

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

## Synthesis, Thermal and Biological Screening of Six co-Ordinate Complex and Heterocyclic Base Adducts of Co (II) derived from N(4) Thiosemicarbazone

Dr.J. R. Gujarathi

Associate Professor, Department of Chemistry, Pratap College, Amalner, Maharashtra, India

**ABSTRACT:** Cobalt (II) complex has been synthesized by refluxing  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  with 5-chloro-2-hydroxy acetophenone N(4) methyl thiosemicarbazone. Adducts were synthesized by refluxing  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ , thiosemicarbazone in presence of heterocyclic base like pyridine, 2-chloro pyridine, 3-chloro pyridine, 4-chloro pyridine. Thiosemicarbazone has been characterized by  $^{13}\text{C}$ -NMR,  $^1\text{H}$  NMR, ESI-MS as well as IR, electronic spectra. Octahedral geometry for the six coordinate complex and adducts has been predicted from magnetic and spectral data. The thiosemicarbazone and its Co (II) complexes have been found antibacterial and showed growth inhibitory activity against *Staphylococcus aureus*, *Bacillus subtilis* (Gram+ve), *Escherichia Coli*, *Pseudomonas aeruginosa* (Gram-ve) bacterial species.

**KEYWORDS:** Thiosemicarbazone, N(4) methyl thiosemicarbazone,  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ .

### I. INTRODUCTION

Thiosemicarbazone ligand loses a proton from the phenolic group and acts as a singly charged tridentate ligand, coordinating through oxygen, the imino-nitrogen and thione sulphur atom. It acts as a doubly negatively charged tridentate by losing proton from mercapto group. Heterocyclic thiosemicarbazones are the compounds having wide spectrum of medicinal properties, antibacterial activity, tuberculosis, leprosy, malaria [1-5]. Thiosemicarbazones have also been investigated for superoxide dismutase-like radical scavengers [6]. The transition metal complexes of ligands containing N/S donor centers constitute the active centers of several metalloenzymes such as hydrogenase, xanthine oxidase and nitrogenase [7].

Co(III) complexes showed wide range of antimicrobial activities. Co(III) complex of antiulcer drug famotidine turned have greater antimicrobial activity against *E. coli* and *M. lysodeikticus* than the metal free drug [8]. The octahedral cobalt complex possessed good activity against both Gram (+) and Gram(-) bacterial strains but not higher than the free ligand [9]. The Co (II) complex of the sodium salt of Monensin A was found active against the Gram(+) bacteria. The mole ratio (M:L) in the complex was 1:2. The cobalt(II) complex was found inactive against Gram(-) bacteria. This might be because of its hydrophobicity and large molecular weight [10]. Cobalt(III) complexes are been hypoxia selective antitumor agents. This concept is based on the the tumor cells develop resistance to chemotherapeutic agents under anaerobic conditions. In hypoxic conditions they may be reduced to Co (II) species by loss of neutral ligand [11- 14].

In this work we report the synthesis, spectral characterisation and biological studies of six coordinate complex and adducts of Co (II) with 3,5-dichloro 2-hydroxy acetophenone N(4) methyl thiosemicarbazone.

### II. MATERIALS AND METHODS

All the chemical used are of A.R. grade. Magnetic measurement was carried out by Faraday method. IR spectra were recorded in the range  $4000\text{-}200\text{ cm}^{-1}$  using Jasco spectrometer. NMR spectra were recorded in the mixture of  $\text{CDCl}_3$  and  $\text{DMSO-d}_6$  (1:1 v/v) with a Bruker AC-300F 300MHz spectrometer. Conductivity measurements were carried out on Systonics conductivity meter-304. UV-Visible spectra were measured on Jasco UV-visible double beam spectrophotometer. Metal in the complex and adducts was estimated by E.D.T.A using xylenol orange as an indicator.

## International Journal of Innovative Research in Science, Engineering and Technology

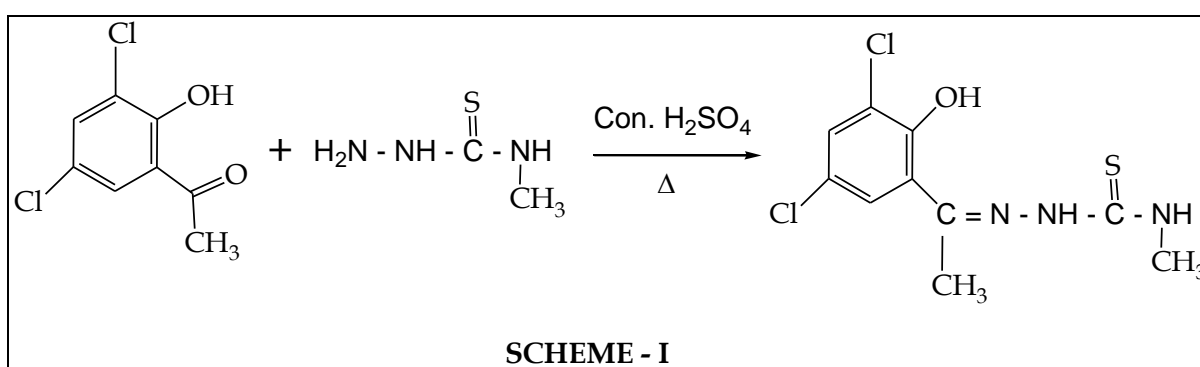
(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

### III. EXPERIMENTAL

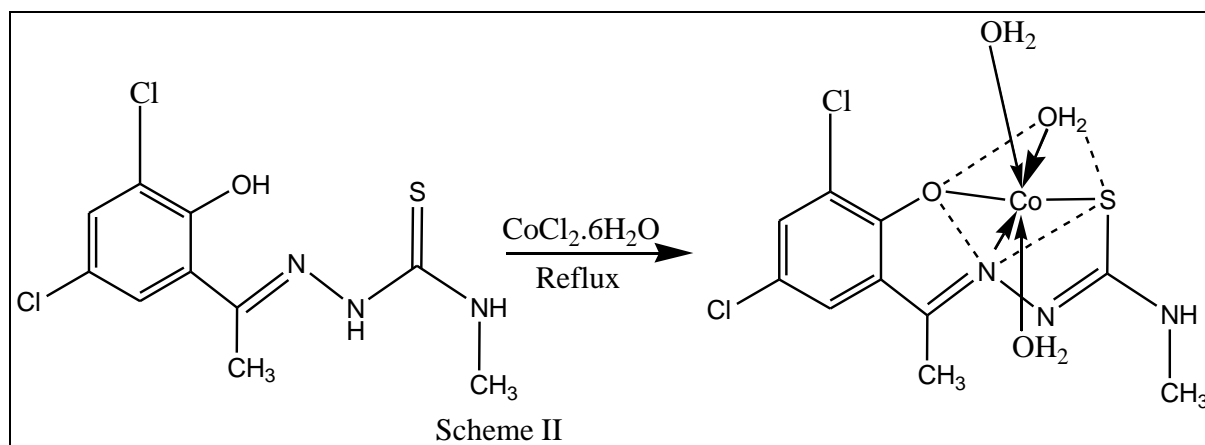
#### Synthesis of ligand:

Thiosemicarbazone was synthesized by refluxing ethanolic solutions of 5-chloro 2-hydroxy acetophenone and *N*(4) methyl thiosemicarbazide in the mole ratio 1:1 for 3 hours. The product obtained was filtered, washed with cold ethanol and then diethyl ether. Recrystallised from acetic acid and dried over  $P_2O_5$  in vacuum.



#### Synthesis of complex

$CoCl_2 \cdot 6H_2O$  (0.01 mole) was dissolved in absolute ethanol. The ethanolic solution of thiosemicarbazone (0.01 mole) in slight excess over the metal: ligand ratio of 1:1 was added to it dropwise and with constant stirring. The reaction mixture was refluxed for an hour, after addition of one gram of sodium acetate. The brown product was filtered and washed with a small portion of hot water, cold ethanol and then ether and dried over  $P_2O_5$  in vacuum.



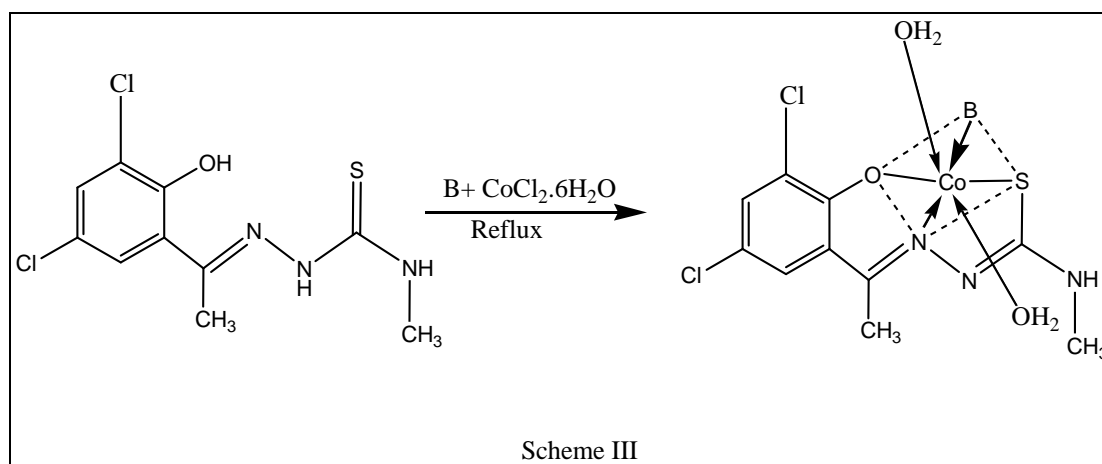
#### Synthesis of adducts

The adduct  $Co.L.B$  (B-heterocyclic base like pyridine, 2-chloro pyridine, 3-chloro pyridine, 4-chloro pyridine) was synthesized by adding slowly ethanolic solutions of  $CoCl_2 \cdot 6H_2O$ , heterocyclic base to the hot ethanolic solution of thiosemicarbazone in the ratio 1:1:1 and refluxing reaction mixture for 7 hours. The adduct obtained was filtered, washed with hot water, cold ethanol and then ether and dried over  $P_2O_5$  in vacuum.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015



( B = pyridine, 2-chloro pyridine, 3-chloro pyridine, 4-chloro pyridine)

**TABLE 1**

Compounds	Colour	Empirical Formula	Molar conductance $\text{Ohm}^{-1}\text{cm}^2\text{mole}^{-1}$	Magnetic Moment B.M.
L	Yellow	$\text{C}_{10}\text{H}_{11}\text{N}_3\text{OSCl}_2$	-	-
Co-L.( $\text{H}_2\text{O}$ ) <sub>3</sub>	Brown	$\text{C}_{10}\text{H}_{15}\text{N}_3\text{O}_4\text{SCl}_2\text{Co}$	50.7	4.50
Co-L.Py.( $\text{H}_2\text{O}$ ) <sub>2</sub>	Brown	$\text{C}_{15}\text{H}_{18}\text{N}_4\text{O}_3\text{SCl}_2\text{Co}$	52.5	4.52
Co- 2-Cl py.( $\text{H}_2\text{O}$ ) <sub>2</sub>	Brown	$\text{C}_{15}\text{H}_{17}\text{N}_4\text{O}_3\text{SCl}_3\text{Co}$	55.9	4.55
Co- 3-Cl py.( $\text{H}_2\text{O}$ ) <sub>2</sub>	Brown	$\text{C}_{15}\text{H}_{17}\text{N}_4\text{O}_3\text{SCl}_3\text{Co}$	57.6	4.59
Co- 4-Cl py.( $\text{H}_2\text{O}$ ) <sub>2</sub>	Brown	$\text{C}_{15}\text{H}_{17}\text{N}_4\text{O}_3\text{SCl}_3\text{Co}$	59.7	4.60

The colours, empirical formula of ligand and its complexes are presented in Table 1. The complex and all adducts are soluble in DMF in which conductivity measurements were made ( $30^\circ\text{C}$ ), showing all complexes to be non electrolyte [15]. The magnetic susceptibility of complex and adducts carried out at room temperature ( $27^\circ\text{C}$ ) fall in the range of 4.50-4.60 B.M (Table 1). The high spin octahedral complexes show magnetic moment in the range 4.50-4.65 B.M. respectively [16].

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

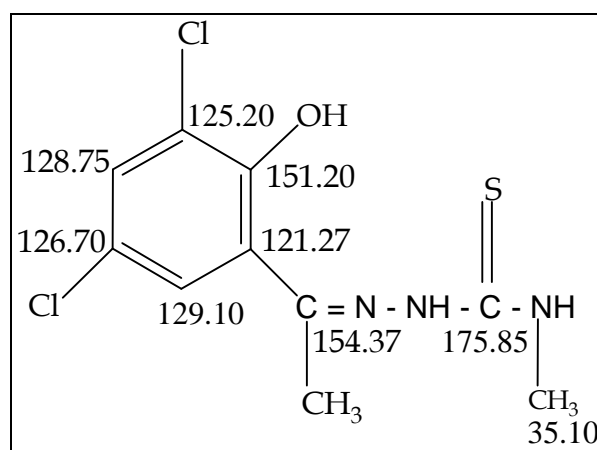
### <sup>1</sup>H-NMR

Signals at 11.6, 3.30 ppm are assigned to – OH, - CH<sub>3</sub> protons respectively.

<sup>1</sup>H-NMR signals at 12.00 and 2.4 ppm are assigned to – OH and – CH<sub>3</sub> protons respectively. The signals at 2.30, 3.01 correspond to <sup>4</sup>NH and H<sup>4</sup>N-CH<sub>3</sub> respectively. Signal at 10.5 ppm corresponds to <sup>2</sup>NH. Aromatic protons show multiplets at 7.0, 7.20, 7.35, ppm.

### <sup>13</sup>C-NMR (DMSO-D<sub>6</sub>): δppm

125.20 (C = C-Cl), 128.75 (C = C), 127.79 (C = C – Cl), 126.70 (C = C), 129.10 (C = C), 151.20 (C = C – OH), 154.37(C = N), 175.85 (C = S), 35.10 (NH – CH<sub>3</sub>).



(Calcd) found ESI-MS m/z, ion M<sup>+</sup> : C<sub>10</sub>H<sub>11</sub> N<sub>3</sub>O<sub>3</sub>SCl<sub>2</sub> (292.17) 292.89, C<sub>10</sub>H<sub>15</sub>N<sub>3</sub>O<sub>4</sub>SCl<sub>2</sub>Co (403.13) 403.78, C<sub>15</sub>H<sub>18</sub>N<sub>4</sub>O<sub>3</sub>SCl<sub>2</sub>Co (464.21) 464.70, C<sub>15</sub>H<sub>17</sub>N<sub>4</sub>O<sub>3</sub>SCl<sub>3</sub>Co (498.65) 498.20, C<sub>15</sub>H<sub>17</sub>N<sub>4</sub>O<sub>3</sub>SCl<sub>3</sub>Co (498.65) 498.22, C<sub>15</sub>H<sub>17</sub>N<sub>4</sub>O<sub>3</sub>SCl<sub>3</sub>Co (498.65) 498.24.

Mass spectral data confirmed the structures of ligand, complex and adducts as indicated by molecular ion peak (M+1) corresponding to their molecular weights.

**TABLE.2 ANALYTICAL DATA**

Compounds	Elemental Analysis Found (Calculated) %				
	Metal%	%C	%H	%N	%S
L	-	41.74 (41.11)	3.13 (3.79)	14.88 (14.38)	10.21 (10.97)
Co-L.(H <sub>2</sub> O) <sub>3</sub>	14.07 (14.62)	29.13 (29.79)	3.24 (3.75)	10.74 (10.42)	7.08 (7.95)
Co-L.Py.(H <sub>2</sub> O) <sub>2</sub>	12.30 (12.69)	38.21 (38.81)	3.32 (3.91)	12.87 (12.07)	6.30 (6.91)
Co- 2-Cl py.(H <sub>2</sub> O) <sub>2</sub>	11.82 (11.03)	36.73 (36.13)	3.84 (3.44)	11.84 (11.24)	6.94 (6.43)

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

Co- 3-Cl py.(H <sub>2</sub> O) <sub>2</sub>	11.77 (11.03)	36.52 (36.13)	3.55 (3.44)	11.72 (11.24)	6.06 (6.43)
Co- 4-Cl py.(H <sub>2</sub> O) <sub>2</sub>	11.88 (11.03)	36.15 (36.13)	3.88 (3.44)	11.88 (11.24)	6.77 (6.43)

Elemental analysis data are consistent with 1:1 ratio of metal ion, thiosemicarbazone for complex and 1:1:1 ratio for metal, thiosemicarbazone and heterocyclic base for all adducts. Metal in the complexes was estimated by using E.D.T.A.

### IV. ELECTRONIC SPECTRAL DATA

**Table 3 .Electronic spectral data (cm<sup>-1</sup>)**

Compound	Mode	d-d	L→M	n→π*	π→π*
L	DMF	-	-	25652 28500	41865
Co-L.(H <sub>2</sub> O) <sub>3</sub>	DMF	17554	27155 25241	30855 35405	44800
Co-L.Py.(H <sub>2</sub> O) <sub>2</sub>	DMF	17744	27627 25600	31106 34450	44500
Co- 2-Cl py.(H <sub>2</sub> O) <sub>2</sub>	DMF	17255	27041 25989	30980 34650	42553
Co- 3-Cl py.(H <sub>2</sub> O) <sub>2</sub>	DMF	17634	27907 25585	31110 34260	43475
Co- 4-Cl py.(H <sub>2</sub> O) <sub>2</sub>	DMF	17938	27500 25727	31650 34055	44660

The Co (II) complexes are usually found in tetrahedral and octahedral environments and less frequently in planer environment. The ground term of Co (II) is <sup>4</sup>T<sub>1g</sub> or <sup>4</sup>E<sub>g</sub> in octahedral coordination depending on whether the complex is high spin or low spin. Three bands have been observed due to spin allowed transitions in the range 30,000-32,000 cm<sup>-1</sup>, 34,000-36,000 cm<sup>-1</sup> and 17,000-18,000 cm<sup>-1</sup> which correspond to <sup>4</sup>T<sub>1g</sub> (F) → <sup>4</sup>T<sub>2g</sub> (F) (ν<sub>1</sub>), <sup>4</sup>T<sub>1g</sub>(F) → <sup>4</sup>A<sub>2g</sub> (F) (ν<sub>2</sub>) and <sup>4</sup>T<sub>1g</sub>(F) → <sup>4</sup>T<sub>1g</sub> (P) (ν<sub>3</sub>) respectively expected for d<sup>7</sup> system in octahedral field. The absorption bands at 25,000 – 28,000 cm<sup>-1</sup> range are assigned to the L → M transitions respectively. The appearance of these bands indicated octahedral geometry around Co (II) [17].

### V. INFRARED SPECTROSCOPIC DATA (cm<sup>-1</sup>)

**1.L:** ν (- OH) 3200; ν (C = N) 1642; ν (- C – S) 790 (s), 1365 (m); ν (N – N) 1060; ν (<sup>2</sup>N-H) 3250; ν (C – O) 1295.

**2.[CoL(H<sub>2</sub>O)<sub>3</sub>]:** ν (C = N) 1575; ν (C = N-N=C) 1520, ν (C-S) 650, 1250, ν (N-N) 1130, ν (M - N) 420, ν (M-O) 505, ν (M-S) 330, ν (C - O) 1201, ν(H<sub>2</sub>O) 3542,3560.

**3.[Co-L.Py.(H<sub>2</sub>O)<sub>2</sub>]:** ν (C = N) 1580; ν (C = N-N=C) 1525, ν (C-S) 655, 1255; ν (N-N) 1132, ν (M - N) Base 270, ν (M - N) 425, ν (M - O) 510, ν (M-S) 335, ν (C - O) 1210, Band due to HB 1275, ν(H<sub>2</sub>O) 3522,3560.

**4.[Co- 2-Cl py.(H<sub>2</sub>O)<sub>2</sub>]:** ν (C = N) 1585; ν (C = N-N=C) 1515, ν (C-S) 660, 1220, ν (N-N) 1120, ν (M - N) Base 278, ν (M - N) 430, ν (M - O) 520, ν (M-S) 338, ν (C - O) 1225, Band due to HB 1420, ν(H<sub>2</sub>O) 3550,3572.

**5.[Co- 3-Cl py.(H<sub>2</sub>O)<sub>2</sub>]:** ν (C = N) 1590; ν (C = N-N=C) 1525, ν (C-S) 665, 1235; ν (N-N) 1128, ν (M - N) Base 280, ν (M - N) 435, ν (M - O) 530, ν (M-S) 340, ν (C - O) 1240, Band due to HB 1450, ν(H<sub>2</sub>O) 3560,3570.

**6.[Co- 4-Cl py.(H<sub>2</sub>O)<sub>2</sub>]:** ν (C = N) 1598; ν (C = N-N=C) 1535, ν (C-S) 670, 1240, ν (N-N) 1130, ν (M - N) Base 290, ν (M - N) 440, ν (M - O) 550, ν (M-S) 350, ν (C - O) 1270, Bands due to HB 1460, ν(H<sub>2</sub>O) 3570,3588.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

The infrared spectra of Co (II) complexes is useful to detect the bonding sites of all ligand molecules interacted with the metal. The coordination of azomethine nitrogen shifted  $\nu$  ( ${}^7\text{C} = {}^1\text{N}$ ) to lower wave numbers. The band shifted from  $1642\text{ cm}^{-1}$  in uncomplexed thiosemicarbazone to about  $1575\text{-}1598\text{ cm}^{-1}$  in the spectra of complexes. The shifting of  $\nu$  (N-N) to higher wave numbers in the spectra of complexes confirms the coordination of azomethine nitrogen. The appearance of new band at  $420 - 435\text{ cm}^{-1}$  confirms the coordination of azomethine nitrogen [18]. The loss of  ${}^2\text{N-H}$  proton on coordination via thiolate sulphur decreases  $\nu$  (C = S) bands found at  $790, 1365\text{ cm}^{-1}$  in L. The new band at  $330 - 350\text{ cm}^{-1}$  is assignable to  $\nu$  (Co-S) [19]. The presence of new band in the range  $505 - 550$  is assignable to  $\nu$  (Co-O) [20]. The coordination of N atom (s) of heterocyclic base is confirmed by  $\nu$  (Co-N) band in  $270\text{-}290\text{ cm}^{-1}$  range [19,21-25]. The bands due to co-ordinated water molecules and heterocyclic bases are also observed [25].

### VI.TGA ANALYSIS DATA

The TGA curves of complexes were recorded between the temperatures  $30\text{ }^\circ\text{C}$  to  $800\text{ }^\circ\text{C}$

- 1.[Co.L.(H<sub>2</sub>O)<sub>3</sub>]: First step,  $115\text{ }^\circ\text{C}$ , Mass loss  $8.30\%$  second step,  $138\text{ }^\circ\text{C}$ , Mass loss,  $13.54\%$  Third Step  $240\text{ }^\circ\text{C}$ , Mass loss,  $58.02\%$  Fourth Step,  $365.14\text{ }^\circ\text{C}$ , Mass loss  $65.5\%$ , Residue  $800\text{ }^\circ\text{C}$ , % of CoO,  $14.23$  ( $14.62$ ).
- 2.[CoL.py.(H<sub>2</sub>O)<sub>2</sub>]: First step,  $113\text{ }^\circ\text{C}$ , Mass loss  $7.70\%$  second step,  $140\text{ }^\circ\text{C}$ , Mass loss,  $25.70\%$  Third Step  $248\text{ }^\circ\text{C}$ , Mass loss,  $55.02\%$  Fourth Step,  $360\text{ }^\circ\text{C}$ , Mass loss,  $65.01\%$ , Residue,  $790\text{ }^\circ\text{C}$ , % of CoO,  $12.10$  ( $12.69$ ).
- 3.[Co- 2-Cl py.(H<sub>2</sub>O)<sub>2</sub>]: First step,  $115\text{ }^\circ\text{C}$ , Mass loss  $7.84\%$  second step,  $145\text{ }^\circ\text{C}$ , Mass loss,  $29.00\%$  Third Step  $245\text{ }^\circ\text{C}$ , Mass loss,  $56.02\%$  Fourth Step,  $361\text{ }^\circ\text{C}$ , Mass loss  $68.5\%$ , Residue  $800\text{ }^\circ\text{C}$ , % of CoO,  $15.74$  ( $15.03$ ).
- 4.[Co- 3-Cl py.(H<sub>2</sub>O)<sub>2</sub>]: First step,  $117\text{ }^\circ\text{C}$ , Mass loss  $7.50\%$  second step,  $142\text{ }^\circ\text{C}$ , Mass loss,  $27.52\%$  Third Step  $250\text{ }^\circ\text{C}$ , Mass loss,  $57.02\%$  Fourth Step,  $366\text{ }^\circ\text{C}$ , Mass loss,  $65\%$ , Residue,  $778\text{ }^\circ\text{C}$ , % of CoO,  $14.70$  ( $15.03$ ).
- 5.[Co- 4-Cl py.(H<sub>2</sub>O)<sub>2</sub>]: First step,  $116\text{ }^\circ\text{C}$ , Mass loss  $7.19\%$  second step,  $150\text{ }^\circ\text{C}$ , Mass loss,  $28.00\%$  Third Step  $238\text{ }^\circ\text{C}$ , Mass loss,  $58.02\%$  Fourth Step,  $370\text{ }^\circ\text{C}$ , Mass loss  $66\%$ , Residue  $800\text{ }^\circ\text{C}$ , % of CoO,  $15.87$  ( $15.03$ ).

The coordinated water molecules were eliminated from their complexes at relatively higher temperature than lattice water molecules. The two coordinated water molecules in complex and adducts were removed in one step at less than  $120\text{ }^\circ\text{C}$  The TGA data of complex and adducts indicated that the decomposition proceeded in several steps. There are three steps after the removal of water molecules in complex and adducts. First at a temperature less than  $160\text{ }^\circ\text{C}$ , second less than  $250\text{ }^\circ\text{C}$  and third less than  $370\text{ }^\circ\text{C}$ . In these steps decomposition of the complexes took place. The decomposition was complete and CoO formed at a temperature  $> 760\text{ }^\circ\text{C}$ .

### VII.BIOLOGICAL ACTIVITY (AGAR PLATE DIFFUSION METHOD)

TABLE.4 MINIMUM INHIBITORY CONCENTRATION L , CO (II) COMPLEXES AND STANDERED

Compound	<i>Staphylococcus aureu</i>		<i>Bacilus subtilis</i>		<i>Escherichia Coli</i>		<i>Peudomonas aeruginosa</i>	
	Gram positive				Gram negative			
	2 μg/ml	2.5 μg/ml	2 μg/ml	2.5 μg/ml	2 μg/ml	2.5 μg/ml	2 μg/ml	2.5 μg/ml
L	0.75	0.42	0.72	0.45	0.77	0.48	0.78	0.47
Co-L.(H <sub>2</sub> O) <sub>3</sub>	0.68	0.35	0.67	0.21	0.69	0.24	0.61	0.23

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

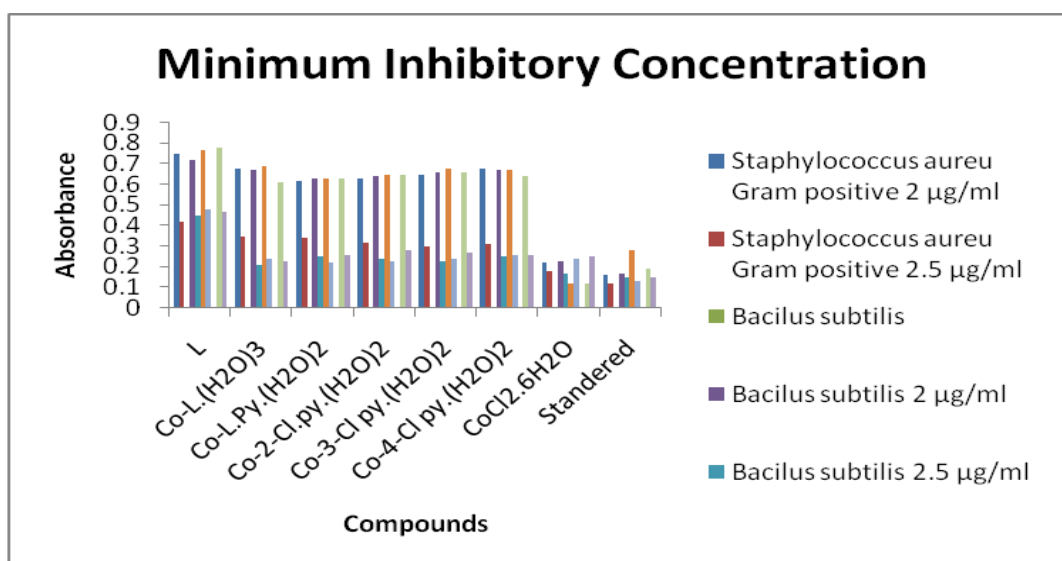
Vol. 4, Issue 12, December 2015

Co-L.Py.(H <sub>2</sub> O) <sub>2</sub>	0.62	0.34	0.63	0.25	0.63	0.22	0.63	0.26
Co-2-Cl.py.(H <sub>2</sub> O) <sub>2</sub>	0.63	0.32	0.64	0.24	0.65	0.23	0.65	0.28
Co-3-Cl py.(H <sub>2</sub> O) <sub>2</sub>	0.65	0.30	0.66	0.23	0.68	0.24	0.66	0.27
Co-4-Cl py.(H <sub>2</sub> O) <sub>2</sub>	0.68	0.31	0.67	0.25	0.67	0.26	0.64	0.26
CoCl <sub>2</sub> .6H <sub>2</sub> O	0.22	0.18	0.23	0.17	0.12	0.24	0.12	0.25
Standard	0.16	0.12	0.17	0.15	0.28	0.13	0.19	0.15

(Std-Amphiciline)

The bacterial assay was carried out by the agar plate diffusion method. Activity was measured by measuring the diameter of inhibition zone in mm. The adducts showed good activity against bacterial species than free ligand. The minimum inhibitory concentration was determined by liquid dilution method [26]. The solutions of ligand and complexes with 2 µg/ml, 2.5 µg/ml and 3 µg/ml concentrations were prepared in the solvent DMF. The solution of standard drug ampicillin was also prepared in the same concentration. Inoculums of the overnight culture were prepared. 0.2 ml of the inoculums was added to the test tubes containing the solutions of the compounds of different concentrations. After the addition of sterile water to each of the test tubes, these were incubated for 24 hours and observed for turbidity. The absorbance of the turbid solutions was measured at 520 nm. The same method was used for standard [27]. It was found that at 2 µg/ml the absorbance is more. Less absorbance was observed at 2.5 µg/ml and no absorbance at 3 µg/ml. The inhibition is more at 2.5 µg/ml. The metal salt solution showed better inhibition than ligand and complexes. The inhibitory concentration is 2.5 µg/ml. Thus increase in coordination number in complexes and coordination of metal ion to ligand increases microbial activity.

**FIG NO.1 BAR GRAPH (MIC)**



The bar graph indicates the minimum inhibitory concentration. The absorbance is less at 2.5 µg/ml concentration. The metal salts are found more active than compounds. The inhibitory activity is more in case of standard. The absorbances

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

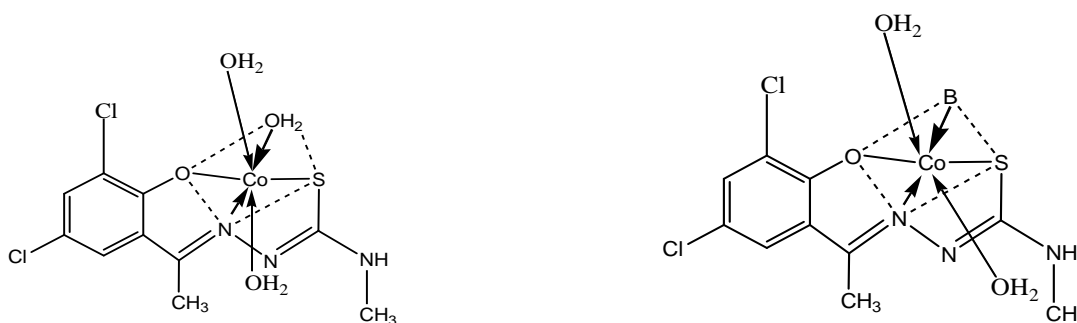
Vol. 4, Issue 12, December 2015

at 2 µg/ml concentration are in the range 0.62-0.68. Inhibition is more at 2.5 µg/ml against the species *Bacillus subtilis*, *Escherichia Coli*, *Pseudomonas aeruginosa*.

## VIII. CONCLUSION

The complexes and adducts synthesised are thermally stable upto 200<sup>0</sup>C. The complexes are paramagnetic and the spectral data indicate octahedral geometry. The complexes have been found active against bacterial species. They showed growth inhibitory activity against the species. The minimum inhibitory concentration is 2.5 µg/ml. The activity is more against the species *Bacillus subtilis*, *Escherichia Coli*, *Pseudomonas aeruginosa*.

## EXPECTED STRUCTURES



(B = pyridine, 2-chloro pyridine, 3-chloro pyridine, 3-chloro pyridine)

## REFERENCES

1. Scovill J.P., Klayman D.L., Franchino C.F., *J. Med. Chem.* 25, **1982**, 1261.
2. Klayman D.L., Scovill J.P., Bartosevich J.F., Mason C.J., *J. Med. Chem.* 22, **1979**, 1367.
3. Klayman D.L., Bartosevich J.F., Griffin T.S., Mason C.J., Scovill J.P., *J. Med. Chem.* 22, **1979**, 855.
4. Hall I.H., Rajendran K.G., West D.X., Liberta A.E., *Anticancer Drugs* 4, **1993**, 251.
5. Genova P., Varadinova J., Metasanz A.I., Marinova D., Souza P., *Toxicol. Appl. Pharmacol.* 197, **2004**, 107.
6. Vada K., Fujibayashi Y., Yokoyama A., *Arch. Biochem. Biophys.* 310, **1994**, 1.
7. Pal S., Barik A.K., Aich P., Peng S.M., Lee G.H., Kar S.K., *Struct. Chem.* 18, **2007**, 149.
8. Miodragovic D.U., Bogdanovic G.A., Miodragovic Z.M., Radulovic M.D., Novakovic S.B., Kaluderovic G.N., Kozlowski H.J., *Inorg. Biochem.* 100, **2006**, 1568.
9. Dixit R.B., Vanparia S.F., Patel T.S., Chandresh L.J., Doshi H.V., Dixit B.C., *Appl. Organometal. Chem.* 24, **2010**, 408.
10. Dorkov P.; Pantcheva I.N.; Sheldrick W.S.; Mayer-Figge H.; Petrova R.; Mitewa M., *J. Inorg. Biochem.* 102, **2008**, 26.
11. Musameh M.D.; Fuller B.J.; Mann B.E.; Green C.J.; Motterlini R., *Br. J. Pharmacol.* 149, **2006**, 1104.
12. Ott I.; Kircher B.; Gust R., *J. Inorg. Biochem.* 98, **2004**, 485.
13. Ware D.C.; Palmer H.R.; Brothers P.J.; Rickard C.E. (1997) *J. Inorg. Biochem.* 68, **1997**, 215.
14. Hall M.D.; Failes T.W.; Yamamoto N.; Hambley T.W., *Dalton Trans.* **2007**, 3983.
15. Geary W.J., *Coord. Chem. Rev.* **1971**, 7, 81.
16. Chaudhary Rakhi, Shelly, *Res. J. Chem. Sci.* **2011**, Vol (1) 5, 1-5.
17. Vallance R.H., Twiss D.F., Russell A.R., *A text book of Inorg. Chem.* 1<sup>st</sup> Edn. **1931**, 383.
18. West D.X., Profilet R.D., Hines J.L., *Transition Met. Chem.* **1988**, 13, 467.
19. Sau D.K., Saha N., Butcher R.J., Chaudhuri S., *Trans. Met. Chem.* 28, **2003**, 229.
20. West D.X., Severns J.C., *Transition Met. Chem.* **1988**, 13, 49.
21. Saha N.C., Seal A., Butcher R.J., Saha N., *J. Indian Chem. Soc.* 78, **2001**, 601.
22. Bera P., Butcher R.J., Chaudhuri S., Saha N., *Polyhedron* 21, **2002**, 1.
23. Mitra A., Banerjee T., Roychowdhuri P., Chaudhuri S., Bera P., Saha N., *Polyhedron* 16, **1997**, 3735.
24. Balch A.L., Fosset L.A., Guimerans, R.R., Olmstead M.M., Reed P.E., Wood F.E., *Inorg. Chem.* 25, **1986**, 1248.
25. John R.P., Sreekanth A., Kurup, M.R.P., Mobin S.M., *Polyhedron* 21, **2002**, 2515.
26. Salmon S.A., Watts J.L., Cheryal A.J., *Clin. Microbiol.* **1995**, 2435.
27. Shankar K., Muralidhar Reddy P., Rohini R., Vadde Ravindra, *Der Pharmacia Letter*; **1**, **2009**, 97.