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RESEARCH ARTICLE

SPECTRAL, MAGNETIC, BIOCIDAL SCREENING AND DNA CLEAVAGE STUDIES OF BINUCLEAR METAL (II) COMPLEXES OF TETRACOORDINATE SCHIFF BASE LIGAND OF 3, 3′-DIHYDROXYBENZIDINE

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ABSTRACT

A group of combinations which have more importance in biological studies, biochemistry and also medical applications are Schiff base complexes. They have been considered by the chemists. Schiff base ligand(4, 4′-Bis-[2-(2-mercapto-phenylimino)-1-methyl-propylideneamino]-biphenyl-3, 3′-diol) was provided by means of condensation of 3, 3′-dihydroxybenzidine, diacetyl and 2-aminothiophenol in absolute ethanol solvent with reflux method. Then the complexes of transition metals Cu(II), Ni(II) and VO(II) with the ligand to being determined synthesized binuclear Schiff base metal complexes and using elemental analyses, molar conductance, magnetic susceptibility, IR, UV-Vis spectral data, ESR and H^1NMR studies. The elemental analysis of the complexes confine to the stoichiometry of the type [M_2L]. The complexes were found to be non-electrolytic in nature on the basis of low value of molar conductance. From the spectral data an square-planar geometry for the Cu(II), Ni(II) and square pyramidal for VO(II) complexes. The possible geometries of metal complex were evaluated using 3D molecular modelling picture. The metal complexes have been screened for their antibacterial (Gram-positive bacteria like *Staphylococcus aureus, Bacillus subtilis* and two Gram-negative bacteria like *Escherichia coli* and *Klebsilla pneumonia*) and antifungal activity (*Fusarium oxysporum* and *Aspergillus fumigates*). DNA cleavage activities of Schiff bases and their metal complexes were monitored by agarose gel electrophoresis method in the presence of H_2O_2. The antioxidant activities of the complexes were also investigated through scavenging effect on DPPH.

INTRODUCTION

Medicinal inorganic chemistry is one of the most rapidly developing areas of pharmaceutical research. It attracted much attention after the prototypical success story of cisplatin [cisdiamminedichloroplatinum(II)] for treating solid tumors (Sartaj Tabassum *et al.,* 2012). Despite its success, there were serious concerns of this drug regarding its toxicity issues, intrinsic resistance, narrow spectrum of activity for phenotypes of cancer and patient compliance (Kelland *et al.,* 2000). Therefore, studies pertaining to essential metalloelements received much attention in contrast to Pt, since the drugs designed and synthesized from endogenous metal ions may be less harmful and more prone to antiproliferative activity against tumors and many other diseases (Zhang *et al.,* 2003, Ronconi *et al.,* 2007). Among all metals, copper is an attractive prospect, being an essential trace element which is required for normal cellular activity as a cofactor for many enzymes. However, role of copper is much more complex because it can also promote nucleic acid cleavage and therefore has been utilized as metallodrug to cause DNA damage. More recently, copper-based heteronuclear complexes were explored for displaying intriguing nuclease properties (Liu *et al.,* 2004). The Schiff base properties of nickel complex are high in demand in bioinorganic chemistry as well as in the redox enzyme reactions (Claudio Mendicute Fierro *et al.,* 2011). Nickel complexes are used in heterogeneous catalysis, electroplating, and in making pigments and ceramics. A number of nickel complexes of Schiff bases have been seen to possess fungicidal and bacterial activity. Applications of vanadium compounds in medicine have focused their activity, *in vitro* and *in vivo*, in the treatment, of insulin deficiency type I diabetes, and insulin tolerance, type 2 diabetes. Besides the insulin-like activity of oxidovanadium (V) and oxidovanadium (IV) compounds (Tudor Rosu *et al.,* 2010), its presence in vanadium dependent haloperoxidases has particularly stimulated the search for structural and functional models. At the onset, the present work stems from our interest to develop the synthesis, characterization, DNA cleavage, antibacterial, antifungal and antioxidant abilities of Cu(II), Ni(II), VO(II) complexes. Complexes were structurally characterized by various physico chemical techniques. All the synthesized compounds show significant biological activity.

Experimental Section

All the chemicals were of reagent grade and the solvents were distilled before use according to the standard procedure. Metal salts, 3, 3′-dihydroxybenzidine, diacetyl and 2-aminothiophenol were obtained from Aldrich and used as received. Ethanol, Acetonitrile, DMSO and DMF were used as solvents purchased from Merck and Loba chemicals.

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Physical Measurements

Elemental analysis was carried out on a Carlo Erba Model 1106 elemental analyzer. Molar conductivity was measured by using an ELICO CM 185 conductivity Bridge using freshly prepared solution of the complexes in DMF solution. IR spectra were recorded on a Thermo Nicolet, Avatar 370 model spectrophotometer on KBr disks in the range 4000– 400 cm^{-1}. Electronic spectral studies were carried out on a Perkin Elmer Lambda-25 spectrophotometer in the range 200– 800 nm. The magnetic studies were carried out at room temperature on a Gouy balance calibrated with $Hg[Co(SCN)_4]$. EPR spectra were recorded on an E-112 ESR spectrometer at X-band microwave frequencies for powdered samples. The ^1H NMR spectra were recorded in DMSO-d_6 on a BRUKER ADVANCED III 400 MHz spectrophotometer using TMS as an internal reference.

Synthesis of 4, 4′-Bis-[2-(2-mercapto-phenylimino)-1-methyl-propylideneamino]-biphenyl-3, 3′-diol

An ethanolic solution of 3, 3′-dihydroxybenzidine (1 mM) in 10 mL of ethanol, diacetyl (2 mM) and 2-aminothiophenol (2 mM) in 20 mL of ethanol was mixed. The resultant mixture was refluxed for 2 h as shown in Figure 1. The solid product formed was filtered and recrystallized from ethanol.

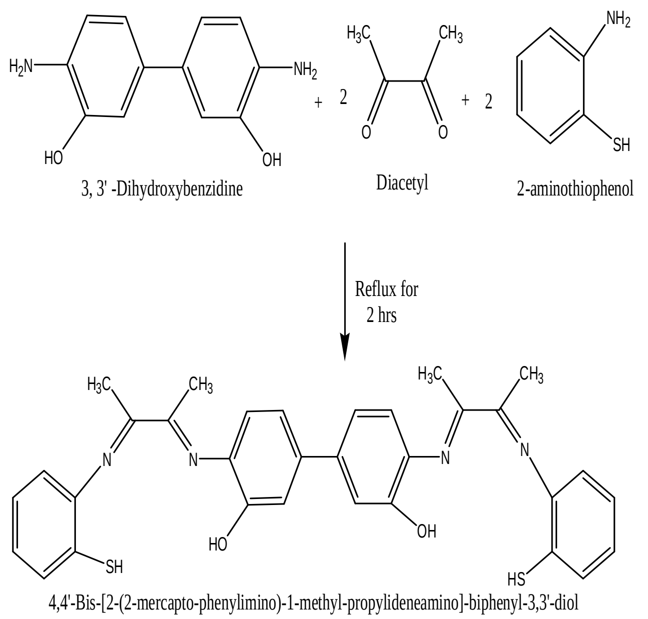
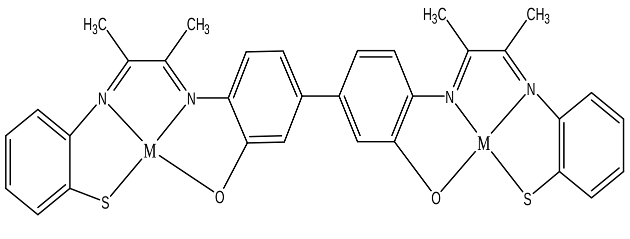


Figure 1 Synthesis of Schiff base ligand (H_2L)

Synthesis of binuclear Schiff base Metal complexes

Metal(II) acetates of [Cu(II), Ni(II)] and [VO(II)] sulphate (2 mM) and the potential binucleating Schiff base ligand (1 mM) were dissolved in ethanol (20 ml) and the mixture was heated to reflux for 4- 5 hrs.



M=Cu(II), Ni(II) & VO(II)

Figure 2 Synthesis of Binuclear Schiff base Metal complexes

After partial evaporation of the solvent, solid (70– 80%) metal (II) Schiff base complexes (Figure 2) were separated and dried in vacuum. The analysis results are in good consistency with proposed formulas in Table 1.

Anti-microbial activity

The Schiff base 4, 4′-Bis-[2-(2-mercapto-phenylimino)-1-methyl-propylideneamino]-biphenyl-3, 3′-diol and its complexes were investigated for anti-bacterial and anti-fungal against *Staphylococcus aureus* and *Bacillus subtilis* as gram positive bacteria and *Escherichia coli* and *Klebsiella pneumoniae* as Gram-negative and the fungi *Fusarium oxysporum* and *Aspergillus fumigates* by using disc-agar diffusion method (Ekamparam Akila *et al.,* 2012). The anti-microbial activity was carried out at Progen Lab at Salem, Tamilnadu (India). The antibiotic *Streptomycin* was used as standard reference in the case bacteria and *Clotrimazole* was used as standard anti-fungal reference. The tested compounds were dissolved in DMF (which have no inhibition activity), to get concentration of 100 µg/mL. The test was performed on medium potato dextrose agar contains infusion of 200 g potatoes, 6 g dextrose and 15 g agar (Mohammad Akbar Ali *et al.,* 2002). Uniform size filter paper disks (three disks per compound) were impregnated by equal volume from the specific concentration of dissolved tested compounds and carefully placed on incubated agar surface. After incubation for 36 h at 27^0C in the case of bacteria and for 48 h at 24^0C in the case of fungus, inhibition of the organism which evidenced by clear zone surround each disk was measured and used to calculate mean of inhibition zones (Poomalai Jayaseelan *et al.,* 2011).

Antioxidant Assay

DPPH radical scavenging assay

4,4′-Bis-[2-(2-mercapto-phenylimino)-1-methyl propylideneamino] - biphenyl-3, 3′-diol and its complexes was determined mainly by its free redical scavenging ability on the stable 1,1-diphenyl-2-picrylhydrazyl(DPPH) free radicals described in the literature (Kavitha *et al.,* 2013). The scavenging ability determines the antiradical power of an antioxidant by measuring the decrease in the absorbance of DPPH at 517 nm. All of these compounds exhibit free radical scavenging ability at the different concentrations (200, 400, 600, 800, 1000 µg/ mL). The radical scavenging activity was calculated using the following formula:

% inhibition = [(Absorbance of control – Absorbance of test Sample)/Absorbance control] x100

IC_{50} values were calculated for compounds, which exhibited the significant activity. IC_{50} is defined as concentration sufficient to obtain 50% of maximum scavenging activity.

Methodology for DNA Cleavage Study

Agarose gel electrophoresis was used to study the DNA cleavage activity of the complexes. pUC18 plasmid was cultured, isolated and used as DNA for the experiment. The gel electrophoresis experiments were performed by incubation of the samples containing 40 µM pUC18 DNA, 50 µM metal complexes and 50 µM H_2O_2 in tris-HCl buffer (pH 7.2) at 37°C for 2 h. After incubation, the samples were electrophoresed for 2 h at 50 V on 1% agarose gel using tris-acetic acid-EDTA buffer (pH 7.2). The gel was then stained using 1 µg cm^{-3} ethidium bromide (EB) and photographed under ultraviolet light at 360 nm. All the experiments were performed at room temperature (Akila *et al.*, 2013).

RESULTS AND DISCUSSION

The Schiff base ligand and its Cu(II), Ni(II) and VO(II) complexes have been synthesized and characterized by spectral and elemental analytical data. They are found to be air stable. The ligand is soluble in common organic solvents and all the complexes are freely soluble in acetonitrile, DMF and DMSO but slightly soluble in methanol and ethanol and insoluble in water.

The metal(II) complexes were dissolved in DMF and the molar conductivities of 10^{-2} M of their solution at room temperature were measured. The lower conductance values (11.3–15.5) of the complexes support their non-electrolytic nature of the compounds (krishna murthy potla *et al.*, 2013).

IR Spectra

The coordination mode and sites of the ligand to the metal ions were investigated by comparing the infrared spectra of the free ligand with its metal complexes.

Table 1 Physical characterization, analytical data of the ligand and binuclear Schiff base complexes.

Compounds	Molecular Formula	Color	Yield %	Melting Point (º)	Calculated (Found) (%)				Λ_m(ohm^{-1}cm^2 mol^{-1})
					C	H	N	Metal	
L	$C_{32}H_{30}N_4O_2S_2$	Pale Yellow	83	152	67.75 (67.74)	5.29 (5.26)	9.88 (9.85)	--	--
[Cu_2L]	[Cu_2 ($C_{32}H_{26}N_4O_2S_2$)]	Dark green	80	>200	55.66 (55.64)	3.76 (3.75)	8.11 (8.10)	18.54 (18.51)	13.3
[Ni_2L]	[Ni_2 ($C_{32}H_{26}N_4O_2S_2$)]	Brownish blue	75	>200	56.46 (56.44)	3.82 (3.80)	8.23 (8.21)	17.30 (17.31)	11.3
[VO_2L]	[VO_2 ($C_{32}H_{26}N_4O_2S_2$)]	Blackish brown	75	>200	55.12 (55.10)	3.73 (3.72)	8.03 (8.01)	15.70 (15.69)	15.5

Table 2 Infrared and Electronic Spectral Data

Compounds	Free-OH (cm^{-1})	(C=N) (cm^{-1})	(C-S) (cm^{-1})	(V=O) (cm^{-1})	(M−N) (cm^{-1})	(M−O) (cm^{-1})	λ_{max}	Geometry
$C_{34}H_{34}N_4O_2S_2$	3370	1612	744	-	--	--	--	--
[Cu_2($C_{34}H_{30}N_4O_2S_2$]	--	1605	732	-	463	534	589	Square planar
[Ni_2($C_{34}H_{30}N_4O_2S_2$)]	--	1595	756	-	456	556	544, 622	Square planar
[VO_2($C_{34}H_{30}N_4O_2S_2$]	--	1597	745	987	446	576	510, 570, 610	Square pyramidal

Elemental analysis and molar conductivity measurements

The elemental analysis results for the metal complexes are in good agreement with the calculated values (Table 1) showing that the complexes have 2:1 metal–ligand stoichiometry of the type M_2L, wherein L acts as a tetradentate ligand. The formation of these complexes may proceed according to the following equation:

$$2\ M\ (COOCH_3)_2 + L \rightarrow M_2L + 4\ CH_3COOH$$

Where, M= Cu (II), Ni (II) and VO (II)

Table 3 Various Bond Lengths of [Cu_2 ($C_{34}H_{30}N_4O_2S_2$] complex.

Atoms	Actual bond length
N(8)-Cu(53)	1.846
N(14)-Cu(54)	1.846
N(19)-Cu(53)	1.846
N(20)-Cu(54)	1.846
O(34)-Cu(53)	1.872
O(35)-Cu(54)	1.798
S(36)-Cu(54)	2.201

The IR spectra of the complexes show a sharp band in the range 1605–1597 cm^{-1}, attributed to azomethine(C=N), which is shifted to lower frequency on going from the free ligand (υ 1612 cm^{-1}) to the complexes (Hassan Keypour *et al.*, 2013). This is indicative of the coordination of the imine nitrogen to the metal. Furthermore, the absence of C=O stretching vibrations in the spectra of the ligands, related to ketone, diamine and 2-aminothiophenol, respectively, indicate occurrence of Schiff base condensation. Deprotonation of all phenolic functions is confirmed by the lack of O-H stretching bands in the IR region 3400–3300 cm^{-1} for all complexes (Sallam *et al.*, 2011). It has been reported that oxovanadium complexes with coordination number 5 have υ(V=O) values higher than and lower than about 987 cm^{-1}, respectively (Akbar Ali *et al.*, 1978). Conclusive evidence of the bonding was also shown by the observation that new bands in the spectra of all metal complexes appearing in the low frequency regions at 576–534 and 463–446 cm^{-1} (Emam *et al.*, 2012) characteristic to υ(M–O) and υ(M–N) stretching vibrations(Table 2), respectively, that were not observed in the spectrum of free ligand.

Table 4 Various Bond Angles of [Cu_2($C_{34}H_{30}N_4O_2S_2$]complex

Atoms	Actual bond angle	Atoms	Actual bond angle
C(2)-N(8)-Cu(53)	111.000	N(8)-Cu(53)-N(19)	104.501
C(16)-N(8)-Cu(53)	111.000	N(8)-Cu(53)-S(33)	99.014
C(11)-N(14)-Cu(54)	111.000	N(8)-Cu(53)-O(34)	87.407
C(15)-N(14)-Cu(54)	111.000	N(19)-Cu(53)-S(33)	90.186
C(18)-N(19)-Cu(53)	110.998	N(19)-Cu(53)-O(34)	139.908
C(25)-N(19)-Cu(53)	111.000	S(33)-Cu(53)-O(34)	126.200
C(17)-N(20)-Cu(54)	111.000	N(14)-Cu(54)-N(20)	104.501
C(27)-N(20)-Cu(54)	110.998	N(14)-Cu(54)-O(35)	84.639
C(24)-S(33)-Cu(53)	95.150	N(14)-Cu(54)-S(36)	160.099
C(3)-O(34)-Cu(53)	110.213	N(20)-Cu(54)-O(35)	118.935
C(10)-O(35)-Cu(54)	114.287	N(20)-Cu(54)-S(36)	80.738
C(28)-S(36)-Cu(54)	90.833	O(35)-Cu(54)-S(36)	109.958

Electronic Spectra and Magnetic Data

The geometry of the metal complexes has been deduced from electronic spectra and magnetic data of the complexes. The electronic spectra of the complexes were recorded in DMF solution. All the complexes show the high energy absorption band in the region 465- 485 nm. This transition may be attributed to the charge transfer band. The electronic spectrum of copper(II) complex displays the d–d transition band in the region 589 nm (Raman *et al.,* 2012) which is due to $^2B_{1g} \rightarrow {}^2A_{1g}$ transition. This d–d transition band strongly favors a square-planar geometry around the metal ion.

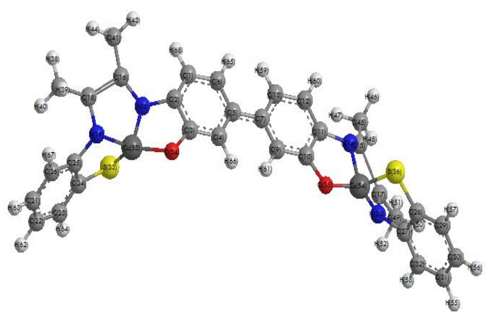


Figure 3 3D Structure of Compound of [$Cu_2(C_{34}H_{30}N_4O_2S_2)$]complex.

Copper complex show μ_{eff} value in the range 1.71 B.M. which is close to the spin only value of 1.73 B.M. The lower value of magnetic moment at room temperature is consistent with square planar geometry around the metal ions. The absorption spectrum of nickel(II) complex displays two d–d bands at 544 and 622 nm. These bands correspond to $^1A_{1g} \rightarrow {}^1A_{2g}$, $^1A_{1g} \rightarrow {}^1B_{1g}$ transitions respectively, being characteristic of square-planar geometry (Claudio Mendicute Fierro *et al.,* 2011), also Ni (II) complex is diamagnetic in nature. The electronic spectrum of VO (II) complex displays three d–d transition bands in the region 510, 570, and 610 nm (Table 2) which are assigned to $d_{xy}\rightarrow d_{xz}$, d_{yz}, $d_{xy}\rightarrow d_{x}^{2}-d_{z}^{2}$ and $d_{xy}\rightarrow d_{z}^{2}$ transitions respectively. This indicates that the complex of VO (II) is five coordinate and probably an square-pyramidal geometry (Leelavathy *et al.,* 2009), which is also supported by its magnetic susceptibility value (1.69 BM).

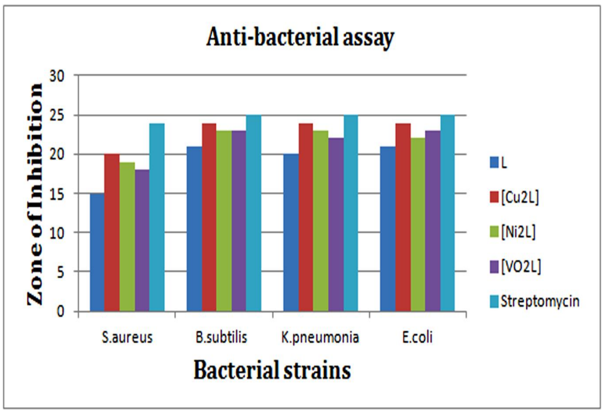


Figure 4 The *in vitro* antibacterial activity of Schiff base and its metal complexes. Standard = *Streptomycine,* Inhibition Zone in mm, Concentration 100 µg/mL.

^{1}H NMR Spectral Studies

The ^{1}H NMR spectrum of the 4, 4′-Bis-[2-(2-mercapto-phenylimino)-1-methyl-propylideneamino]-biphenyl-3, 3′-diol was recorded in DMSO-d_6 at room temperature respectively. The signal at δ (12.23) (s, 1H) is assigned to thiophenolic proton of (–SH–) group and the signal at δ (8.76) (s, 1H) is assigned to azomethine proton, respectively. The aromatic protons at δ(6.16–8.54) shifted downfield in the complexes (Mustafa Dolaz *et al.,* 2009) respectively.

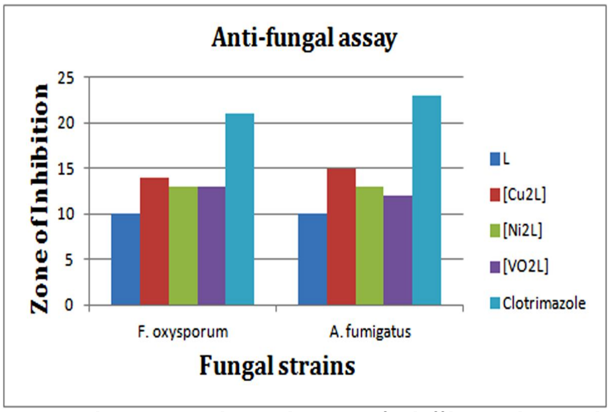


Figure 5 The *in vitro* antibacterial activity of Schiff base and its metal complexes. Standard = Clotrimazole, Inhibition Zone in mm, Concentration 100 µg/mL.

Electron paramagnetic resonance spectra

The EPR spectrum of copper complex provides information, important in studying the metal ion environment. The EPR spectra were recorded in DMSO at RT (room temperature). The copper complex exhibited the g|| value of 2.264 and g⊥ value of 2.066. These values indicate that the Cu(II) lies predominantly in the $dx^2–y^2$ orbital, as was evident from the value of the exchange interaction term G, estimated from the expression:

$$G = (g\| - 2)/ (g\perp - 2) = 4.0$$

if G > 4, the exchange interaction between copper(II) centers in the solid state is negligible. Whereas G < 4, a considerable exchange interaction occurs in the solid state complexes. The observed value for the exchange interaction parameter for the copper complex (G = 4.1) suggests that the Cu (II) complex is in square planar geometry and the unpaired electron is present in the $dx^2–y^2$ orbital. This result also indicates that the exchange coupling effects are not operative in the present complex (Sulekh Chandra, *et al.,* 2005).

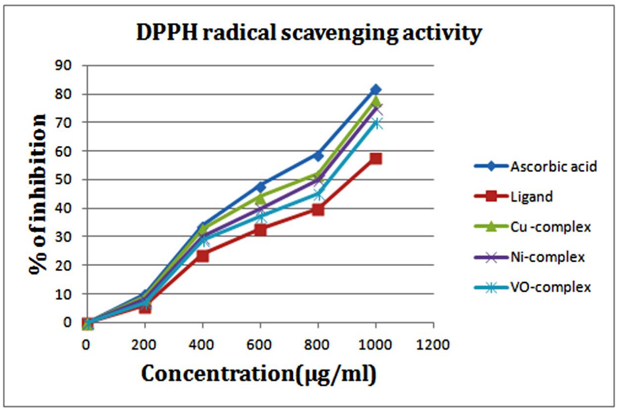


Figure 6 DPPH Scavenging Activity of ligand and Its Complexes

Molecular Modelling

The molecular modelling of $[Cu_2(C_{34}H_{30}N_4O_2S_2]$ complex as a representative, is based on its square planar structure with tetradentate ligand. This Molecular modeling structure also shows the stereochemistry of the complex. The details of the bond lengths (Å) and bond angles (˚) as per the 3D structure (Figure 3) are given in Tables 3 and 4 respectively (Maurya *et al.*, 2008). From the observed bond lengths and bond angles thus the proposed structure is square planar geometry and is suitable.

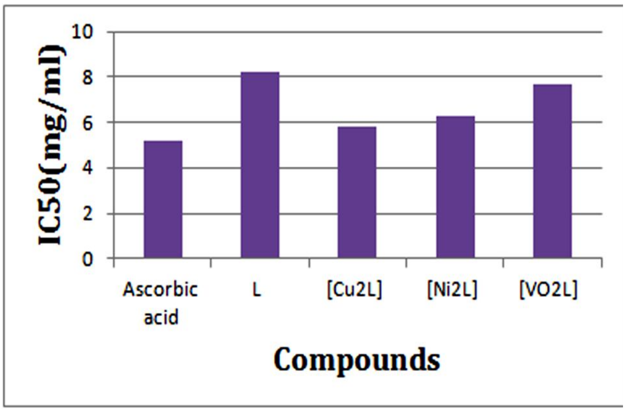


Figure 7 DPPH Scavenging Capacities (IC_{50}) of ligand and Its Complexes

Antibacterial assay

The Schiff base complexes have provoked wide interest because they possess a diverse spectrum of biological and pharmaceutical activities. The synthesized ligand and its complexes were tested for their *in vitro* antibacterial activity. *Streptomycine* was used as standard here. They were tested against the bacteria (Gram-positive bacteria like *Staphylococcus aureus*, *Bacillus subtilis* and two Gram-negative bacteria like *Escherichia coli* and *Klebsilla pneumonia*) by disc diffusion method. The antibacterial activity of the newly synthesized compounds as shown in the Figure 4. The results indicate that the ligand exhibits moderate antibacterial activity with respect to the complexes against the same microorganisms under identical experimental conditions. Further, the antibacterial action of Schiff base ligand may be significantly enhanced on the presence of azomethine groups which have chelating properties. These properties may be used in metal transport across the bacterial membranes or to attach to the bacterial cells at a specific site from which it can interfere with their growth. The copper complex shows better antibacterial activity against the tested microorganisms than the other complexes. It may be attributed to the atomic radius and the electronegativity of Cu(II) ions. Current studies reveal that the high atomic radius and electronegative metal ions in their metal complexes exhibit high antimicrobial activity. Higher electronegativity and large atomic radius decreases the effective positive charges on the metal complex molecules which facilitates their interaction with the highly sensitive cellular membranes towards the charged particle (krishna murthy potla *et al.*, 2013).

Antifungal activity

The Schiff base and its metal complexes were screened for their antifungal activity against *Fusarium oxysporum* and *Aspergillus fumigates*. *Clotrimazole* was used as standard here. The results indicate that the metal complexes exhibit higher antifungal activity than the ligand as shown in the Figure 5. Such increased activity on metal chelation can be explained on the basis of Tweedy's chelation theory. Chelation reduces the polarity of the metal ion considerably because of the partial sharing of its positive charge with the donor groups and also due to π -electron delocalization on the whole chelating ring. The lipids and polysaccharides are some important constituents of the cell wall and membranes which are preferred for metal ion interaction. Apart from this, the cell wall also contains many phosphates, carbonyl and cystenyl ligands which maintain the integrity of the membrane by acting as a diffusion barrier and also provide suitable sites for binding. Furthermore, increased lipophilicity enhances the penetration of the complexes into lipid membrane and blocking of the metal binding sites in the enzymes of microorganisms. These complexes also disturb the respiration process of the cell and thus block the synthesis of the proteins which restricts further growth of the organism (Raman *et al.*, 2011).

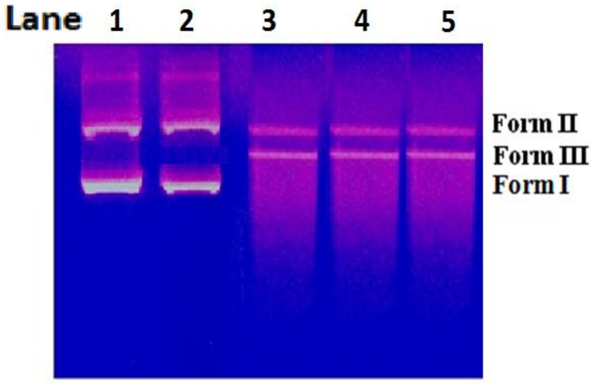


Figure 8 Changes in the Agarose Gel Electrophoretic Pattern of pUC18DNA Induced By H_2O_2 and Metal Complexes: Lane 1, DNA alone; Lane 2, DNA alone + H_2O_2; Lane 3, DNA + $[Cu_2(C_{34}H_{30}N_4O_2S_2]$ complex + H_2O_2; Lane 4, DNA + $[Ni_2(C_{34}H_{30}N_4O_2S_2)]$ complexH_2O_2; Lane 5, DNA + $[VO_2(C_{34}H_{30}N_4O_2S_2]$ complex + H_2O_2.

Antioxidant activity

DPPH Free radical scavenging activity

The variation of DPPH radical scavenging activity with concentration of test compounds is represented in Figure 6 and 7. In this study, the ligand and its Cu (II), Ni(II) and VO(II) complexes were screened for their DPPH radical scavenging activity. The copper (II) complex shows very good activity when compared to Ni (II) and VO (II) complexes and its ligand, respectively. The IC_{50} values were determined for all compounds and reported in Figure 6 and 7. From the results, it was found that the IC_{50} value of $[Cu_2\ (C_{34}H_{30}N_4O_2S_2]$ is 5.89 mg/ml show significant activity compared to remaining complexes and ligand. Ascorbic acid is used as standard. The order of the scavenging activity of all the complexes according to their IC_{50} values is given below.

Ascorbic acid > $[Cu_2\ (C_{34}H_{30}N_4O_2S_2]$>
$[Ni_2\ (C_{34}H_{30}N_4O_2S_2)]$> $[VO_2\ (C_{34}H_{30}N_4O_2S_2]$> $C_{34}H_{34}N_4O_2S_2$

Chemical nuclease activity

The study on the cleavage capacity of transition metal complex to DNA is considerably interesting as it can contribute to understanding the toxicity mechanism of them and to develop novel artificial nuclease. DNA cleavage is controlled by relaxation of super coiled circular form of pUC18 DNA into nicked circular form and linear form. When circular plasmid DNA is conducted by electrophoresis the fastest migration will be observed for the supercoiled form (Form I). If one strand is cleaved, the supercoils will relax to produce a slowed moving open circular form (Form

II). If both strands are cleaved a linear form (Form III) will be generated that migrates in between (Ekamparam Akila *et al.*, 2013). Figure 8 shows the result of gel electrophoretic separations of plasmid pUC18 DNA induced by an addition of metal (II) complexes in the presence of H_2O_2. All super coiled (Form I) DNA was cleaved to form the mixture of Form II and Form III with the addition of the complex. These phenomena imply that Cu(II), Ni(II) and VO(II) complexes induce intensively the cleavage of plasmid pUC18 DNA in the presence of H_2O_2. These observations suggested that all the complexes effectively cleave DNA.

CONCLUSION

In this paper, the coordination chemistry of a Schiff base ligand obtained from the reaction of 3, 3′-dihydroxybenzidine, diacetyl and 2-aminothiophenol is described. Cu(II), Ni(II) and VO(II) complexes have been characterized by spectral and analytical data. The IR, electronic transition data lead to the conclusion that the Cu(II) and Ni(II) ion assumes a square planar geometry and the VO(II) are square pyramidal in nature. In all the complexes, the ligand acts as tetradentate. The complexes are capable of cleaving pUC18 DNA in the presence of H_2O_2. The antimicrobial and antioxidant screening data reveal that the complexes have higher activity than the free ligand.

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