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## Synthesis, Characterization, DNA Binding and Antimicrobial Activity of 4- Amino Antipyrine Schiff base Metal Complexes

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### ABSTRACT

A new series of transition metal complexes of Cu(II),Ni(II),Co(II),Fe(III),Zn(II) ,and VO(IV) have been synthesized from the Schiff base (L) derived from 4-Amino antipyrine and 5- Nitro Salicylaldehyde. The structural features have been obtained from their Elemental analyses, magnetic susceptibility, molar conductivity, ESI-Mass, IR,UV-VIS ,<sup>1</sup>HNMR and ESR spectral studies. The data show that the complexes have composition of ML<sub>2</sub> type. The UV-VIS ,magnetic susceptibility and ESR spectral data suggest an octahedral geometry around the central metal ion. Binding of synthesized complexes with calf thymus DNA (CT DNA) was studied by spectroscopic methods. Biological screening of the complexes reveals that the Schiff base transition metal complexes show significant activity against microorganisms.

**Keywords;** Aminoantipyrine, Nitro-Schiff base; complex, ,DNA binding.

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## INTRODUCTION

The Schiff bases of 4-amino antipyrine and its complexes have a variety of applications in the biological, clinical, analytical and pharmacological areas [1-7]. Earlier works reported that some drugs showed increased activity when administered as metal chelates rather as organic compounds. The coordinating property of 4-aminoantipyrine has been modified into a flexible ligand system by condensation with a variety of reagents like aldehydes, ketones, thiosemicarbazones, carbazides etc [8-17].

A number of metal chelates are of current interest due to their important applications in nucleic acid chemistry as DNA probes of DNA structure in solutions, reagents for the mediation of strand scission of duplex DNA under physicochemical conditions, and as chemotherapeutic agents and in the genomic research (Raman et al ,2008 ;Lu et al ,2002). The interaction between DNA and transition metal complexes is an important fundamental issue in life sciences. These complexes can bind to DNA in non-covalent modes such as electrostatic, intercalative, and groove binding.

The above application require that the complex binds to DNA through an intercalative mode where in the planar aromatic heterocyclic group is inserted and stacked between the base pairs of DNA, which is related to the in vivo replication and transcription of DNA, mutation of genes, variations of species in their character, and to the action mechanism of some synthetic nucleases.

A search through the literature reveals that no work has been done on the transition metal complexes of Schiff base formed by the condensation of 4-aminoantipyrine with 5-nitro salicylaldehyde. In the present context, we synthesized tridentate ligand system from 4-aminoantipyrine and 5-NO<sub>2</sub> Salicylaldehyde. The synthesized compound and its ligation behaviour with metal ions was studied.

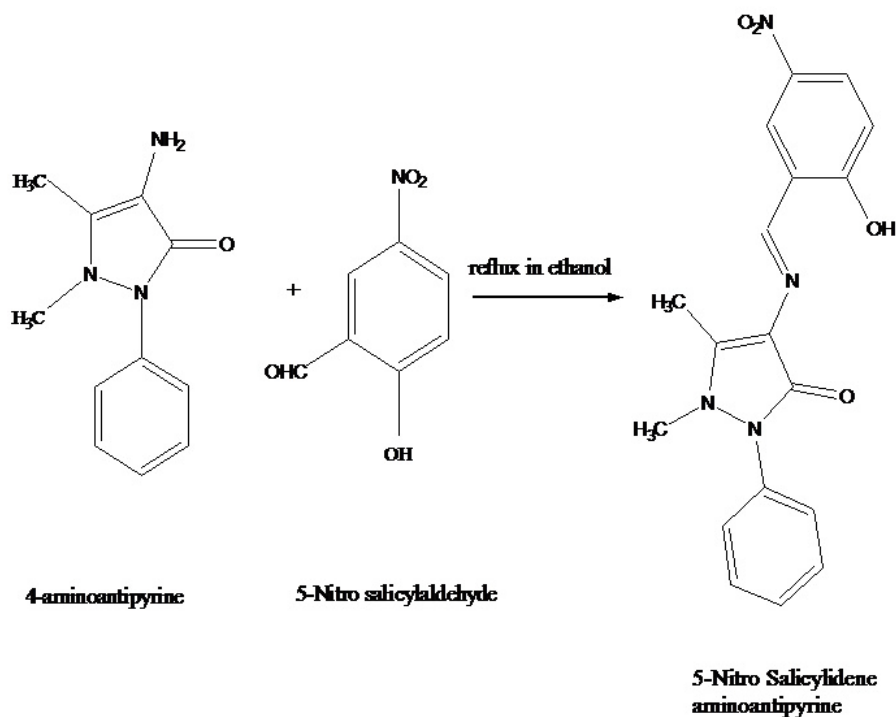
## MATERIALS AND METHODS

### Materials

All the chemicals used were of analar grade. 4-aminoantipyrine, metal salts and, 5-Nitro Salicylaldehyde were obtained from sigma aldrich. Solvents such as ethanol, methanol, and petroleum ether were purified by standard procedures.

### Synthesis of Schiff base

The 5-Nitro Salicylidene-4-aminoantipyrine was prepared (Fig1) by using the reported method [18]. 4-Aminoantipyrine (20.3mg 0.1mmol) and 5-Nitro Salicylaldehyde (16.6mg 0.1mmol) were dissolved in a methanol solution (15 cm<sup>3</sup>). The mixture was stirred for 30 min at room temperature to give a yellow precipitate. The mixture was filtered, and the solid obtained was recrystallised from Methanol solution. m.p 205.3 -205.9<sup>o</sup> C.



**Figure 1 Synthesis of schiff's base ligand**

### Synthesis of metal complexes

In the preparation of the metal complexes, the metal and the ligands were mixed in 1:2 molar ratio using required quantities of ethanol. Hot ethanolic solution of ligand (0.01 mol) and hot ethanolic solution of corresponding metal salts (0.01/0.005mol) ( $\text{MX}_2$  &  $\text{MX}_3$  where  $\text{M}=\text{Cu}(\text{II}), \text{Ni}(\text{II}), \text{Co}(\text{II}), \text{Zn}(\text{II}), \text{Fe}(\text{III})$  and  $\text{VO}(\text{IV})$   $\text{X}=\text{Cl}$ ; for  $\text{VO}(\text{IV}); \text{X}=\text{SO}_4$ ) were mixed together, refluxed for 2-3 hrs and left for evaporation at room temperature for 3 days. Coloured solid metal complexes were obtained. The products were filtered, washed with cold ethanol and dried under vacuum over Calcium Chloride.

### Physical measurements

Elemental analysis of the ligands and their metal complexes was carried out using a perkin-Elmer 240C (USA) elemental analyser. Molar conductances of the metal complexes were measured in a DMSO solution using Digisun Electronic conductivity meter. Magnetic susceptibilities of the complexes were determined on Guoy balance, model 7550 using  $\text{Hg}[\text{Co}(\text{NCS})_4]$  as standard. The diamagnetic corrections of the complexes were done using pascal's constants. TGA studies were carried on Shimadzu DTG -60 H system in the temperature range of 0-1000  $^\circ\text{C}$ . Melting points of the ligands and m.p/ decomposition temperature of complexes were determined on Polmon instrument (model No.MP -96) IR spectra were

recorded in KBr discs on Bruker FTIR spectrophotometer from 400 to 4000  $\text{cm}^{-1}$ . Electronic spectra were recorded with a Elico SL 159 UV Visible spectrometer from 200 – 1100 nm.  $^1\text{H}$  NMR &  $^{13}\text{C}$  NMR spectra were recorded using  $\text{CDCl}_3$ , at Bruker 400 HZ spectrometer. The mass spectra were recorded by ESI technique on LCQ ion trap (thermo Finnigan Sanjose CA (USA) Mass spectrometer instrument. The ESR spectra of the Cu(II) complex was recorded on Jeol, JES –FA 200 ESR Spectrometer at room temp.

### DNA Binding activity

A concentrated CT –DNA stock solution was prepared in 5mM Tris- HCl / 50 mM aq NaCl buffer (pH 7.5) and its concentration was determined by UV absorbance at 260 nm. The molar absorption coefficient was taken as  $6600\text{M}^{-1}\text{cm}^{-1}$  [19]. A solution of CT-DNA in 5mM Tris-HCl /50mM aqueous NaCl gave a ratio of UV absorption at 260 nm and 280 nm ( $A_{260/280}$ ) of 1.8 – 1.9 indicating that the DNA was sufficiently free from protein.[20] All stock solutions were stored at  $4^\circ\text{C}$  and were used within a week. Absorption spectra were recorded on a UV-Visible spectrophotometer using 1 cm quartz microcuvettes. Absorption titrations were performed by keeping the concentration of the complex constant (100 $\mu\text{M}$ ) and by varying the concentration of CT –DNA from 0-40 $\mu\text{M}$ . The binding constant ( $K_b$ ) for the binding of the complex with DNA, has been determined from the spectroscopic titration data using the following equation.[21,22]

$$[\text{DNA}]/(\epsilon_a - \epsilon) = [\text{DNA}] / (\epsilon_b - \epsilon_f) + 1/K_b (\epsilon_b - \epsilon_f) \dots 1$$

Where [DNA] is the concentration per nucleotide, the apparent extinction coefficient  $\epsilon_a$ , was obtained by calculating  $A_{\text{obs}} / [\text{Complex}]$ , The terms  $\epsilon_f$  and  $\epsilon_b$  correspond to the extinction coefficients of the free (unbound) and of the fully bound complex respectively.  $K_b$  the ratio of the slope to the intercept, was obtained from a plot of  $[\text{DNA}] / (\epsilon_a - \epsilon_f)$  versus [DNA], a slope  $1/(\epsilon_b - \epsilon_f)$ . And an intercept  $1/K_b (\epsilon_b - \epsilon_f)$ .

### Antimicrobial activity

Bacterial test cultures: *Escherichia coli*, *Staphylococcus aureus*.

*Source:* Pure cultures of these bacterial strains were obtained from National collection of Industrial Microorganisms (NCIM), NCL (National Chemical Laboratory, CSIR Institute) Pune, India. *In vitro* antibacterial activity of chemical complexes was carried out using two bacterial test cultures using Agar Diffusion Well method.

Muller –Hinton medium was used for test assay.

Test cultures used were: *Escherichia coli* (Gram negative rods), *Staphylococcus aureus* (Gram positive cocci). The test samples were diluted to give complex / 400  $\mu\text{l}$  dilution with DMSO. Controls were run in the form of solvent, ligand and element with which complex was formed. The overnight broth of inoculation was prepared. Inoculations were seeded on agar plates (1.5 x  $10^8$  CFU / ml) (Colony forming units). Wells were prepared in seeded agar plates with 8mm

diameter and samples were introduced in each well. Plates were incubated at 37<sup>0</sup> C for 24 hours. The antimicrobial spectrum of sample was determined in terms of zone sizes around each well .i.e diameter or inhibition zones.

## RESULTS AND DISCUSSION

### Characterization of ligand

Synthesized Schiff base ligand (2,3–dimethyl-1-phenyl-4-(5-Nitro-2-hydroxy benzylideneamino)-pyrazol-5-one) is yellow coloured solid and is stable at room temperature. It is soluble in Ethanol and DMSO.

### Infrared spectra

The Infrared spectrum of the Ligand [Fig 2] exhibited a broad medium intensity band around 3446 cm<sup>-1</sup> is due to intramolecular hydrogen bonded OH group. A very strong band occurring at 1667 cm<sup>-1</sup> is attributed to  $\nu_{C=O}$  of pyrazolone ring. A band at 1598 cm<sup>-1</sup> in the ligand spectrum is due to the vibrational stretching frequency of azomethine  $\nu_{C=N}$  group. The  $\nu_{C-O}$  (Phenolic) stretching frequency of ligand seen at 1329 cm<sup>-1</sup>.

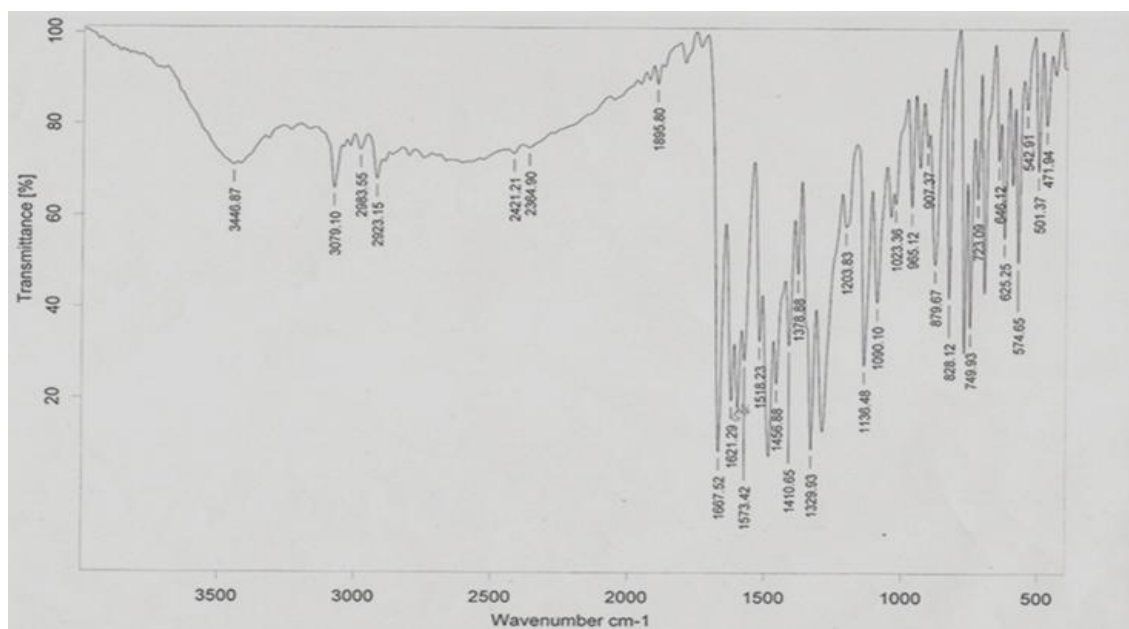
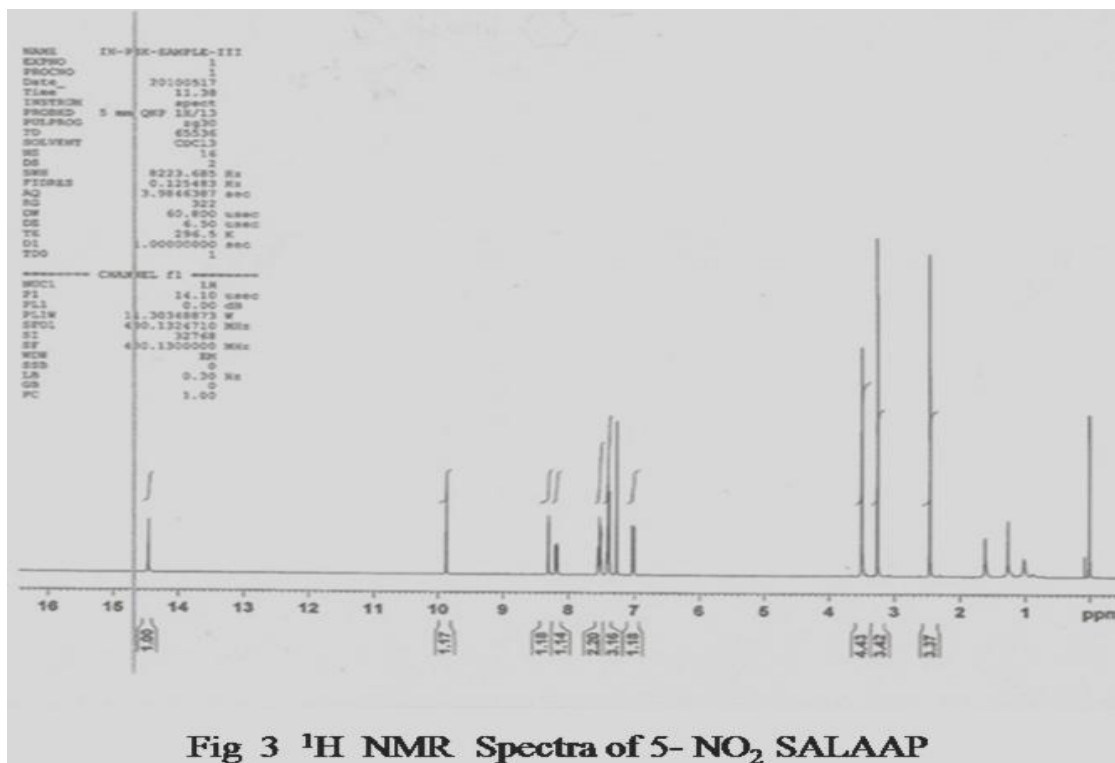


Figure 2 IR Spectra of 5-NO<sub>2</sub> SALAAP

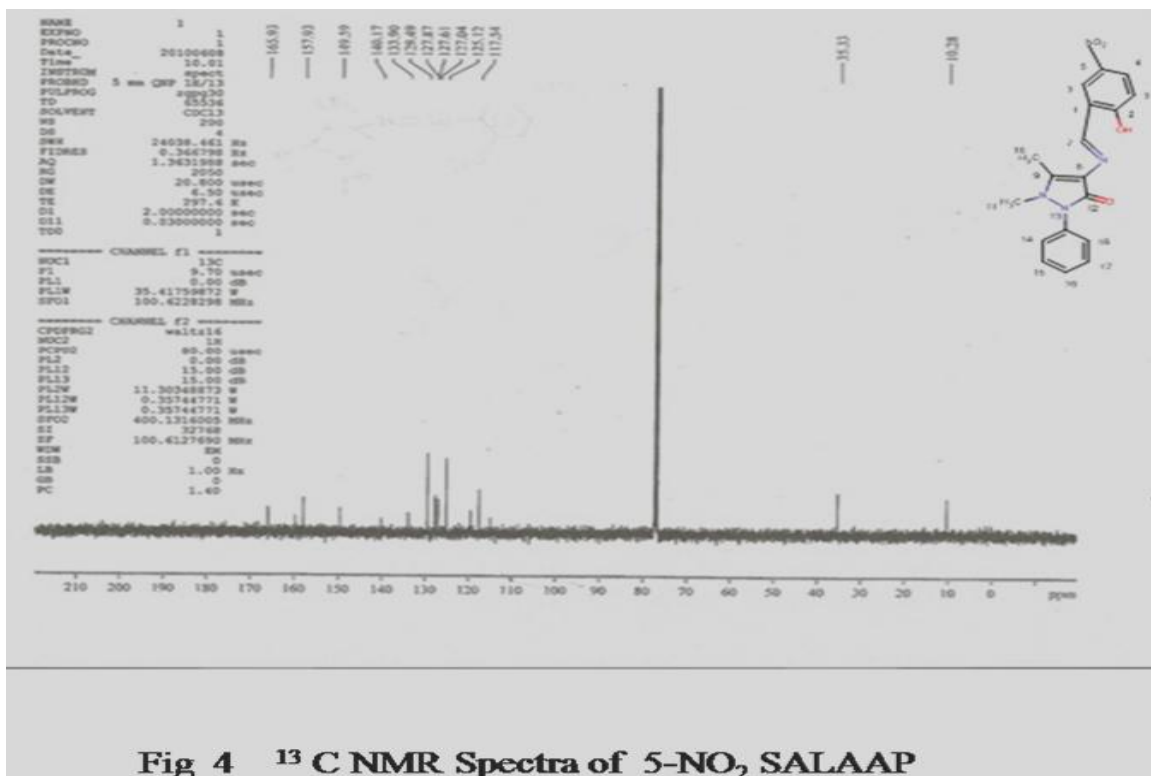
### <sup>1</sup>H NMR Spectra

The <sup>1</sup>H NMR spectrum of the Ligand (Fig 3) displays the following signals: C<sub>6</sub>H<sub>5</sub> as a multiplet at 6-8 ppm . =C –CH<sub>3</sub> at 2.4 ppm -N-CH<sub>3</sub> at 3.2 ppm and azomethine proton –CH=N- at 9.8 ppm , intramolecular hydrogen bonded OH group at 13.4 ppm.



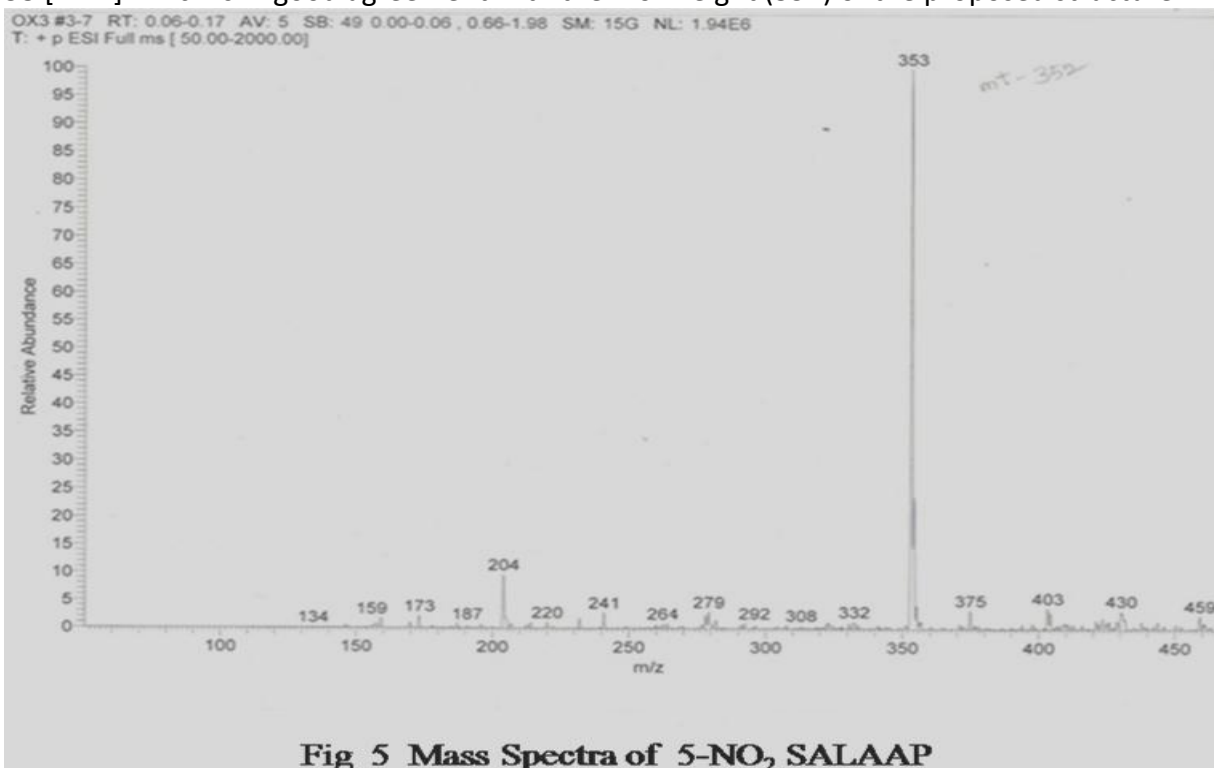
### <sup>13</sup>C NMR Spectra

<sup>13</sup>C spectrum of Ligand (Fig 4) has 119 (C-1), 163(C-2), 116 (C-3) ,127(C-4), 141 (C-5), 122.5(C-6), 165.93(C-7) , 110 (C-8) ,156.2 (C-9), 10.38(C-10), 35.33 (C-11), 160.7(C- 12), 142 (C- 13), 112 (C-14), 129(C-15) ,118.9 (C-16),129 (C-17) ,112(C-18).



**Mass Spectra**

In the ESI-Mass spectrum of Ligand (Fig 5) the molecular ion peak was observed at  $m/z$  353 [M+1] which is in good agreement with the mol weight (352) of the proposed structure.



## Characterization of Metal complexes

Table- 1 Analytical data of metal Complexes

Complex	Formula	M.Wt	C	H	N
Ligand	[C <sub>18</sub> H <sub>16</sub> N <sub>4</sub> O <sub>4</sub> ]	352	61.31% (61.36%)	4.476% (4.545%)	16.20% (15.90%)
Cu(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ·H <sub>2</sub> O	[C <sub>36</sub> H <sub>30</sub> N <sub>8</sub> CuO <sub>8</sub> ]	766	56.12% (56.39%)	3.92% (3.91%)	14.76% (14.62%)
[Ni(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ·H <sub>2</sub> O	[C <sub>36</sub> H <sub>30</sub> N <sub>8</sub> NiO <sub>8</sub> ]	760	56.76% (56.39%)	3.942% (3.79%)	14.717% (14.67%)
[Co(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ·H <sub>2</sub> O	[C <sub>36</sub> H <sub>30</sub> N <sub>8</sub> CoO <sub>8</sub> ]	762	56.56% (56.69%)	3.94% (3.93%)	14.71% (14.69%)
[Zn(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ·H <sub>2</sub> O	[C <sub>36</sub> H <sub>30</sub> N <sub>8</sub> ZnO <sub>8</sub> ]	767	59.46% (59.42%)	4.16% (4.12%)	15.47% (15.40%)
[VO(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ·H <sub>2</sub> O]	[VO <sub>2</sub> C <sub>36</sub> H <sub>30</sub> N <sub>8</sub> O <sub>8</sub> ]	770	56.16% (56.10%)	3.91% (3.89%)	14.56% (14.54%)
[Fe(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ·H <sub>2</sub> O	[C <sub>36</sub> H <sub>30</sub> N <sub>8</sub> FeO <sub>8</sub> ]	758	56.99% (56.91%)	3.95% (3.76%)	14.77% (14.65%)

\*Calculated (Found)

We have prepared and characterized the complexes of Cu(II), Ni(II), Co(II), Fe(III), Zn(II), and VO(IV) with 5-NO<sub>2</sub> SALAAP ligand. All the complexes are stable at room temperature and non hygroscopic, insoluble in water, but soluble in DMSO and Ethanol. Based on the data of Elemental Analysis & ESI Mass, the composition assigned to the complexes, are formulated and presented in Table 1. The conductance values for all complexes were measured using DMSO solvent, the obtained low values (10 – 15 Ohm<sup>-1</sup>cm<sup>2</sup>mol<sup>-1</sup>) suggest the presence of a non – electrolytic nature of complexes in the solvent [23] and that no anions are present outside the co-ordination sphere.

### Infrared spectra

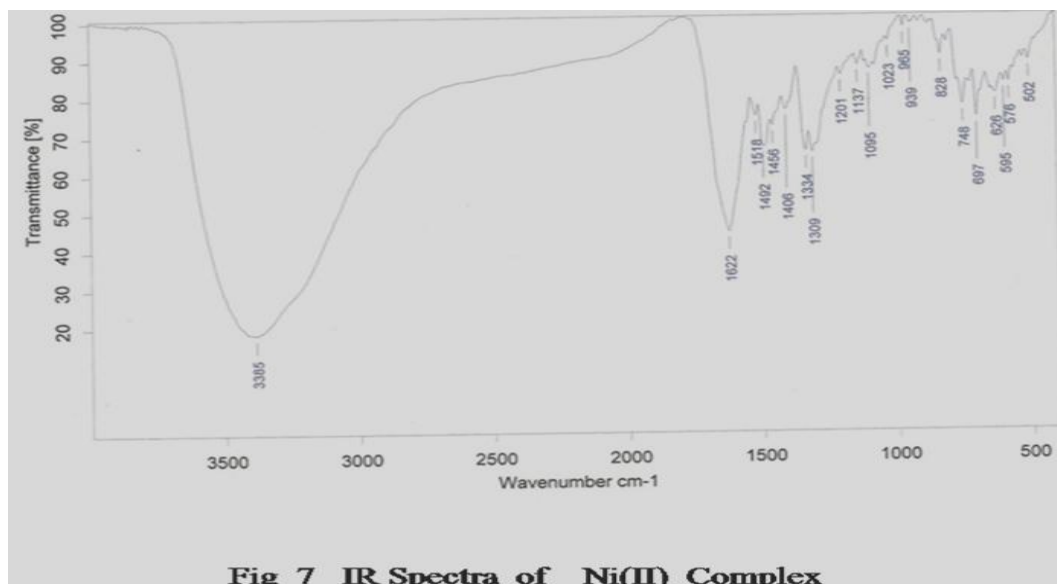
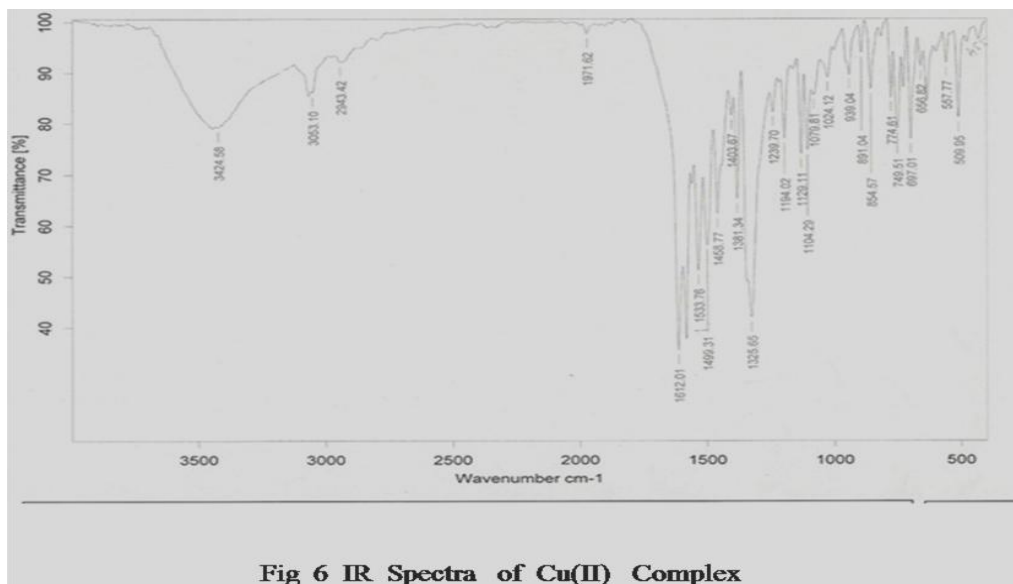
The IR spectra provide valuable information regarding the nature of functional group attached to the metal atom. In order to study the bonding mode of Schiff base to the metal complexes, the IR spectrum of the free ligand is compared with the spectra of the complexes. The main IR bands and their assignments are listed in Table 2.

Table – 2 IR spectral data of ligand and complexes (in cm<sup>-1</sup>)

Compound	ν <sub>O-H</sub>	ν <sub>C=N</sub>	ν <sub>C=O</sub>	ν <sub>C-O</sub>	ν <sub>M-O</sub>	ν <sub>M-N</sub>	ν <sub>V=O</sub>
Ligand (L)	3446	1598	1667	1329	--	--	--
[Cu(L) <sub>2</sub> ·H <sub>2</sub> O	3424	1533	1612	1325	557	455	--
[Ni(L) <sub>2</sub> ·H <sub>2</sub> O	3385	1518	1622	1309	576	427	--
[Co(L) <sub>2</sub> ·H <sub>2</sub> O	3402	1519	1622	1407	500	435	--
[Zn(L) <sub>2</sub> ·H <sub>2</sub> O	3390	1543	1596	1377	553	449	--
[VO(L) <sub>2</sub> ·H <sub>2</sub> O]	3419	1623	1666	1330	543	473	989
[Fe(L) <sub>2</sub> ·H <sub>2</sub> O]	3387	--	1612	1321	592	499	--



- The  $\nu_{C=N}$  observed band at  $1598\text{cm}^{-1}$  in free Schiff base is shifted to lower frequencies by about  $39\text{-}80\text{ cm}^{-1}$  in the spectra of Cu(II), Ni(II) (Fig6&7), Co(II), Fe(III) and Zn(II) complexes. In VO complex, shifted to higher frequency by  $25\text{cm}^{-1}$  which confirms the coordination of the nitrogen atom to the metal ion [24]. The IR broad bands of metal complexes are in the range of  $3385 - 3424\text{cm}^{-1}$  indicate the presence of coordinated / latticewater molecules [25]. The  $\nu_{C-O}$  (phenolic) stretching frequency of ligand is seen at  $1329\text{cm}^{-1}$ , which gets shifted to lower or higher ( $1321\text{-}1401\text{ cm}^{-1}$ ) region in the complexes indicating coordination of phenolic oxygen.[26]



- A band at  $1667\text{cm}^{-1}$ ,  $\nu_{C=O}$  stretching frequency of free Schiff base which is also shifted to lower frequency ranging from  $1622\text{-}1612\text{ cm}^{-1}$  in all the metal complexes, except in

VO complex suggests the coordination of ligand to the metal ion via the C=O group. In VO complex carbonyl of antipyrine is not involved in coordination.

- Appearance of non ligand bands at appropriate positions in far infrared region ( $500$  to  $592\text{cm}^{-1}$ ) and ( $427$  to  $499\text{cm}^{-1}$ ) due to  $\nu_{\text{M-O}}$  and  $\nu_{\text{M-N}}$  vibrations respectively are observed [27].
- The peak observed at  $989\text{cm}^{-1}$  complex of VO are due to  $\nu_{\text{V=O}}$ .

### Electronic Spectra & magnetic measurements

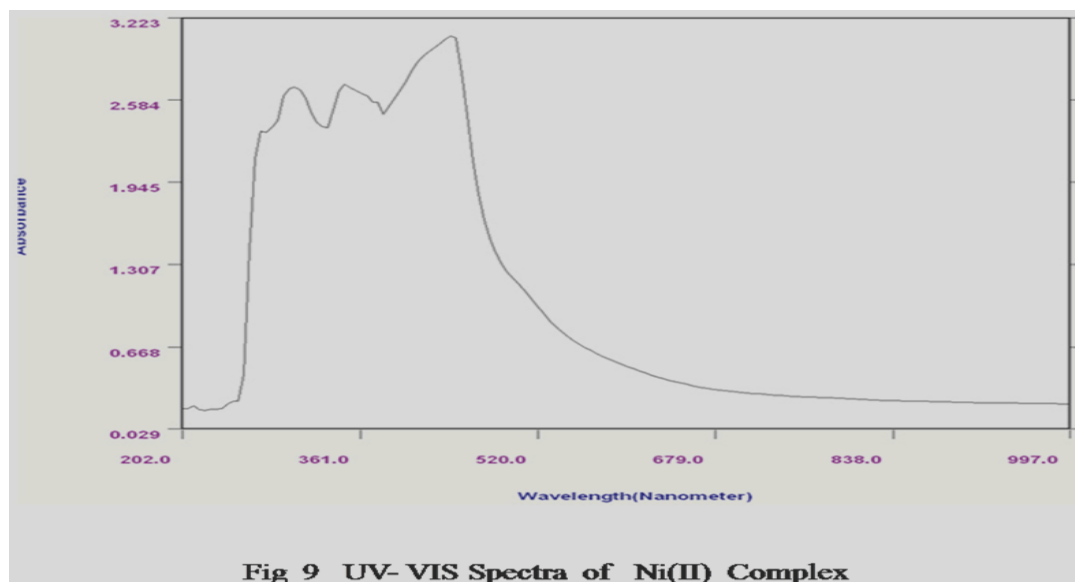
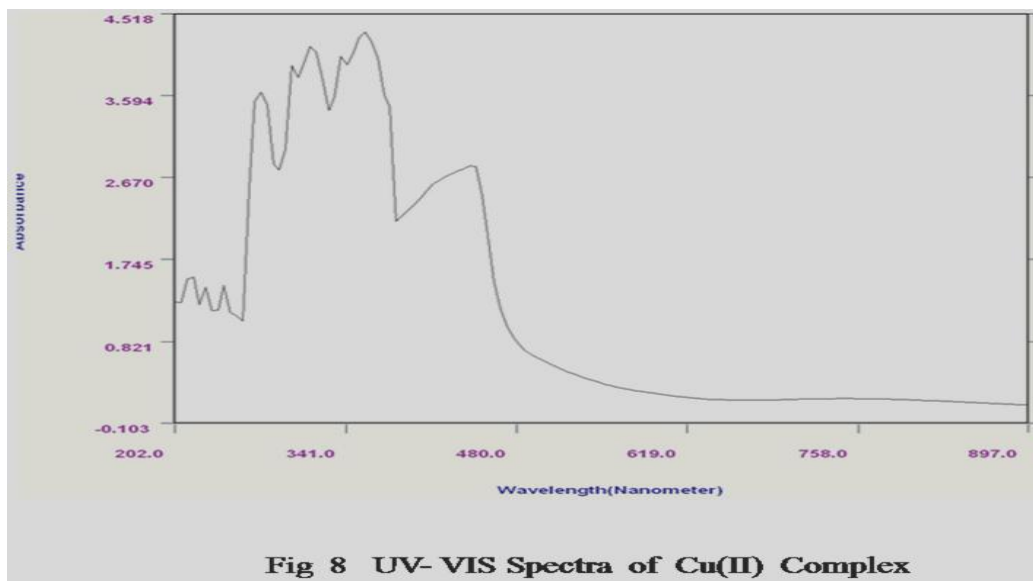
The electronic spectral data and magnetic moments of the complexes are presented in Table 3. The electronic absorption spectra of metal complexes were recorded in DMSO, in the range of  $200$  –  $1100$  nm. The electronic spectrum of free Schiff base showed three bands at  $302$  nm,  $357$  nm,  $412$  nm are due to  $\pi \rightarrow \pi^*$  transitions.[28] The electronic absorption spectrum of Cu(II) complex(Fig 8) displayed four bands at  $312$  nm,  $357$  nm,  $442$  nm and  $759$  nm. The first two peaks are most probably due to ligand  $\rightarrow$  metal charge -transfer transitions. The last two peaks are due to d – d transitions, which is assigned  ${}^2 E_g - {}^2 T_{2g}$  suggesting tetragonal geometry (distorted octahedral geometry) [29]. The magnetic moment of Cu(II) was seen at  $2.01$  B.M. On the basis of electronic spectra, ESR spectra and magnetic susceptibility measurements, a distorted octahedral geometry around Cu(II) is suggested. The electronic spectrum of Ni(II) complex,(Fig 9) displayed four bands at  $302$  nm,  $347$  nm,  $442$  nm and  $792$  nm. The first two peaks are most probably due to ligand  $\rightarrow$  metal charge – transfer transitions .The last two peaks are due to d-d transitions and are assigned as  ${}^3 A_{2g} (F) \rightarrow {}^3 T_{1g} (P)$  and  ${}^3 A_{2g} \rightarrow {}^3 T_{1g} (F)$  respectively. This suggests an octahedral geometry [29-32] around Ni(II) ion. The magnetic moment of Ni(II) complex was found to be  $2.48$  which are in the normal range observed for octahedral Ni(II) complexes. The electronic spectrum of the Co(II) complex exhibited four bands at  $302$  nm,  $347$  nm,  $447$  nm and  $680$  nm. The first two intense maxima are due to intraligand transitions of the organic moiety. The other two transitions may be assigned to  ${}^4 T_{1g} \rightarrow {}^4 T_{1g} (P)$  and  ${}^4 T_{1g} (F) \rightarrow {}^4 T_{2g} (F)$  respectively, suggesting an octahedral geometry around Co(II) ion [33]. The magnetic moment of Co(II) complex which was found to be  $4.11$  B.M. is also an indicative of octahedral geometry.[34]

Table-3 Electronic spectra & Magnetic susceptibility data for Complexes

Complex	Absorption(nm)	$\mu_{\text{eff}}$ B.M.
Ligand	302,357,412	--
Cu(5-NO <sub>2</sub> SALAAP) <sub>2</sub> H <sub>2</sub> O	312 ,357, 442 ,759	2.01
[Ni(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ]H <sub>2</sub> O	302 , 347 ,442, 792	2.48
[Co(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ]H <sub>2</sub> O	302, 347, 447,680	4.11
[Zn(5-NO <sub>2</sub> SALAAP) <sub>2</sub> ]H <sub>2</sub> O	---	diamag
[VO(5-NO <sub>2</sub> SALAAP) <sub>2</sub> H <sub>2</sub> O ]	302 , 352 432,570	1.86
[Fe (5-NO <sub>2</sub> SALAAP) <sub>2</sub> ]H <sub>2</sub> O	305,361,468,767	5.79

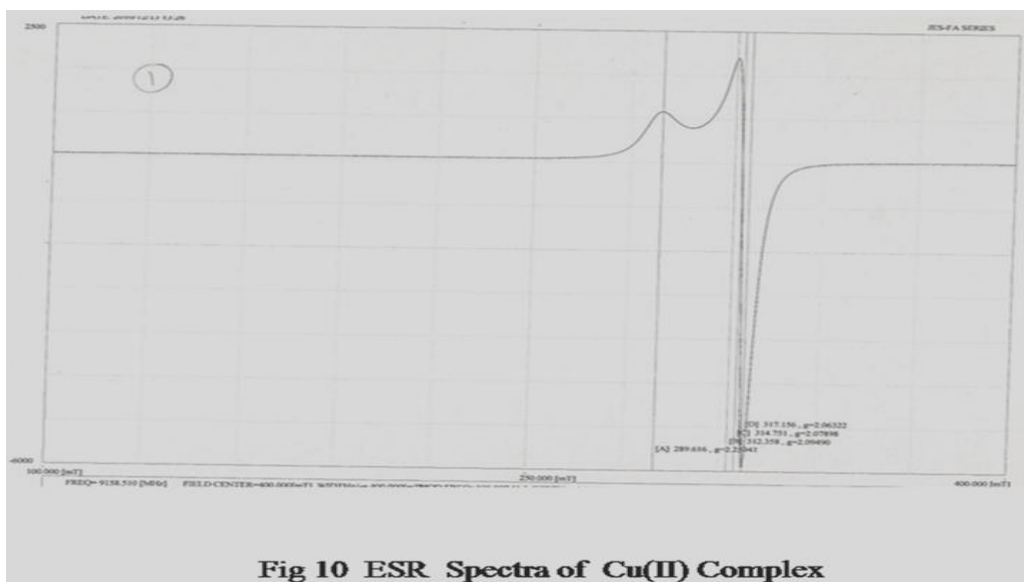
The Zn (II) complex shows no d-d bands as is expected for a  $d^{10}$  system and was found to be diamagnetic in nature. On the basis of analytical, conductance and spectral data, the Zn (II) complex was assigned to be an octahedral geometry [35]. The Fe (III) complex is exhibiting four bands at  $305$  nm,  $361$  nm,  $468$  nm and  $767$  nm. The first two intense maxima are due to intra

ligand transitions of the organic moiety. The other two bands may be assigned to  ${}^6A_{1g} \rightarrow {}^4T_{2g}$  &  ${}^6A_{1g} \rightarrow {}^4T_{1g}$  transitions respectively, suggesting octahedral geometry [36]. The observed magnetic moment for Fe(III) complex is 5.79. In the present studies, VO (IV) complex show four bands at 302 nm, 352 nm 432 nm and 570 nm. The first two intense maxima are due to intraligand transitions of the organic moiety. The other two transitions may be due to  ${}^2B_2 \rightarrow {}^2B_1$  and  ${}^2B_2 \rightarrow {}^2A_1$ . The low frequency band corresponding to  ${}^2B_2 \rightarrow {}^2E$  is not clearly resolved in the spectrum. The observed magnetic moment value for VO (IV) complex is 1.86 B.M. which suggests octahedral geometry for this complex [37, 38].



## ESR Spectra

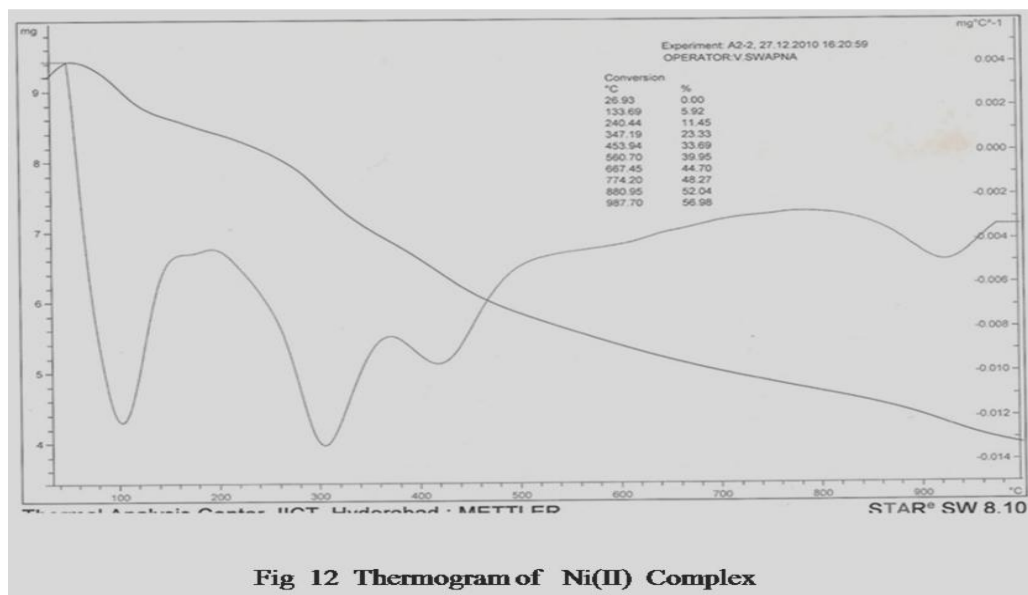
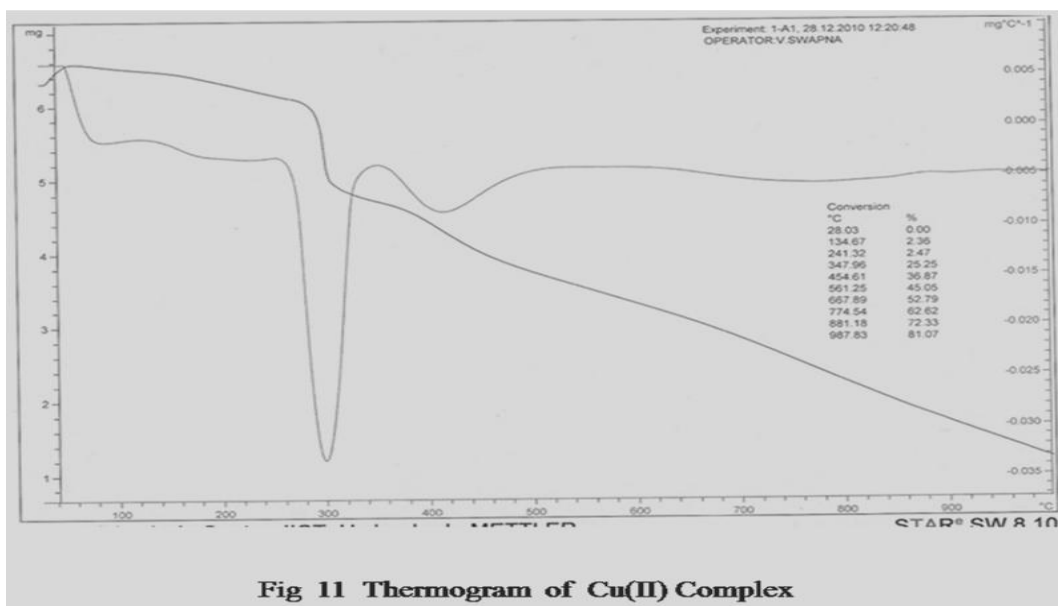
The ESR spectra of the Cu(II) complex (Fig 10) was recorded on Jeol, JES –FA 200 ESR Spectrometer at R.T. The present Cu(II) complex exhibited well resolved anisotropic signals in the parallel and perpendicular regions. The observed data showed that  $g_{\parallel} = 2.0 - 2.49$  and  $g_{\perp} = 2.09 - 2.24$ . The  $g_{\parallel}$  values are greater than  $g_{\perp}$  suggesting major distortion from octahedral symmetry in the Cu(II) complex [39]. Kivelson and Neiman have shown that  $g_{\parallel}$  is a moderately sensitive function for indicating covalency. Relatively speaking  $g_{\parallel} > 2.3$  is characteristic of an anionic environment and  $g_{\parallel} < 2.3$  of covalent environment in M–L bonding [40]. The observed  $g_{\parallel}$  values for complex is less than 2.3 in agreement with the covalent character of the M–L bond. The trend  $g_{\parallel} > g_{\perp} > 2.00023$  observed for the complexes indicates that unpaired electron is localised in  $d_x^2 - d_y^2$  orbital of the Cu(II) ion. Thus a tetragonal geometry is proposed for the complex.  $G = (g_{\parallel} - 2) / (g_{\perp} - 2)$ , which measure the exchange interaction between the metal centres in a polycrystalline solid has been calculated. According to Hathaway [41] if  $G > 4$  the exchange interaction is negligible if  $G < 4$  indicates considerable exchange interaction in the solid complexes. The above reported complex showed  $G$  values  $< 4$  indicating the exchange interaction in complexes. Furthermore, Masa cesi et al [42] reported that  $g_{\parallel}$  is 2.4 for copper-oxygen bonds and 2.3 for copper–nitrogen bonds. For the complexes reported here,  $g_{\parallel}$  values between 2.3 - 2.4 which further confirms, the presence of mixed copper- nitrogen and copper–oxygen bonds in these chelate complexes.



## Thermal Analysis

In the present investigation heating rates were suitably controlled at  $10^{\circ} \text{C min}^{-1}$  under nitrogen atmosphere, and the weight loss was measured from the ambient temperature upto  $1000^{\circ} \text{C}$ . Water molecules in complexes are generally of two types lattice water and coordinated water [43]. The lattice water will be lost at low temperature ( $60-120^{\circ} \text{C}$ ) where as the loss of coordinated water molecule is observed at high temperatures ( $150-200^{\circ} \text{C}$ ). In the thermograms of DTA and TGA of complexes  $[\text{Cu(II)}_5\text{-NO}_2\text{SALAAP}]_2\text{H}_2\text{O}$ ,  $[\text{Ni(II)}_5\text{-}$

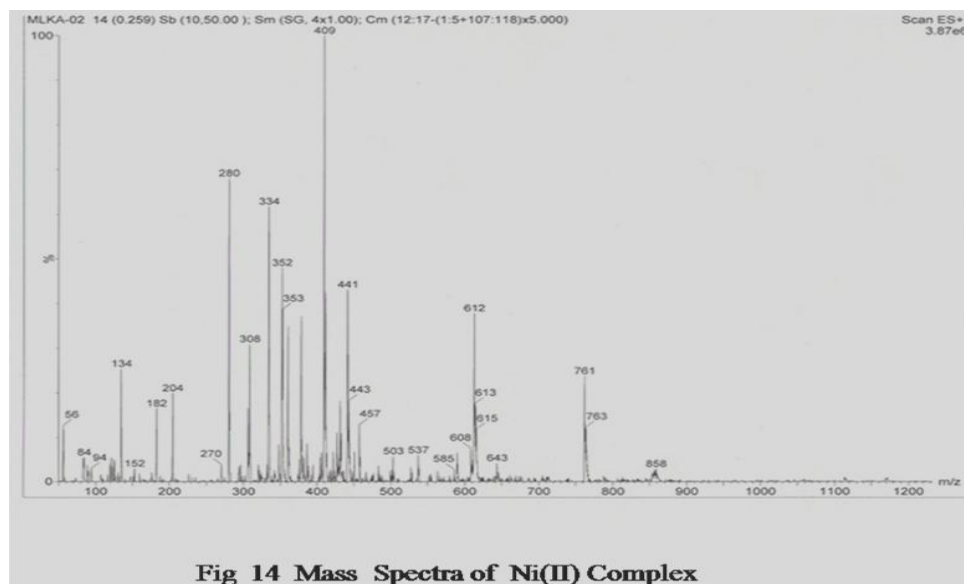
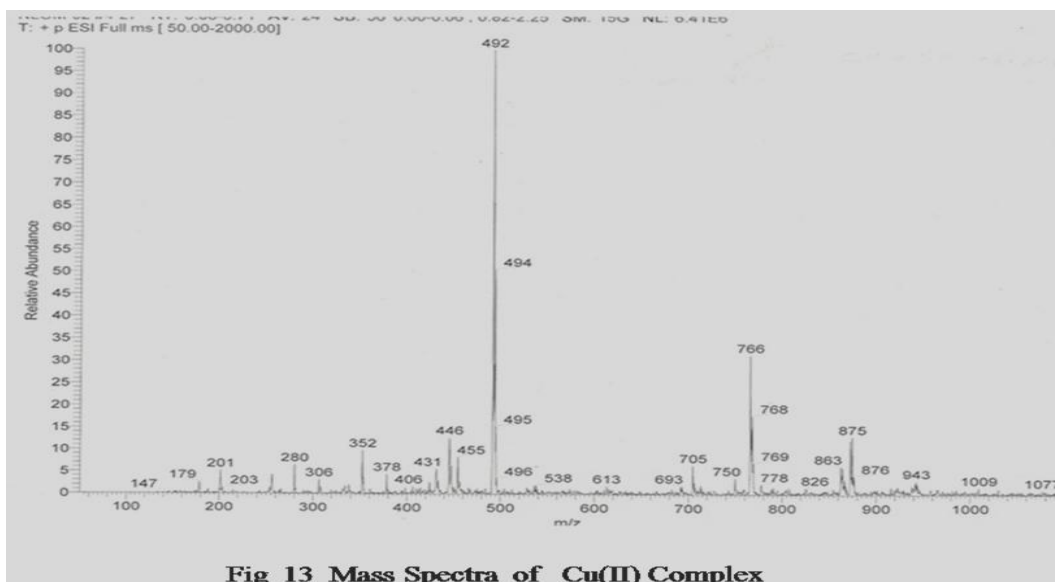
$\text{NO}_2\text{SALAAP}]_2\text{H}_2\text{O}$ , (Figs 11 &12 ) A small weight loss in the range of 60- 120<sup>0</sup>C is assigned to loss of lattice water, maximum and gradual weight loss in the range of 300<sup>0</sup>C- 1000<sup>0</sup>C is and attributable to decomposition of ligand moiety. The residue at 1000<sup>0</sup> C indicates the non volatile metal component present in the complex.



### Mass Spectra

Mass Spectra of complexes provides a vital clue for elucidating the structure of compounds. The ESI mass of the ligands and its metal complexes recorded at room temperature

were used to compare their stoichiometry. The molecular ion peaks of Cu(II),Ni(II), (Fig 13 & 14),Co(II) ,Zn(II) ,Fe(III) and VO(IV) complexes were observed respectively at 766,761(M+1),762,768,758 and 770, which were in good agreement with the molecular weight of the proposed structures and few unidentified ions were also observed.



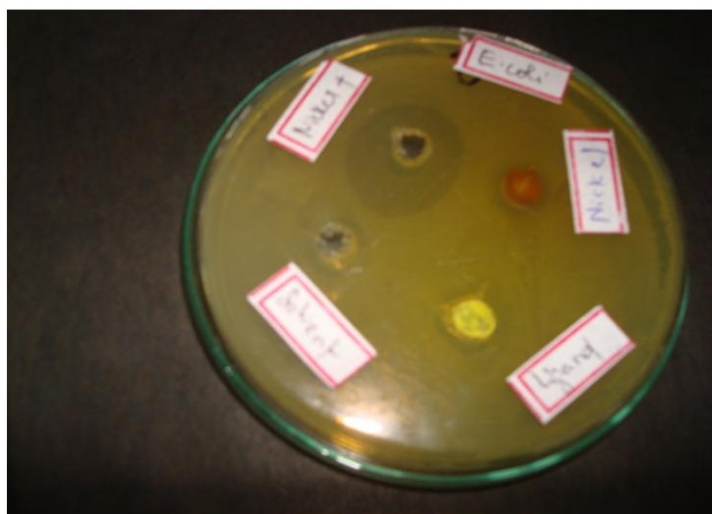
### Antimicrobial activity

In the present investigation , biological activity of the ligand and its complexes with Cu(II),Ni(II),Co(II) ,Zn(II), Fe(III) and VO(IV) and have been screened for antimicrobial activity against bacteria (E.coli and staphylo coccus aureus) by well diffusion method. (Fig 15&16) In

the present study ,the zones of inhibition of antibacterial activity have been presented in Table 4. The results indicate that Cobalt complex show highest activity against E.coli and Staph.

**Table -4 Antimicrobial Activity of Complexes (Zone of inhibition in mm)**

Complex	<i>E.Coli</i>	<i>Staph</i>
Ligand	--	--
Cu(II) Complex	--	--
Ni(II) Complex	23	27
Co(II) Complex	30	37
Zn(II) Complex	--	35
VO(IV) Compex	--	--
Fe(III) Complex	23	20
DMSO Control	--	--



**Fig 15 E.Coli of Ni(II) Complex**

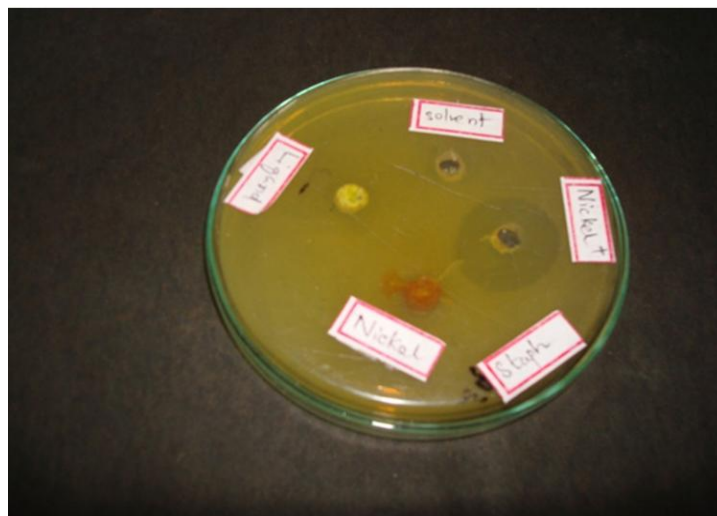
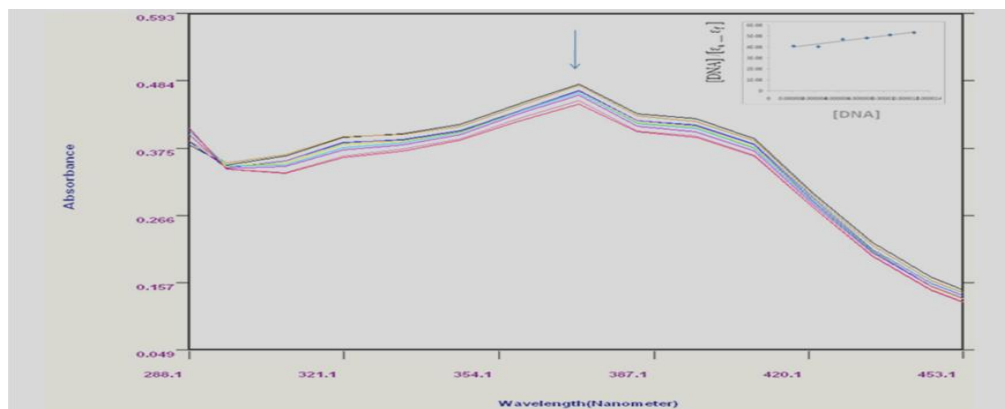


Fig 16 Staphylococcus aureus of Ni(II) Complex

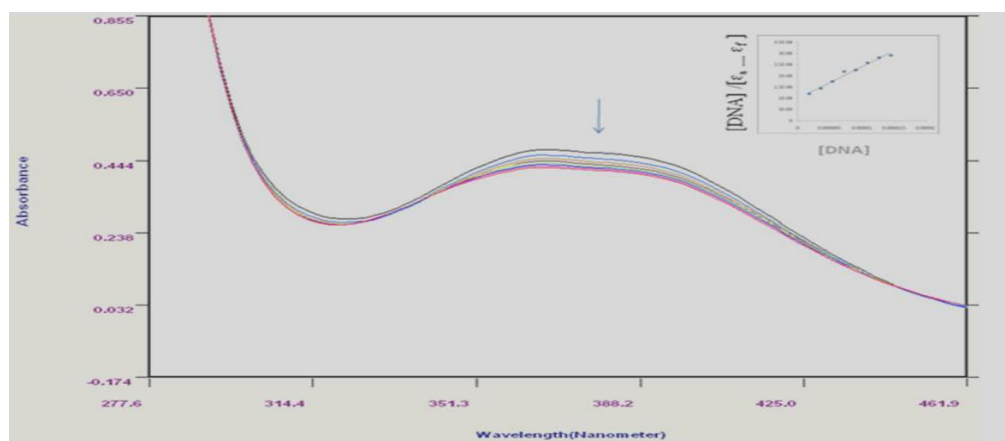
### DNA Binding activity

In general, complexes with aromatic moieties which bind to DNA through intercalation usually results in hypochromism and bathochromism, due to the stacking interaction between aromatic chromophore of the complexes and the base pairs of DNA. The absorption spectra of the complexes, Cu(II)-5-NO<sub>2</sub> SALAAP (**1**), Co(II)-5-NO<sub>2</sub> SALAAP (**2**) in the absence and presence of calf thymus DNA are illustrated in Figs ( 17 & 18) in the presence of DNA, decrease of peak intensities were observed in the absorption spectra of complexes. Hypochromism was suggested to be due to the interaction between the electronic state of the intercalating chromophore and that of the DNA bases [44-48]. In addition to the decrease in intensity, a small red shift (bathochromism) was also observed in the spectra. These spectral changes are consistent with the intercalation of complexes into the DNA base stack. The plot of the absorption titration data according to Equation  $[DNA]/(\epsilon_a - \epsilon_f) = [DNA] / (\epsilon_b - \epsilon_f) + 1/K_b (\epsilon_b - \epsilon_f)$  gave a linear plot and resulted in an intrinsic binding constant ( $K_b$ ) of,  $2.5 \times 10^4$ .




**Fig 17**

Absorbance spectra of complex  $[Cu(5-NO_2 SALAAP)_2]$  in the absence and presence of increasing amounts of DNA.  $[Cu] = 100 \mu M$ , with increasing DNA concentration from 0–40  $\mu M$ . Arrow ( $\downarrow$ ) shows the absorbance changes upon increasing DNA concentration. Inset: Linear plot for the calculation of the intrinsic DNA binding constant  $K_b$ .


**Fig 18**

Absorption spectra of complex  $[Co(5-NO_2 SALAAP)_2]$  in the absence and presence of increasing amounts of DNA.  $[Co] = 100 \mu M$ , with increasing DNA concentration from 0–40  $\mu M$ . Arrow ( $\downarrow$ ) shows the absorbance changes upon increasing DNA concentration. Inset: Linear plot for the calculation of the intrinsic DNA binding constant  $K_b$ .

### Proposed structures for metal complexes

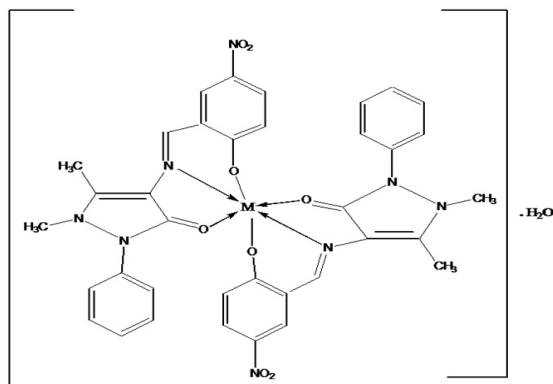


Fig 19 M = Cu(II), Ni(II), Co(II), Zn(II) & Fe(III),

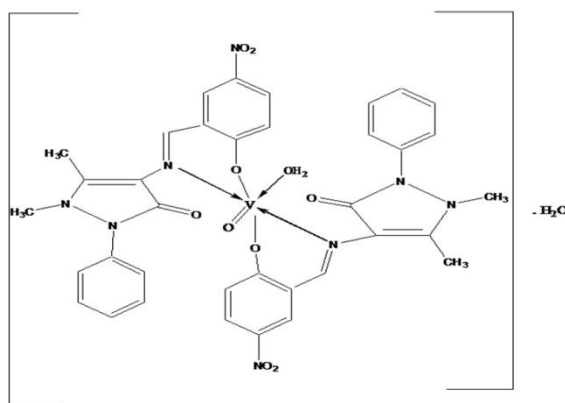


Fig 20 VO(IV) Complex

## CONCLUSION

The metal chelates of Ligand have been structurally characterized. The complexes of the ligand are non electrolytes in DMSO. This ligand act as tridentate, coordinating through nitrogen of azomethine, phenolic oxygen and carbonyl of antipyrine ring respectively. Geometries of the metal complexes are assigned, based on analytical, conductance, magnetic and electronic spectral data. Biological studies of these complexes reveal that they show better activity when compared to that of the ligand.

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