

Synthesis, Spectral Characterization and Antibacterial Assay: Co(II) Coordination Compounds of 4-Aminoantipyrine based Macrocyclic Ligands

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Abstract

A new series of tetra dentate N_4 donor macrocyclic Schiff bases L1-L5 were synthesized by condensation reaction between the derivative of 4-aminoantipyrine(L) and a variety of diamines such as 1,4-diamino butane, carbanohydrazide, 4H-1,2,4-triazole-3,5-diamine, 2-amino benzohydrazide and naphthalene-1,8-diamine respectively. Macrocyclic Schiff base ligands L1-L5 were further treated with cobalt chloride to yield Co(II) complexes (CoL1-CoL5). All these newly prepared ligands and complexes have been characterized with the help of Mass, Infra-Red, ^1H & ^{13}C NMR, Electronic spectral, Elemental magnetic, Molar conductance and Thermal studies. Macrocyclic and complex compounds were screened to evaluate antibacterial property in opposition to some cultured microbes. Inhibition zones are measured further minimum inhibitory concentrations determined, compared with existing drugs.

Keywords: 4-Aminoantipyrine, Macrocyclic, Schiff base, Co(II) complexes, Spectral Characterization, Antibacterial studies.

Introduction

Antipyrine name derived from its temperature dropping property in human beings which first time observed by Knorr. 4-aminoantipyrine, important derivative of pyrazolone readily condensed with the different carbonyl compounds to give a various types of Schiff bases which are applied in several significant fields such as biology, pharmacology, clinical and analytical industries¹⁻². The Schiff bases have azomethine linkage in which nitrogen is donor atom hence these act as potential ligands in the formation of complexes with various metals³⁻⁸. People from diverse divisions have worked on 4-aminoantipyrine and reported vast number of transition metal complexes with this pyrazolone based heterocyclic compound⁹⁻¹¹. Amongst Schiff base derived from 4-aminoantipyrine complexes attracted huge attention owing to their applications in the area of biology¹²⁻¹⁷.

However, 4-aminoantipyrine and Schiff bases of 4-aminoantipyrine are good antimicrobial agents, the activity enhanced upon coordination with different metal ions¹⁸⁻²¹. Hence we are aimed to synthesize new macrocyclic ligands of antipyrine derivative and their Co(II) compounds to screen antibacterial activity.

Materials and Methods

Materials: Chemicals viz., Cobalt(II) chloride, 4-aminoantipyrine, orthophthalaldehyde (OPA), 1,4-diamino butane, carbanohydrazide, 4H-1,2,4-triazole-3,5-diamine, 2-amino benzohydrazide and naphthalene-1,8-diamine were obtained from Aldrich and organic solvents such as ethanol, methanol,

dichloro methane, DMSO used in this study were analytical grade acquired from MERCK. These were all solvents purified by standard procedures and kept with using molecular sieves²². All the compounds were verified for purity with the help of TLC silica gel plates.

Physical and analytical methods: The percentages of carbon, hydrogen and nitrogen present in ligands and their complexes were obtained by help of Elemental Analyzer Perkin-Elmer 240 C apparatus. The melting points of the products were determined by open capillaries on a Buchi apparatus. TG-DTG studies were performed under a dynamic atmosphere of dry nitrogen with sample masses approximated to <10 mg using Mettler-Toledo instrument. The FTIR spectra recorded with Perkin Elmer-283 spectrophotometer. ^1H and ^{13}C NMR spectra were recorded with a Mercury plus 400 spectrometer (operating at 400 MHz for ^1H and 100.58 MHz for ^{13}C); chemical shifts were referenced to TMS. EI (electron impact) mass spectra (ionizing voltage of 70 eV) were obtained using a Finnigan Mat 1210 and MICROMASS-7070 spectrometers. Shimadzu UV-160A a double beam spectrophotometer consists of quartz cells with path length 1 cm are employed for recording electronic spectra. To determine molar conductance values Digison DL-909 conductivity instrument is used. Magnetic nature and susceptibility values of complexes are established by using Gouy balance method.

Synthesis of ligands: Initially derivative of 4-aminoantipyrine (L) prepared by introducing 4-aminoantipyrine (2 mmol), dissolved in ethanol (25 mL), to orthophthalaldehyde (1 mmol) solution in ethanol (25 mL) (Scheme-1). The resulting yellowish solution was refluxed and reaction mixture subjected to very

low pressure conditions and set aside at 27°C for two days to remove solvent. The light gold colored semisolid (L) obtained is filtered with suction pump, rinsed with ethoxy ethane solvent. It was recrystallised by using ethanol. Further ethanolic solution of L (2 mmol) was refluxed with diamines (2 mmol) viz., 1,4-diamino butane(L1), carnohydrazide(L2),4H-1,2,4-traizole-3,5-diamine(L3),2-amino benzohydrazide(L4) and naphthalene-1,8-diamine(L5) respectively by adding 1g of dry K₂CO₃ for about 5-7 h (Scheme-2). The quantity of reaction medium was lessened to get the semisolid and then it is washed by rinsing with warm water and kept at 0°C for one day. Final product obtained has been separated followed by recrystallized with ethanol.

Synthesis of Macrocylic Schiff base Co(II) complexes: All newly synthesized Macrocylic Schiff base ligands and the metal salt CoCl₂.6H₂O were used as starting materials. Standard procedure was used to prepare all complexes and same method employed for all ligands due to similarity. 25 mL Ethanolic solution of cobalt chloride (5 mmol) is introduced in to a newly prepared 5 mmol ligand solution with continuous rotating. Further reaction flask is placed on hot water tub and refluxed for few hours to get solid. This solid is separated from solvent with help of suction pump and then rinsed many times with chloroform followed by ethanol, further it is placed in evacuated anhydrous calcium chloride chamber to become dry .

Antibacterial activity: All newly prepared compounds are investigated for In vitro antibacterial studies using four different microorganisms are *Escherichia coli*, *Klebsiella pneumonia*, *Basillussubtilis*, *Staphylococcus aureus*.

Antibiotics Streptomycin and Rifampicin are used as the standards in the present investigation and compared with the newly synthesized compounds. Antibacterial screening was carried out by cup plate method is a standard literature procedure²³. In present study microorganism media is blend of agar and broth which is purchased from Hi-media. Sample solution of compound has been made by adding compound (10 mg) to appropriate (10 ml) solvent. Further it is used to prepare various concentrated solutions like 100, 50, 20, 15, 10, 5, 2, 1 µg/ml by simple dilution. Agar medium in molten state about to 25 ml was placed in sterilized Petri dishes and kept a side for some time to become solid. Later one day cultured microorganism about 50 ml was introduced and spreaded evenly on to the above prepared agar medium dish by using sterilized cotton scrub.

With the help of borer regular holes (5mm) were prepared on the medium contains microorganism culture. These bores were further filled with sample solutions of compounds properly with micropipette. Same procedure also followed in the case of standard antibiotics. In presence of aerobic conditions all plates were incubated at the temperature of 37 °C for 24 hours²⁴. Then zones of inhibition of growth for all compounds and antibiotics were determined and compared. The results were represented as

good active, medium active and inactive. The MIC values of active compounds measured by using literature method²⁵⁻²⁷.

Characterization of new compounds: Macrocylic Schiff base ligands have been prepared by treatment of derivative of 4-aminoantipyrine with different diamines and diaminohydrazides in basic medium (Scheme-1). All newly synthesized ligands were prepared their Co(II) complexes by reacting CoCl₂.6H₂O with five N4 donor ligands individually and all the complexes formed are air stable. Elemental studies (C, H and N percentages) for all these compounds are carried out by using CHN analytic instrument. Quantitative estimation of metal in complexes carried out by standard method²⁸. Tentative molecular formulas for all newly synthesized compounds were established based on these analytical methods (Table-1).

Infrared Spectral Studies: IR and far IR spectral data of all compounds with important absorption bands were tabulated in Table-2, spectra of L1 and its Co(II) complex are represented in Figure-1 and 2. The comparison of the absorption bands of the complexes with that of ligands helps in identifying the bonding pattern in complex compounds. All ligands exhibited two strong intensity bands (three in the case of L3) in between 1608-1565 cm⁻¹ is matching to stretching frequencies of azomethine group (ν_{C=N}) which indicates the formation of condensed product of L and corresponding diamines^{29,30}.

It is also supported by disappearance of 1698 cm⁻¹ absorption band is corresponding to carbonyl functional group of L in formation all ligands³¹. But compared to that of their ligands a lower absorption bands about to 25-42 cm⁻¹ less were found in the stretching frequencies of C=N of all the complexes is conforming the coordinate covalent bond formation between nitrogen donor atom of C=N group and metal(II) ion²⁹. Further it was confirmed by a non-ligand band with medium intensity around ~500 cm⁻¹ corresponding to metal nitrogen bond (M-N) stretching frequency³².

The ligands L2 and L4 contains one C=O group and this band was appeared around ~1670 cm⁻¹. Whereas this was shifted towards higher frequency region about to 20 cm⁻¹ revealing the fact that no involvement of C=O group in the complex formation. In complexes of ligands L2, L3 and L4 a positive shift observed for N-H frequency as compared to its position (3160-3144 cm⁻¹) for ligands indicating non-participation of nitrogen atom in coordination. Stretching frequencies and wagging frequencies of aromatic rings have been found in the range of 1412-1365 and 3086-3045 cm⁻¹ for all ligands and important changes were not found in these frequencies in the case of respective complexes suggesting that ring atoms are not in coordination with metal ion²⁹. A band was found in between 314-302 cm⁻¹ revealed orientation of chloride ligands axially to metal in opposite direction each other³³.

NMR Spectral Studies: The ¹H NMR spectra recorded to identify the dissimilar protons present in newly synthesized

Schiff base ligands. A singlet signal was found in the range of 8.05-8.44 δ for all macrocycles corresponding to azomethine protons (HC=N). This signal confirms the condensation between OPA and 4-amino antipyrine in the formation of L, which is also confirmed by the absence of aldehydic proton peak about 9.91 δ . The spectrum of ligand L1 exhibited a triplet signal at 3.73 δ (4H, t, CH₂-N=C) and 1.9 δ (4H, t, CH₂-C). A singlet peak at 6.12 δ (2H, s, N-NH-CO) appeared in the spectrum of ligand L2. Triazole proton signal in the ligand L3 found at 4.75 δ (1H, s, N-H) as a singlet. Ligand L4 showed a singlet signal at 6.62 δ (1H, s, N-NH-CO). N-CH₃ and C-CH₃ protons were observed in the range of 2.71-3.65 δ and 2.16-2.31 δ correspondingly for all ligands. All ligands exhibited multiplets in the region of 6.58-7.92 δ due to aromatic ring protons³⁴.

A characteristic peak has been exhibited in ¹³C NMR spectra in between 153.1-165.8 δ indicating a carbon which linked to nitrogen with double bond, in case of all macrocycles. It confirms the condensation of OPA with amine group of 4-amino antipyrine in the synthesis of L and further condensation of L with respective diamines³⁴.

The spectrum of the L shows one signal due to presence of one -C=N group while remaining all 4 ligands shows two different -C=N signals. In the spectrum of L the C=O carbon frequency resonated at 162.4 δ this signal disappeared for all ligands when condensation reaction L with corresponding diamines, which is also evidence for the formation of all macrocyclic Schiff base ligands. The ligands L2 and L4 have shown a signal in the range of 156.5-168.2 δ corresponding to C=O group of amide. In all ligands N-CH₃ and C-CH₃ signals appeared in the region of 33.4-38.3 and 8.1-12.5 δ respectively. The aromatic ring carbons found in between 116.3-148.2 δ . The ¹H & ¹³C NMR signal positions for all macrocycles are given in Table-3 and spectra of ligand L1 are presented in Figure-3 and 4 respectively.

Electrolytic nature, magnetic properties, electronic and thermogravimetric data: The electrolytic behavior of complexes has been checked at 10⁻³ M concentration by using dichloromethane as a favorable medium. All complexes have shown Λ_M values 10.2-15.2 ohm⁻¹cm²mol⁻¹ representing non-electrolytic behavior of these complexes³⁵.

The magnetic susceptibility determination for all Co(II) complex compounds have been performed at room temperature and were found to be lay in between 4.71-5.05 B.M. indicating the octahedral structure³⁶. The electronic spectra of all the Co(II) complexes exhibited three absorption bands (Figure-5) in the range of 623-682 nm (ν_1), 405-446 nm (ν_2) and 341-372 nm (ν_3). The first two transitions assigned to ⁴A_{2g} ← ⁴T_{1g} (F) (ν_1) and ⁴T_{1g} (P) ← ⁴T_{1g} (F) (ν_2) respectively and the last intense maxima is due to intra ligand transitions of the organic moiety, suggesting an octahedral geometry for these complexes³⁷.

(Scheme-3). In thermogravimetric analysis of complexes TG curves were shown two important clear stages of decomposition, the first attribute to cleavage of coordinated covalent bonds between metal and ligand leads to the dissociation of complex and second due to formation of metal oxide. TG curves have not shown any initial weight loss until 125 °C, also DTG curves of these complexes have not shown any endothermic changes at same temperature revealing the absence of lattice water molecules³⁸. Further no weight loss was observed in the temperature range of 150-200°C and also no endothermic peak was found in DTG curve at above temperature range conforming the absence of coordinated water molecules⁴⁰.

All these complexes showed first decomposition curve at around 300°C due to dissociation of ligand and metal. This is further supported by the DTG curve, which show exothermic peak around this temperature range. All products after 500°C correspond to oxidation of metal. TG-DTG curves of Co(II) complex of L2 is given in Figure-6. All the above physical data of macrocyclic ligand complexes were depicted in Table-4.

Mass spectral interpretation: Mass spectra of macrocyclic ligands recorded and the molecular ion has an m/z value 506(L), 558(L1), 560(L2), 569(L3), 621(L4), and 628 (L5), which is corresponds to (M⁺+1) respectively. The spectra of complexes have been shown highest m/z value 686(M⁺, for comp-CoL1), 689 (M⁺+1, for comp-CoL2), 698 (M⁺+1, for comp-CoL3), 751(M⁺+2, for comp-CoL4), and 757 (M⁺+1, for comp-CoL5). These values were coordinated with the theoretical formula mass. The mass fragmentation pattern of ligand L1 and its complex were presented in Figure-7 and 8.

Antibacterial studies: In the present investigation, all the newly synthesized Schiff-bases and complexes are examined for antibacterial property in opposition to some given bacteria. It was found that complex compounds are shown higher activity when compared to uncoordinated ligands against four different bacteria under similar experimental environment. Increase in the antibacterial character of complexes owing to the influence of the metal ion on the regular metabolism of cell. Based on Tweedy's chelation theory³⁹⁻⁴⁰, ring formation significantly reduces the polar nature of the metal ion as of inadequate distribution of its positive charge with ligating groups and plausible resonance of π -electron over the entire ring. Thus central metal atom's lipophilic character increases which leads to allows its access via lipid coatings around cell.

In conclusion, all Co(II) complexes were acted in opposition to selected bacteria strains. Additionally, these all active macrocycles and their complexes were used to determine minimum inhibitory concentration (MIC) values (Table-5) for antibacterial activity. Results revealed that, Co(II) complexes were more active at low concentrations when compared to standard antibiotics Streptomycin and Ampiciline, on the other hand less active in contrast to Rifampicine.

Table-1
Physical and analytical data of the Macro cycles and their complexes

Ligand/Complex (Formula)	Molecular Weight	Color (% Yield)	Found (Calculated)%			
			C	H	N	Co
L (C ₃₀ H ₂₈ N ₆ O ₂)	505	Yellow (72)	71.38 (71.41)	5.55 (5.59)	16.61 (16.66)	-
L1 (C ₃₄ H ₃₆ N ₈)	557	Light Red (60)	73.31 (73.35)	6.50 (6.52)	20.10 (20.13)	-
L2 (C ₃₁ H ₃₀ N ₁₀ O)	559	Light Orange (71)	66.63 (66.65)	5.40 (5.41)	25.05 (25.07)	-
L3 (C ₃₂ H ₂₉ N ₁₁)	568	Light Brown (68)	67.70 (67.71)	5.13 (5.15)	27.13 (27.14)	-
L4 (C ₃₇ H ₃₃ N ₉ O)	620	Light Yellow (65)	71.69 (71.71)	5.33 (5.37)	20.32 (20.34)	-
L5 (C ₄₀ H ₃₄ N ₈)	627	Cream (63)	76.63 (76.65)	5.44 (5.47)	17.85 (17.88)	-
[Co(L1)Cl ₂] (C ₃₄ H ₃₆ Cl ₂ N ₈ Co)	686	Pink (72)	59.45 (59.48)	5.27 (5.29)	16.30 (16.32)	8.53 (8.58)
[Co(L2)Cl ₂] (C ₃₁ H ₃₀ Cl ₂ N ₁₀ OCo)	688	Pale Pink (68)	54.05 (54.08)	4.36 (4.39)	20.33 (20.34)	8.55 (8.56)
[Co(L3)Cl ₂] (C ₃₂ H ₂₉ Cl ₂ N ₁₁ Co)	697	Purple (69)	55.07 (55.10)	4.16 (4.19)	22.07 (22.09)	8.41 (8.45)
[Co(L4)Cl ₂] (C ₃₇ H ₃₃ Cl ₂ N ₉ OCo)	749	Violet (74)	59.27 (59.29)	4.41 (4.44)	16.81 (16.82)	7.84 (7.86)
[Co(L5)Cl ₂] (C ₄₀ H ₃₄ Cl ₂ N ₈ Co)	756	Lilac (70)	63.46 (63.50)	4.50 (4.53)	14.80 (14.81)	7.75 (7.79)

Table-2
Infra Red values of Macrocylic Schiff bases and their complexes

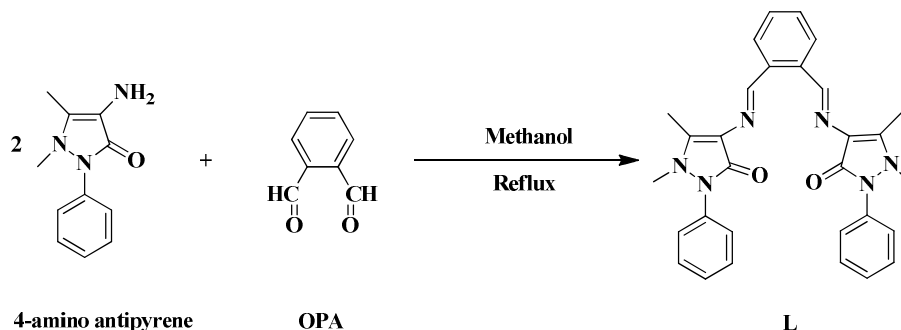
Ligand/Complex	Selected bands(cm ⁻¹)				
	ν_{N-H}	$\nu_{C=O}$	$\nu_{C=N}$	ν_{Co-N}	ν_{Co-Cl}
L	-	1698	1610	-	-
L1	-	-	1592, 1576	-	-
[Co(L1)Cl ₂]	-	-	1566, 1548	523	306
L2	3155	1672	1608,1582	-	-
[Co(L2)Cl ₂]	3172	1692	1568, 1557	504	310
L3	3148	-	1601,1598,1585	-	-
[Co(L3)Cl ₂]	3163	-	1581,1570,1552	518	305
L4	3160	1665	1571,1561	-	-
[Co(L4)Cl ₂]	3178	1698	1551,1545	532	312
L5	-	-	1578, 1565	-	-
[Co(L5)Cl ₂]	-	-	1556,1541	525	308

Table-3
NMR spectral analysis data of Macrocyclic ligands

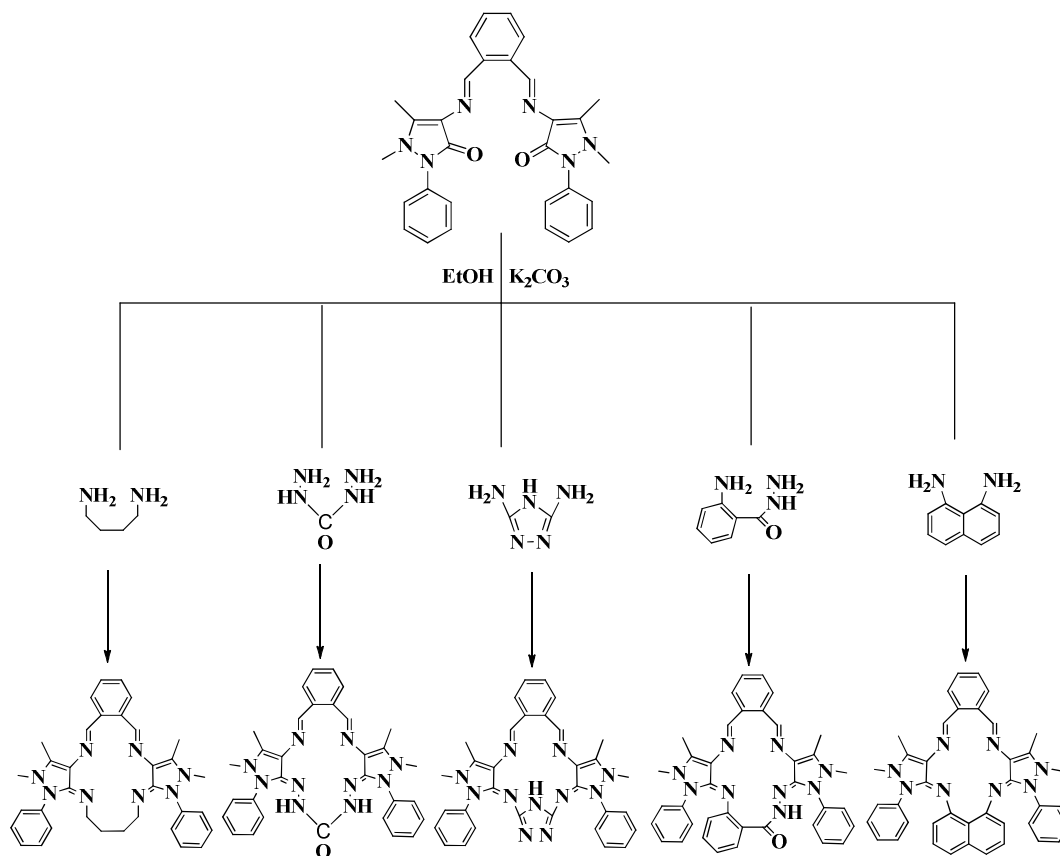
Ligand	¹ H NMR peak position (δ ppm)	¹³ C NMR peak position (δ ppm)
OAAP	8.16(2H, s, CH=N), 7.53-7.65(4H, m, Ar-H), 6.62-6.88(10H, m, Ar-H), 2.71(6H, s, N-CH ₃), 2.16(6H, s, C-CH ₃).	12.5(2C, C-CH ₃), 33.4(2C, N-CH ₃), 112.2(2C, =C-N-), 123.1, 124.5, 130.1, 130.8, 132.5, 134.6, 135.2 (18C, Ar-C), 148.3(2C, =C-N-), 161.2 (2C, C=O), 164.5 (2C, CH=N).
L ₁	8.05(2H, s, CH=N), 7.51-7.70(4H, m, Ar-H), 6.70-6.95(10H, m, Ar-H), 3.73(4H, t, CH ₂ -N=C), 2.72(6H, s, N-CH ₃), 2.21(6H, s, C-CH ₃), 1.9(4H, t, CH ₂ -C)	9.8(2C, C-CH ₃), 29.1(2C, C-CH ₂ -C), 36.5(2C, N-CH ₃), 47.1(2C, C-CH ₂ -N=), 109.8(2C, =C-N-), 123.5, 124.1, 130.6, 130.9, 132.3, 134.2, 136.8 (18C, Ar-C), 145.2(2C, =C-N-), 153.1(2C, C=N), 162.8(2C, CH=N).
L ₂	8.23(2H, s, CH=N), 7.55-7.68(4H, m, Ar-H), 6.60-6.86(10H, m, Ar-H), 6.12(2H, s, N-H), 3.65(6H, s, N-CH ₃), 2.25(6H, s, C-CH ₃).	9.1(2C, C-CH ₃), 37.1(2C, N-CH ₃), 110.1(2C, =C-N-), 122.2, 123.5, 129.8, 130.5, 132.6, 134.8, 136.8 (18C, Ar-C), 146.1(2C, =C-N-), 147.2(2C, C=N), 156.5(1C, C=O), 163.6 (2C, CH=N).
L ₃	8.44(2H, s, CH=N), 7.58-7.72(4H, m, Ar-H), 6.66-6.88(10H, m, Ar-H), 4.75(1H, s, N-H), 2.76(6H, s, N-CH ₃), 2.27(6H, s, C-CH ₃).	9.6(2C, C-CH ₃), 34.1(2C, N-CH ₃), 111.4(2C, =C-N-), 121.9, 124.6, 130.8, 131.8, 132.5, 134.2, 137.1 (18C, Ar-C), 143.4(2C, =C-N-), 150.1(2C, -C=N) 153.3(2C, =C-N-), 164.1 (2C, CH=N).
L ₄	8.35(2H, s, CH=N), 7.55-7.92(8H, m, Ar-H), 6.68-7.2(10H, m, Ar-H), 6.62(1H, s, N-H), 2.80(6H, s, N-CH ₃), 2.26(6H, s, C-CH ₃).	8.9(2C, C-CH ₃), 34.1(2C, N-CH ₃), 107.5-112.0(2C, =C-N-), 121.1, 123.5, 124.2, 127.1, 127.8, 128.1, 130.2, 131.6, 132.5, 134.6, 135.8, 137.1, 146.2(24C, Ar-C), 147.1-148.2(2C, =C-N-), 151.6-153.6(2C, C=N) 164.7 (2C, CH=N), 168.2(1C, C=O).
L ₅	8.21(2H, s, CH=N), 7.50-7.71(10H, m, naphthalene+Ar-H), 6.58-6.72(10H, m, Ar-H), 2.76(6H, s, N-CH ₃), 2.31(6H, s, C-CH ₃).	9.1(2C, C-CH ₃), 38.3(2C, N-CH ₃), 112.2(2C, =C-N-), 123.1, 124.2, 130.1, 132.3, 132.8, 135.8, 137.1 (18C, Ar-C), 145.2(2C, =C-N-), 153.4(2C, CH=N), 165.8 (2C, CH=N), 116.3, 121.2, 127.2, 129.1, 138.1, 148.2(10C, naphthalene ring).

Table-4
UV-Vis spectral, conductance and magnetic susceptibility data of Schiff base complexes

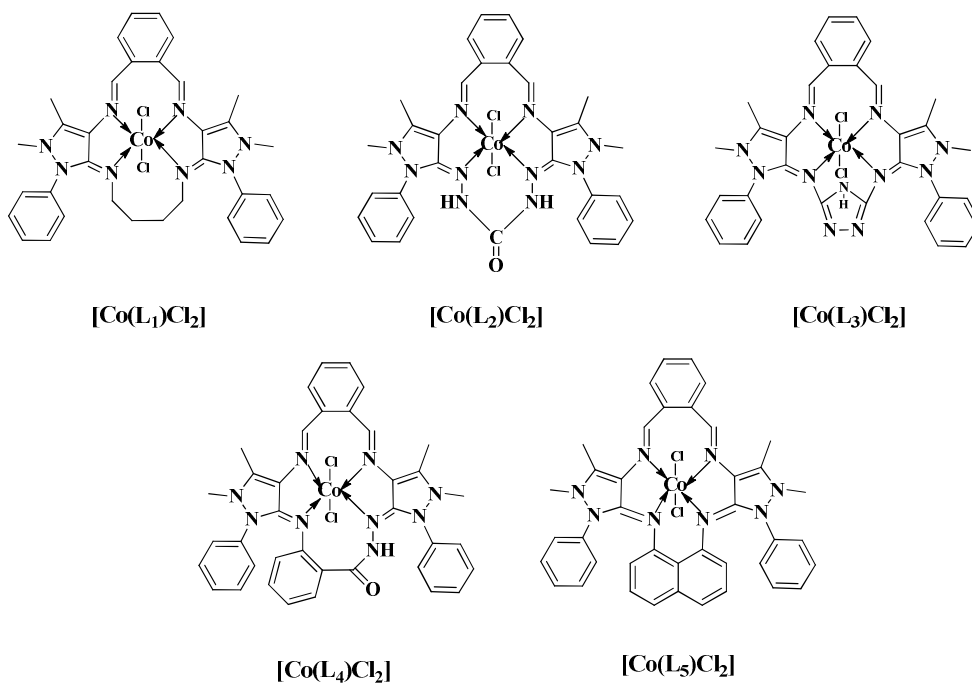
Schiff base Co(II) Complex	λ _{max} (nm)	Λ _M (Ω ⁻¹ cm ² mol ⁻¹)	μ _{eff} (B.M.)	Decomposition Temperature (°C)
[Co(L1)Cl ₂]	365, 438, 652	12.4	4.71	275
[Co(L2)Cl ₂]	341, 412, 642	10.2	4.96	241
[Co(L3)Cl ₂]	358, 405, 682	11.3	5.05	232
[Co(L4)Cl ₂]	372, 425, 658	15.2	4.98	224
[Co(L5)Cl ₂]	364, 446, 623	14.1	4.91	228



Scheme-1
Synthetic procedure of derivative of 4-amino antipyrine (L)



Scheme-2
Synthetic procedure of Macrocyclic Schiff base ligands (L1-L5)



Scheme-3
Tentative structures of Co(II) complexes

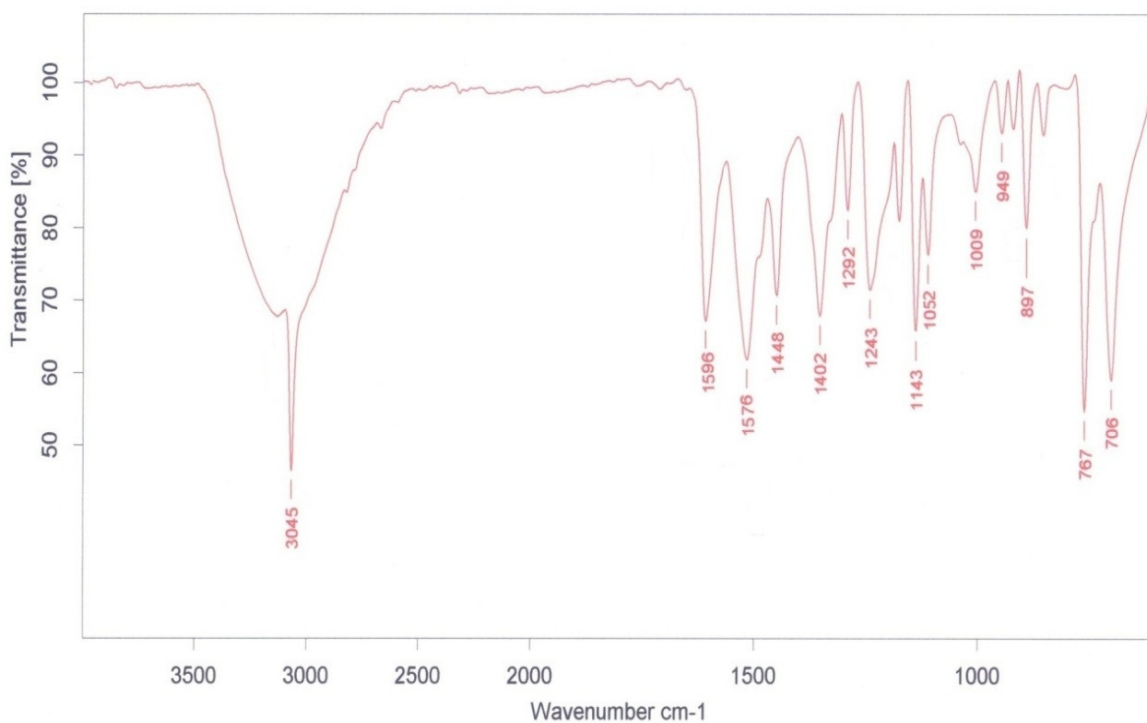


Figure-1
Infra Red Spectral bands of L1

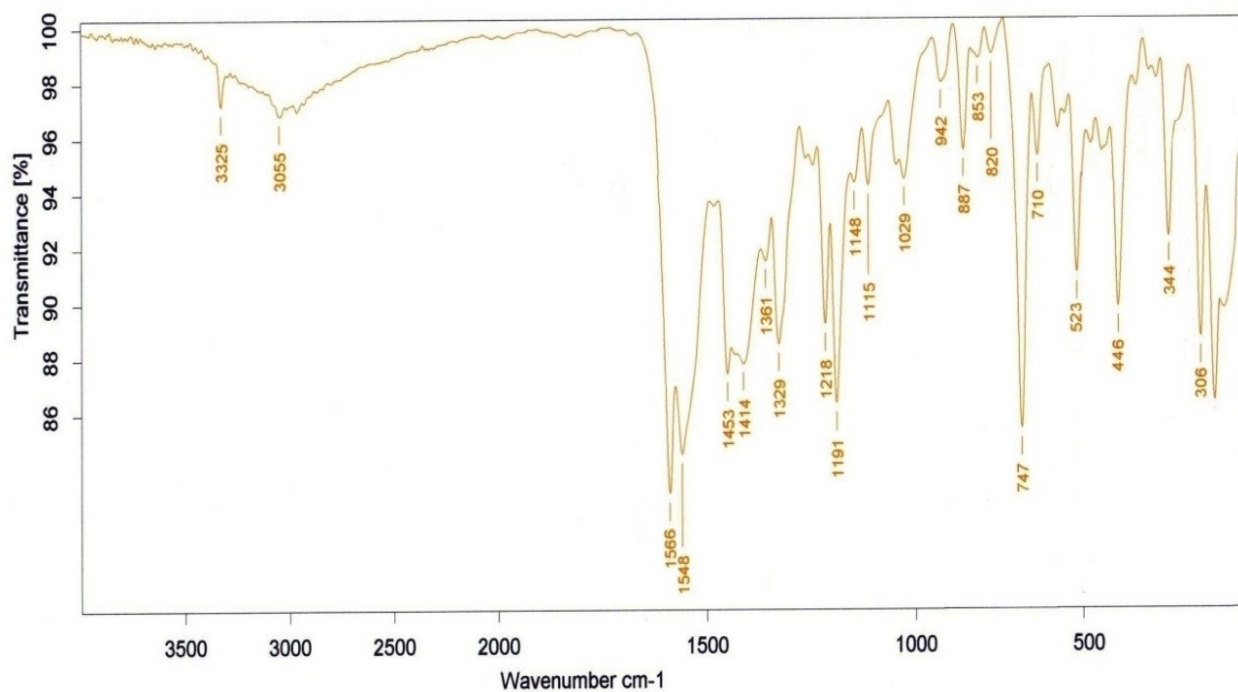


Figure-2
Infra Red Spectral bands of [Co(L1)Cl₂]

^1H

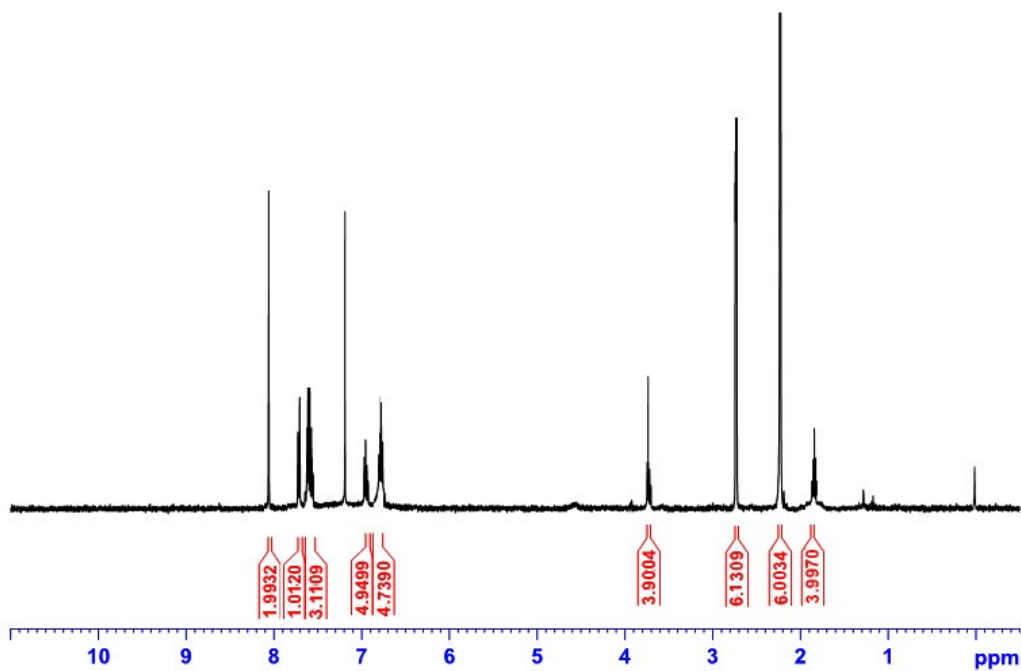


Figure-3
 ^1H NMR peak pattern of L1

^{13}C

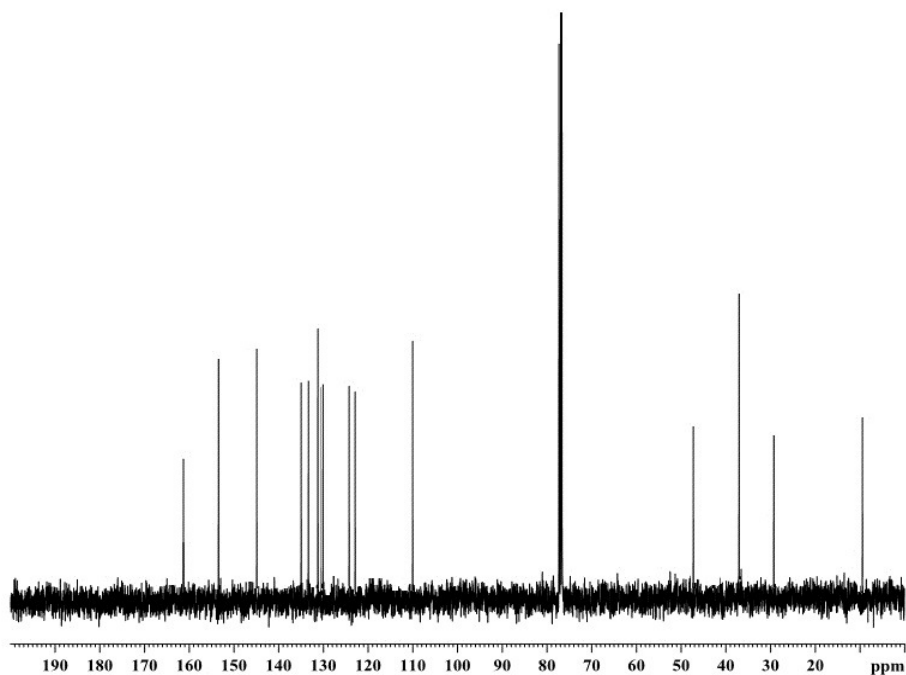


Figure-4
 ^{13}C NMR peak pattern of L1

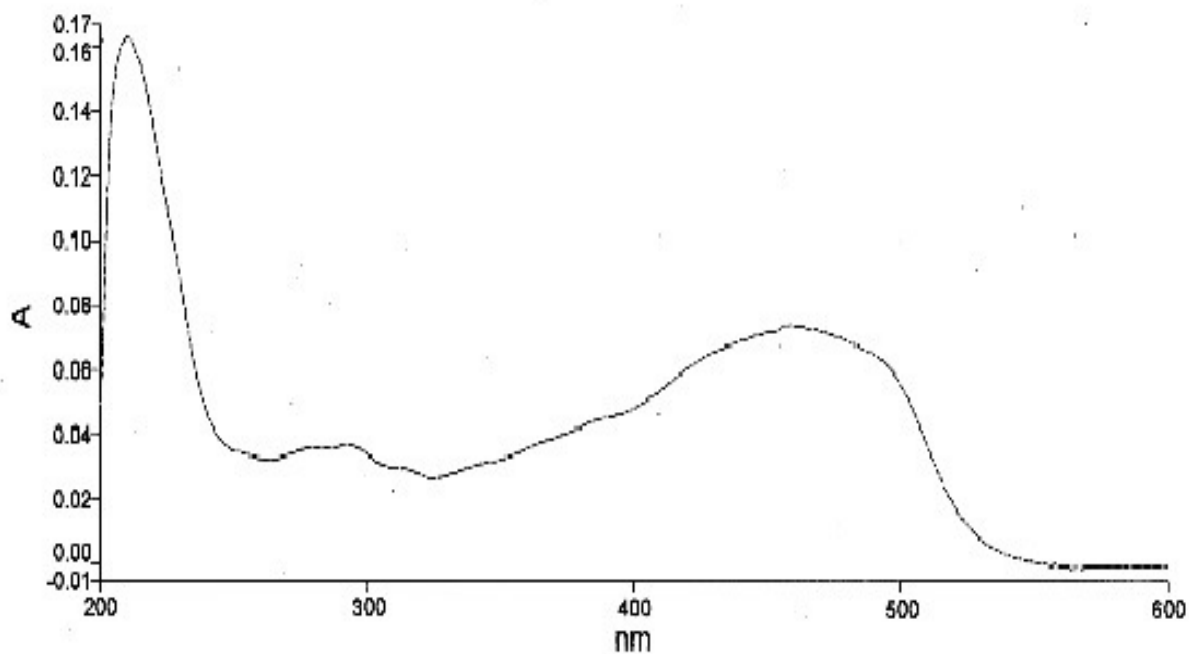


Figure-5
Electronic Spectrum of [Co(L1)Cl₂]

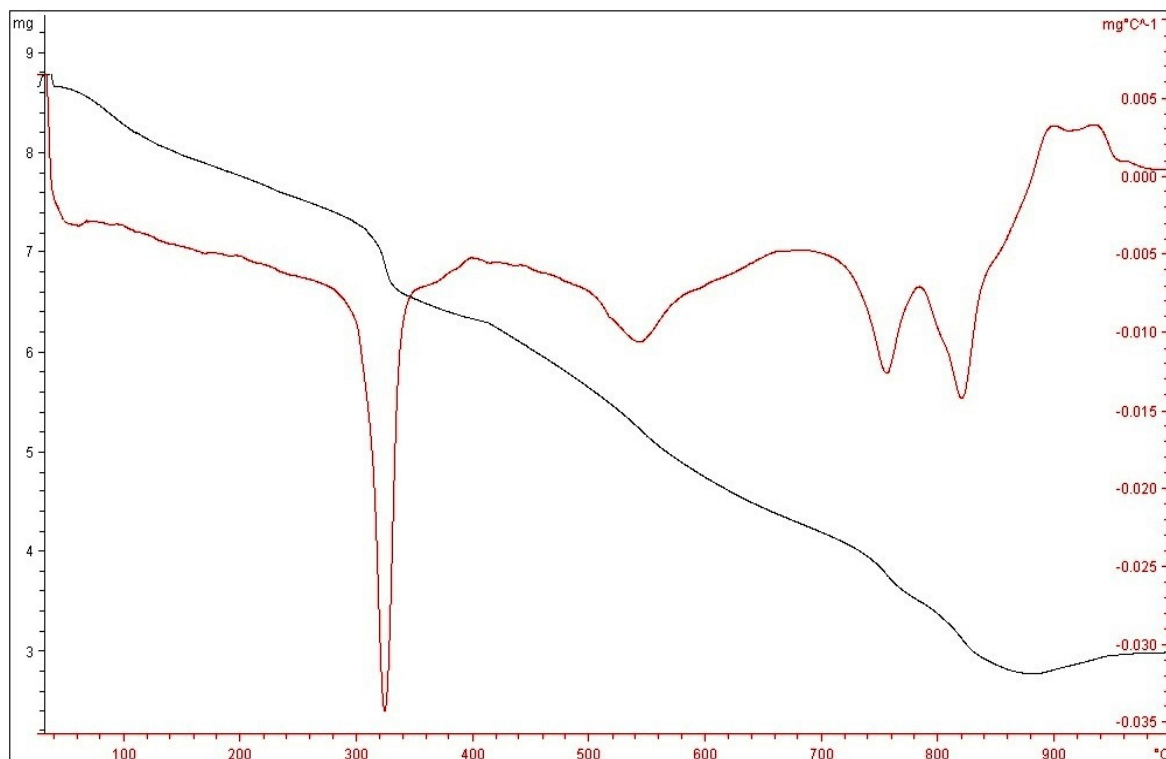


Figure-6
TG-DTG curves of [Co(L1)Cl₂]

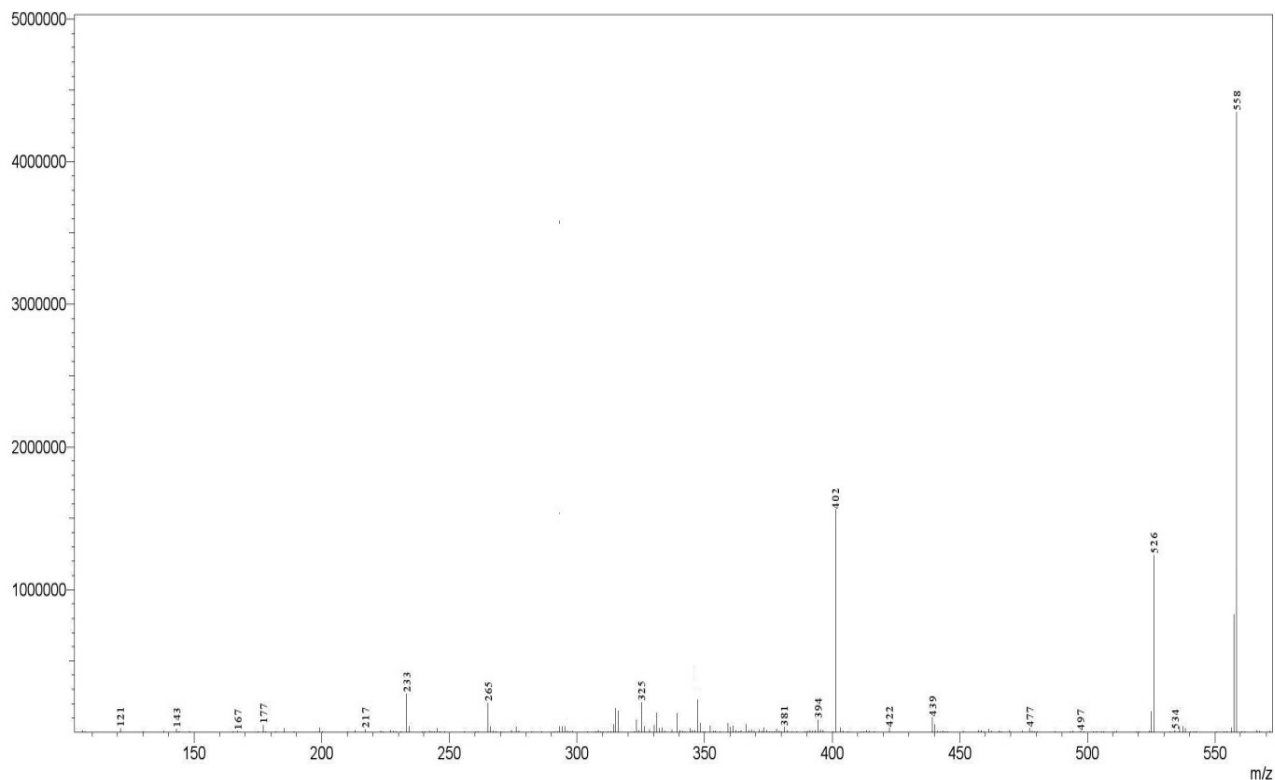


Figure-7
Mass fragmentation pattern of L1

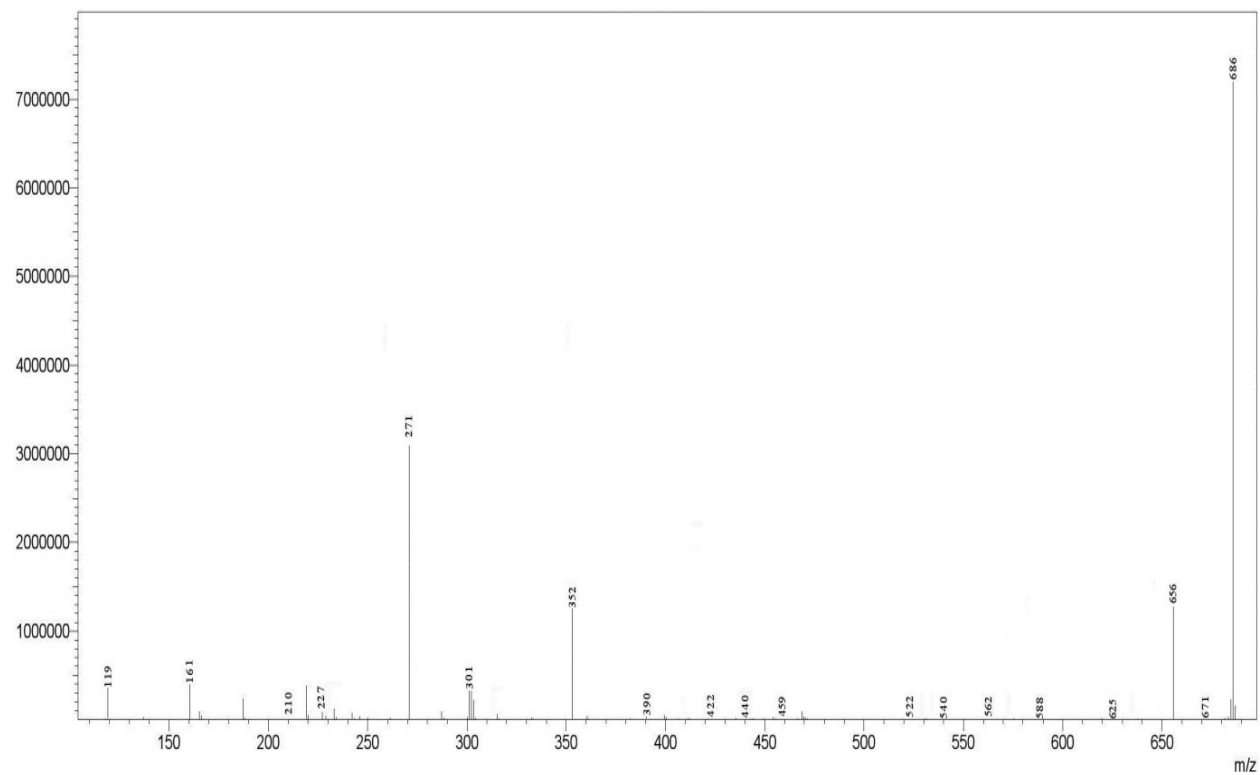


Figure-8
Mass fragmentation pattern of [Co(L1)Cl₂]

Table-5
Antibacterial assay

Ligand/complex	Range of concentration (µg/ml)			
	Basillus subtilis	Staphylo Coccus aureus	Escherichia coli	Klebsiella pneumonia
L1	25	28	31	22
L2	24	31	33	30
L3	26	27	29	26
L4	28	32	26	25
L5	32	26	23	23
[Co(L1)Cl ₂]	03	05	03	05
[Co(L2)Cl ₂]	02	03	06	03
[Co(L3)Cl ₂]	04	02	01	02
[Co(L4)Cl ₂]	06	07	04	04
[Co(L5)Cl ₂]	05	07	03	03
Streptomycin	02	10	12	15
Ampicillin	15	13	16	18
Rifampicin	08	0.21	0.23	0.21

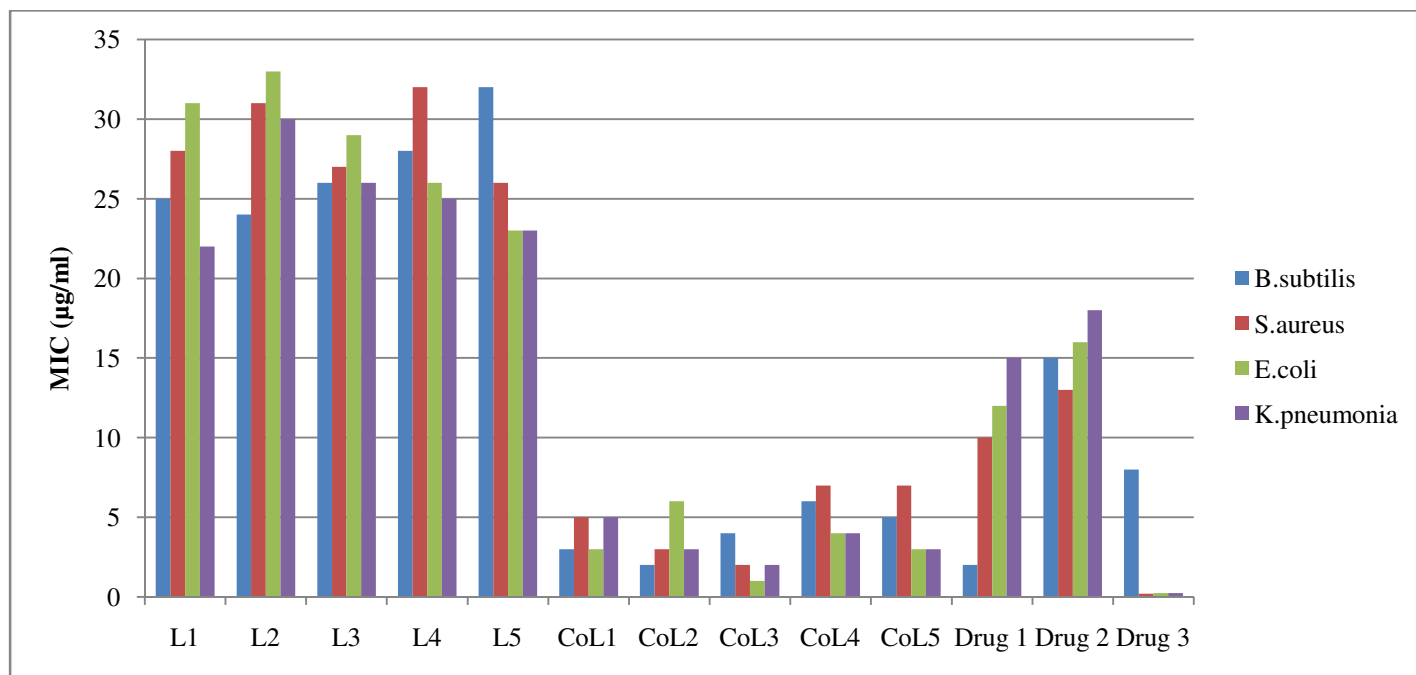


Figure-9
MIC of macrocyclic Schiff bases, their Co(II) complexes and antibiotics

Conclusion

Macrocyclic Co(II) complexes have been synthesized by using $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ as starter with the six newly prepared ligands individually. In all Co(II) complexes, macrocyclic ligand coordinate to metal ion via four nitrogen donor atoms and all mono-nucleus and non-electrolytic behavior was observed. According to elemental and spectral results octahedral geometries were suggested for metal compounds. These Co(II) compounds were applied as antibacterial agents and these complexes are found to be more potent than the free macrocyclic Schiff bases.

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