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RESEARCH ARTICLE

ANALYTICAL CHEMISTRY

PHYSICO-CHEMICAL INVESTIGATION AND BIOLOGICAL STUDIES OF METAL COMPLEXES WITH 2-[N-(3,4-DIMETHOXY-2-HYDROXYPHENYL)–METHYLIDINYL]-AMINO-4, 5-DIHYDRONAPHTHO[1,2D]-THIAZOLE

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ABSTRACT

Condensation of substituted salicylaldehydes with primary amine of naphtha-thiazole gave a of Schiff base, such as 2-[N-(3,4-dimethoxy-2-hydroxyphenyl)–methylidinyl]-amino-4, 5-dihydronaphtho[1,2d]-thiazole (HL); Complexes were synthesized by reaction between cobalt chloride, nickel chloride and copper chloride with the ligand (HL). These complexes were characterized by elemental analyses, conductance measurements, magnetic susceptibility measurements, IR, ^{1}H NMR, and electronic spectral studies. On the basis of magnetic and spectral studies, octahedral geometry was assigned for these complexes. These complexes have been screened *in vitro* for their possible antimicrobial activity

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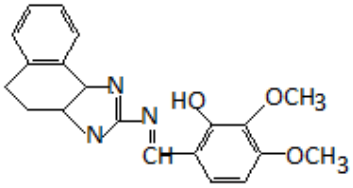
KEY WORDS

Metal complexes, Thiazoles, Ligand, Magnetic Susceptibility,

INTRODUCTION

A large number of substituted thiazoles are known for their various biological activities[1-2]. It is also believed that the presence of N-C-S linkage is responsible for the amoebicidal, anticonvulsant, fungicidal and antiviral activities[3-4].Their is growing interest in the studies on the metal complexes of Schiff bases derived from thiazoles which are biologically important ligands[5]. 1-Tetralone was condensed with thiourea and iodine by Dodson-King method[6-8] and the resulting 2-amino-4,5-dihydronaphtho-[1,2d]-thiazole was then treated with substituted salicylaldehyde to get the corresponding Schiff base, 2-[N-(3,4-dimethoxy-2-hydroxyphenyl)–methylidinyl]-amino-4,5-dihydronaphtho[1,2d]-thiazole **(HL)**. Literature survey has revealed that no attempt has been made to study the bivalent cobalt, nickel, and copper complexes with the above mentioned Schiff bases. The present paper reports the synthesis, characterization and antimicrobial activity of some thiazole complexes of Co(II), Ni(II) and Cu(II) metal ions.



MATERIALS AND METHODS

All the chemicals and solvents used were of AR grade. Salicylaldehyde was obtained from Sisco-chem Industries. The metal salts were purchased from commercial sources. Metal contents were estimated using standard methods [9].

IR spectra of the compounds were recorded on a Beckman IR-20 spectrophotometer in the region 4000-250cm^{-1} ^{1}H NMR spectra were recorded on a Perkin-Elmer 90 MHz spectrometer. The electronic spectra were recorded on an Elico SL 159 spectrophotometer in the 200-1000nm ranges in DMF solution (10^{-3}). Elemental analyses were obtained HERAEUS C, H, N-O rapid analyzer. E.s.r measurements were carried out on a VARAN E-109 GHz. The experiment was carried by taking DPPH as the reference with the field set at 3200 Gauss.Mangetic susceptibilities were determined by the faraday method using a Model 300 Lewis Coil Force Magnetometer of one tesla field strength at room temperature. The instrument being calibrated with Hg [Co (SCN)$_4$][10].

Preparation of ligands

2-[N-(2-hydroxy-4/5-substituted phenyl)-methylidinyl]-amino-4, 5-dihydro naphtha[1,2d]-thiazoles.(HL):

A mixture of 2-amino-4,5-dihydronaphtho-[1,2d]-thiazole (II) (1.94g. 0.01mol) and substituted salicylaldehyde (0.01mol) in absolute ethanol (25ml)was refluxed for 4 hours. The reaction mixture was cooled and the separated solid was crystallized from ethanol.

Preparation of complexes

A mixture of hot ethanol solution (50ml) of the metal salt (0.002ml) and the ethanol solution of **HL** (0.002mol) was refluxed for 8 hours and solid was separated. The complexes were filtered, washed with hot ethanol and dried in *vacuo.*

RESULTS AND DISCUSSION

The analytical and physical data of the compounds are given in Table-1. The results of elemental analyses of the complexes (Table-1) correspond to stoichiometry for metal:ligand in 1:2 molar ratios. Molar conductance measurements of these complexes in DMF correspond to nonlectrolytes. The magnetic moment of the $Co(L)_2$, $Ni(L)_2$ and $Cu(L)_2$ are 4.82, 3.15 and 1.80 B.M respectively. The μ_{eff} values are well within the range known for six coordinate octahedral geometry[11-12] (Table-1). The electronic spectra of the complexes recorded in DMF display three bands at 11760-15620cm^{-1}(ν_1), 15600-19230cm^{-1}(ν_2) and 20830-22720cm^{-1}(ν_3) (Table 2). Six coordinate complexes with Oh symmetry show three spin allowed bands. These bands are due to $^4T_{1g}(F)\rightarrow{}^4T_{2g}(F)(\nu_1)$, $^4T_{1g}(F)\rightarrow{}^4A_{2g}(F)(\nu_2)$ and $^4T_{1g}(F)\rightarrow{}^4T_{1g}(P)(\nu_3)$ for cobalt complexes, $^3A_{2g}\rightarrow{}^3T_{2g}(\nu_1)$, $^3A_{2g}\rightarrow{}^3T_{1g}(F)(\nu_2)$ and 3A2g$\rightarrow{}^3T_{1g}(P)(\nu_3)$ for nickel complexes and $^2B_{1g}\rightarrow{}^2A_{1g}(\nu_1)$, $^2B_{1g}\rightarrow{}^2B_{1g}(\nu_2)$ and $^2B_{1g}\rightarrow{}^2E_g(\nu_3)$ for copper complex[13-15]. Various ligand field parameters have been evaluated for cobalt and nickel complexes (Table2). The nephelauxetic parameter, β is readily obtained using the relation β=B(complex)/B(free ion), indicate that complex under study have appreciable covalent character. The value of D_q could be evaluated with the help of the curve transition energies versus D_q by Orgel using the energy level due to transitions $^4T_{1g}(F)\rightarrow{}^4A_{2g}(F)$ and $^3A_{2g}\rightarrow{}^3T_{1g}(P)$ respectively. The parameter B was evaluated by using the methods reported earlier [16-18]. IR spectra of ligand show a broad medium intensity band in the region 3450-3300cm^{-1} due to phenolic-OH [16], in complexes these bands were not observed due to the complexation through O via deprotonation of phenolic-OH. The band in the region 1640-1590cm^{-1}is assigned to HC=N group, indicates that the condensation between amino group of thiazole and substituted salicylaldehyde. In ligand, a medium intensity band is observed in the range of 1090-950cm^{-1}are assigned to the $\nu_{(C-S)}$ vibrations [19]. The band due to$\nu_{(C=N)}$ appears in the region of 1630-1590cm^{-1} as a high intensity band in the complexes, indicating that the C=N group is involved in coordination of metal ions through nitrogen. In complexes the bands due to C=N group are shifted to lower frequency by 30-20cm^{-1}. The ESR spectra of the copper complexes as polycrystalline sample have been recorded at room temperature, (ESR chart was calibrated with DPPH). The polycrystalline sample gives one broad isotropic signal centered approximately at 2.022 and 2.030 for the complex Cu $(L)_2$. The observed g values of the Cu $(L)_2$ complex as follows $g_{||}$ =2.058, $g_{\perp}$ =2.014, g_{av} =2.028 and G = 4.19. While for Cu (L^2), $g_{||}$ = 2.052 $g_{\perp}$ = 2.024 g_{av} = 2.030 and G = 4.22. The isotropic g values have been calculated Kneubuhl`s methods and methods reported earlier. G = $(g_{||}-2)/(g_{\perp}-2)$ which measures the exchange interaction between copper centers in a polycrystalline solid has been calculated. According the Hathaway[20-21] if the G value is greater than 4, the exchange interaction is negligible, while a value of G less than 4 indicates a considerable exchange in the solid complex

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Table-1

Physical data, elemental analyses, magnetic measurements and molar conductance of metal complexes with ligand HL

Ligands/ Complexes[a]	Colour M.P(°C)/ Yield(%)	Metal (%) Found/ (Calcd),M	μ_{eff} (B.M)	Molar Cond. mho cm^2 mol^{-1}

HL ($C_{20}H_{19}N_2SO_3$)	Yellow 137(75)	———	———	———
$Co(L)_2$ $Co(C_{20}H_{18}N_2SO_3)_2$	Brown 210(68)	7.50 (7.45)	4.77	30.85
$Ni(L)_2$ $Ni(C_{20}H_{18}N_2SO_3)_2$	Brown 220(62)	7.46 (7.42)	3.22	45.30
$Cu(L)_2$ $Cu(C_{20}H_{18}N_2SO_3)_2$	Yellow 228(65)	8.05 (7.98)	1.79	35.20

All the ligands and their complexes showed satisfactory C, H and N analysis.

Table-2
Electronic spectra and ligand field parameters of complexes

Complexes	ν_1 (Cm^{-1})	ν_2 (Cm^{-1})	ν_3 (Cm^{-1})	Dq (Cm^{-1})	B` (Cm^{-1})	β	LFSE
$Co(L)_2$	1242	17650	21515	5223	1562.05	1.60	18.00
$Ni(L)_2$	11762	15875	22225	4112	1715.00	1.64	12.99
$Cu(L)_2$	12030	15622	22740	--	--	--	--

Antimicrobial Activity

The antimicrobial activity of the ligand HL and their metal complexes were determined by agar cup-plate method[22-24]. The antibacterial activity against *Escherichia coli* and *Pseudomonas aeroginosa* and antifungal activity against *Aspergillus niger* and *Candida albicans*, were screened by the ligands and their metal complexes. The medium was prepared as per the instructions of the manufacturer of dry Mueller Hinton agar powder (Hi-Media). The test ligands and their metal complexes were dissolved in dimethylsulphoxide (DMSO) at a concentration of 100µg/ml. Ciproflaxacin (100µg/ml) in DMSO was used as reference standard for antibacterial and flucanozole (100µg/ml) in DMSO was used as reference standard for antifungal activity. The solvent control (only DMSO) was also maintained throughout the experiment. The zones of inhibition are reported in Table-2.

From the Table-2, it is clear that all the ligands HL show moderate activity against all the antibacterial and antifungal microorganisms. But all the metal complexes show moderate to high active against all the organisms. Among the complexes, copper complex $Cu(L)_2$ is found to be most active against all the microbes tested, as compared to their ligand which due to the faster diffusion of the Cu(II) complexes[25-26]. Even though the test compounds are less active with reference to the standarad drug *ciproflaxacin* and *flucanozole*, the data reported in this article may be a helpful guide for the medicinal chemists who are working in this area.

Table-3
Antibacterial and antifungal activity data of the ligands and their complexes (Zone of inhibition in mm*)

Ligands/ Complexes	Antibacterial		Antifungal	
	E.coli	*P.aeroginosa*	*A.niger*	*C.albicans*
HL	12	14	11	09
$Co(L)_2$	14	17	13	12
$Ni(L)_2$	15	18	14	12

$Cu(L)_2$	20	19	18	16
Ciproflaxacin	27	30	__	__
Flucanozole	__	__	24	23
DMSO	00	00	00	00

[*] ***Diameter of cup is 6 mm:, E.coli: Escherichia coli, P.aeroginosa: Pseudomonas aeroginosa, A.niger: Aspergillus nige, C.albicans: Candida albicans.***

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