complex (5c)	-	6	12	12	14	-	7	7	8	16	-	-	6	7	10

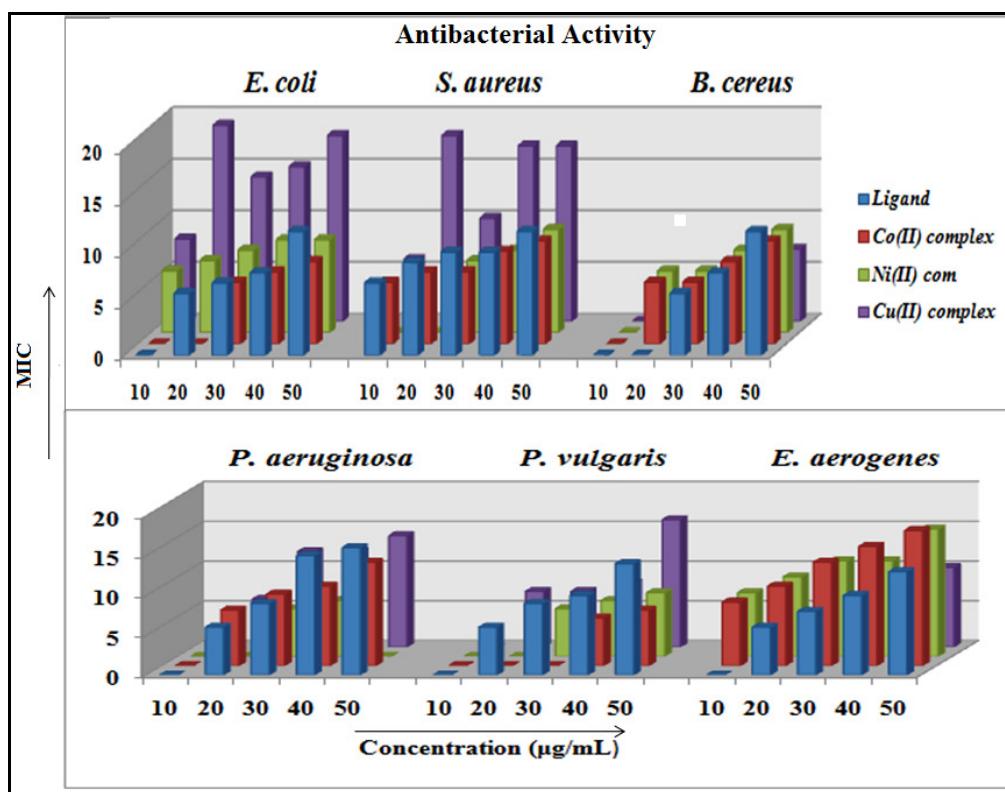


Fig 5.16. Inhibition zones for the LH (**2c**), Co(II) complex (**3c**), Ni(II) complex (**4c**) and Cu(II) complex (**5c**).

Cu(II) complex (**5c**) was most effective against the tested bacteria. The observation suggested that the chelation could facilitate the capability of the complexes to penetrate bacterial cell membrane [46]. Such a chelation could enhance the lipophilic property of the corresponding metal ions that favours permeation towards the lipid layer of cell membrane. The activity of both the complexes and ligand enhanced as the concentration was increased which were due to the growth of degree of inhibition.

5.4. Conclusion

Herein this chapter, new Co(II), Ni(II) and Cu(II) complexes of an ionic liquid-based Schiff base, 1-{2-(2-hydroxy-5-nitrobenzylideneamino)ethyl}-3-ethylimidazolium tetrafluoroborate were synthesized and characterized by different spectral and analytical techniques. The Schiff base ligand played as a potential bidentate ligand coordinating through the N-atom of azomethine and O-atom of phenolic group to the metal ions and thus formed 1:2 (M:L) complexes. Spectral and magnetic susceptibility data revealed that the ligand was arranged in square planar

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geometry around the central metal ions. The antibacterial study of the synthesized compounds was performed and metal complexes have exhibited promising activity against the tested bacteria.

References

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Chapter V

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