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Research Article

Synthesis, Characterization and Antibacterial Activity of Novel Schiff Base Derived From 2-((3-methyl-1-phenyl-1H-pyrazol-4-yl)- methylene)hydrazinecarboxamide And it's Transition Metal Complexes

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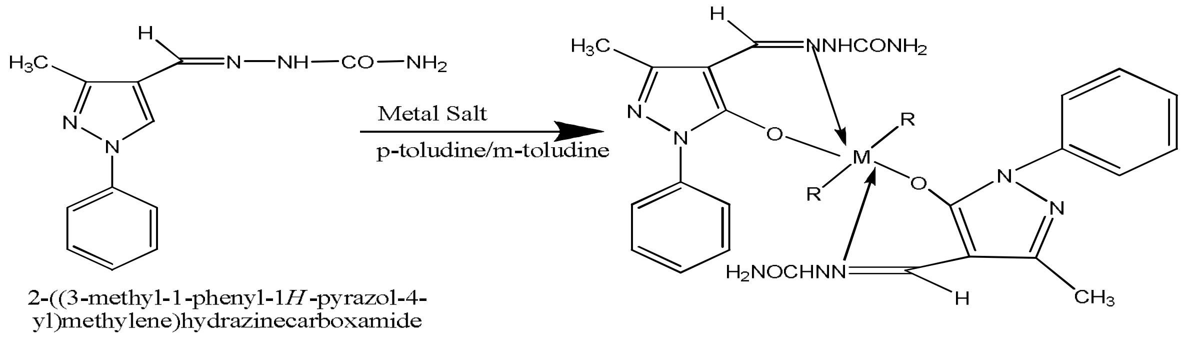
ABSTRACT

2-((3-methyl-1-phenyl-1H-pyrazol-4-yl)methylene)hydrazinecarboxamide (FMP-SC) was prepared and its metal chelates of Cu^{2+},Ni^{2+},Co^{2+} with its adducts of m-toludine, p-toludine were prepared. The ligands and its chelates were characterized by elemental analysis, Metal: ligand (M:L) stoichiometry, IR-electronic spectral studies and magnetic properties. The compounds also were screened for their antimicrobial activity.

Keywords 2-((3-methyl-1-phenyl-1H-pyrazol-4-yl) methylene) hydrazinecarboxamide (FMP-SC).

INTRODUCTION

Number of 1-phenyl-2-pyrazolin-5-one derivatives has been studied for their metal complexation study[2-4]. Recently the thiosemicarbazone derivatives of 2-((3-methyl-1-phenyl-1H-pyrazol-4-yl) methylene) hydrazinecarboxamide (FMP-SC) have been prepared from our laboratory[5] and studied their metal complexation properties. As the semicarbazones derivatives of 2-((3-methyl-1-phenyl-1H-pyrazol-4-yl) methylene) hydrazinecarboxamide[6-8]have been reported so far for their metal complexation . Hence, the present communications comprised the work in connection with the metal complexation study of (FMP-SC) with adduct of m-toludine and p-toludine is shown in Scheme-1.



R=p-toludine/m-toludine

Where M = Cu^{2+}, Ni^{2+}, Co^{2+}

Scheme. 1

EXPERIMENTAL

MATERIALS

All the chemicals used in the present work were of pure grade. For the preparation of the metal chelates of the Cu^{2+}, Ni^{2+}, C_O^{2+} metal nitrates were used.

Synthesis of 2-((3-methyl-1-phenyl-1H-pyrazol-4-yl) methylene) hydrazinecarboxamide

The ligand FMP-SC was prepared in two steps described below

(1) Preparation of 4-Formyl-2-pyrazolin-5-one

The 1-phenyl-3-methyl-2-pyrazolin-5-one (0.1mole, 17.4gm) was placed in a flask equipped with a stirrer, separating funnel, and reflux condenser. It was then dissolved in dioxane (85ml) by application of heat. To the reaction mixture, calcium hydroxide (0.2mole, 14.81gm) was added, followed by the dropwise addition of the Formyl chloride (0.1mole) at this stage ,the mixture become a thick paste and it's temperature also increased, as this being a exothermic reaction. The reaction mixture was then refluxed for half an hour. The resulting calcium complex was then decomposed by pouring it into the dilute hydrochloric acid (200ml,2M).The resultant colored crystals were then collected on a Buchner-funnel and recrystallized from an acidified Methanol-Water mixture 20:40 (v/v)[2,3,28].

Preparation of 2-((3-methyl-1-phenyl-1H-pyrazol-4-yl) methylene) hydrazinecarboxamide (FMP-SC)

Following procedure has been adopted in the preparation of semicarbazone of FMP used in the present study. The semicarbazone was prepared by refluxing 1:1 mole 4-Formyl-2-pyrazolin-5-one and semicarbazide hydrochloride in methanol for 1hr. The semicarbazone of FMP, thus obtained was filtered, recrystallised from methanol and designated as FMP-SC. Yield was 72%. It m.p.was 228^{0}c (uncorrected).

Elemental Analysis

$C_{12}H_{13}N_5O$ (243.26)

	C%	**H%**	**N%**
Calculated:	59.25	5.39	28.79
Found :	59.12	5.20	28.24

IR Features

3380 cm^{-1}	N-H (m, br)	3300 cm^{-1}	N-H (m, s)
3052 cm^{-1}	C-H(m ,br)	2957 cm^{-1}	C-H(w,sh)
1640cm^{-1}	C=N (w,br)	1630 cm^{-1}	C=N (m,br)
1700 cm^{-1}	C=O(s,sh)	965 cm^{-1}	N-N (m,sh)
1219 cm^{-1}	O-H (m,sh)		

NMR

(DMSO) 7.2-7.6 ppm multiplet aromatic -H
7.40-7.51ppm (1H) Singlet -H
2.0-2.9 ppm (3H) Singlet $-CH_3$
6.0-6.10 ppm (2H) singlet $–NH_2$
7.01-7.20ppm (1H) singlet -NH

Synthesis of adducts of C_O (II), Ni (II), and Cu (II) chelates

The metal salt was dissolved in distilled water .The DMF ligand solution containing base (m-toludine /p-toluidine) in slight excess over the metal: ligand ratio 1:2 was added to it dropwise and with constant stirring. The mixture was refluxed for 30 minutes on a hot oil-bath. The reddish brown product was filtered and washed well with ethanol and distilled water and was dried in oven at a temperature 45°C.

Measurements

The elemental analysis for C, H, and N were carried out on elemental analyzer. IR spectra of FMP-SC and its metal complexes were scanned on a Perkin-Emer 983(USA) spectrophotometer KBr. Estimation of metal in each compound was carried out by gravimetric oxide method and EDTA titration as described by Flaschka [1].The vibrating sample magnetometer (VSM), model 7304(4-inch electromagnet VSM system), lakeshore crytronics, Inc., USA, was used to characterize magnetic properties of metal chelates[24]. The diffused reflectance spectra of solid metal complexes were recorded on a Beckman-DK-2A spectrophotometer with a solid reflectance compound. The thermograms of the chelates were recorded on SDT-2960 simultaneous DSC-TGA. The electrical conductivity of all the complexes were measure in DMF using "conductivity Bridge 305" (systronics).

Antifungal activity

The fungicidal activity of all the compounds was studied at 1000 ppm concentration in vitro plant pathogenic organisms listed in Table-4. The antifungal activities of the entire sample were measured by cup plate method. Each of the plant pathogenic strains on potato dextrose agar (PDA) medium[26]. Such a PDA medium contained potato 200 gms, dextrose 20gms, agar 20gms and water 1 litre. 5 days old cultures were employed. The compounds to be tested were suspended (1000ppm) in a PDA medium and autoclaved at 120° C for 15 min. at 15 atm pressure. These medium were poured into sterile Petri plate and the organisms were inoculated after cooling the Petri plate. The percentage inhabitation for fungi was calculated after 5 days using the formula given below.

$$\textbf{Percentage of inhibition} = \frac{100\ (X\text{-}Y)}{X}$$

Where, X: Area of colony in control plate
Y: Area of colony in test plate

The fungicidal activity all compounds are shown in Table-3.

RESULT AND DISCUSSION

The parent ligand FMP-SC was amorphous powdered, soluble in various solvents like dioxane, DMSO, and DMF. The results of elemental analysis of the ligands are reported in a Table-1. They are consistent with the predicted structure as Scheme-1. The ligand was synthesized as shown in Scheme-1. Examination of IR spectrum of FMP-SC reveals that a broad band of N-H is observed at 3380cm^{-1} as well as 1640 cm^{-1} C=N (azomethine),1700 cm^{-1}(C=O). The NMR data also confirm the structure of FMP-SC. The metal complexes of FMP-SC with it' adducts and the metal ions Cu^{2+}, Ni^{2+}, Co^{2+} vary in colours. On the basis of the proposed structure as shown in Scheme-1, the molecular formula of the FMP-SC ligand is $C_{12}H_{13}N_5O$ (243.30) which upon complex ion coordinates with one central metal atom at four coordinates sites and with two adduct molecules. Therefore the general molecular formula of the resulting metal complex is $[C_{12}H_{13}N_5O]_2.M.(Adduct)_2$ for divalent metal ions[25]. This has been confirmed by results of elemental analysis of all the metal chelats and their parent ligand. The data of elemental analysis reported in Table-1 are in arrangement with the calculated values of C, H and N based on the above mentioned molecular formula of parent ligand as well as metal complex. The electrical conductivity of these complexes in acetonitrile indicates that the complexes are essentially non-electrolytes.

IR spectra of metal complexes reveal that all the spectra are identical in all respects. The comparison of IR spectrum of the parent ligand FMP-SC (Table-3) with that of its each metal complex has revealed certain characteristics differences.

One of the significant differences to be expected between the IR spectrum of the parent ligand and its metal complex is the presence of more broadened bands in the region of 3450-3100cm^{-1} for the metal complex as the oxygen of the O-H, nitrogen of N-H of ligands forms a coordination band with the metal ions. It is gratifying to note that the ligand band at 965cm^{-1} assigned to ν (N-N), shifts to 990-1000cm^{-1} on complexation leading further support to the involvement of nitrogen of azomethine moiety in the complex formation. The ligand band at 1700cm^{-1} show an absorption due to O-H in the region 1250-1210cm^{-1}.This peak is either missing or shows a significance lowering of intensity in the chelates[9,22,23].

Examination of data of the metal content in each compound revealed a 1:2 metal: ligand (M:L) stoichiometry in all of the complex of divalent metal ions.

The diffuse electronic spectrum of $[Cu(FMP\text{-}SC)_2(m\text{-}T)_2]$ metal complex shows broad band at 15384cm^{-1} on a strong charge transfer band [10] at 25000cm^{-1}.the $[Ni(FMP\text{-}SC)(\ m\text{-}T)_2]$ and $[Cu(FMP\text{-}SC)(\ m\text{-}T)_2]$ complex gave three absorption bands respectively at 11169, 17239,27395 and 15384 cm^{-1} corresponding to $^4T_{1g} \rightarrow {}^2T_{1g}$ and $^4T_{1g}(p)$ transitions. thus absorption bands at the diffuse, reflectance spectra and the value of magnetic moments indicate and octahedral configuration for the $[Ni(FMP\text{-}SC)(\ p\text{-}T)_2]$ and $[Cu(FMP\text{-}SC)(\ p\text{-}T)_2]$ complex[11,14,24,25]. The spectra show bands at 11420, 17392 and 26315cm^{-1}. These bands correspond to the $^6A_{1g} \rightarrow {}^4T_{1g}(G)$, $^6A_{1g} \rightarrow {}^4T_{2g}(G)$ and $^4A_{1g} \rightarrow {}^4E_g$, $^4A_{1g}$ (G)transition respectively, in an octahedral stereochemistry [15-21].

Conductivities of all the complexes were measured in acetonitrile solvent, all the complexes were found to be non-electrolytic in nature of 1:1 type, and molar conductivity values were in the range of 3.28-22.22 ohm^{-1} cm^{2}mole^{-1}in DMF.

The antifungal activity of all the compounds measured for various plant pathogens. Inspection of the result shown in Table-3 indicated that all compounds are good toxic for fungi. Out of all the compounds copper chelates is more toxic than other. These compounds almost inhibit the fungi about 70%. Hence, produced metal chelates can be employed as garden fungicides. Further work in these directions is in progress[27].

Table 1: Analysis of FMP-SC Ligand and its metal chelates with adducts

Empirical Formula	Yield (%)	Elemental Analysis								a_M	μeff B.M.
		C%		H%		N%		M%			
		Cald	Found	Cald	Found	Cald	Found	Cald	Found		
$C_{12}H_{13}N_5O$	72	59.25	59.12	5.39	5.20	28.79	28.54	----	-----	-	-
[Cu(FMP-SC)$_2$(m-T)$_2$]	75	57.45	57.00	5.33	5.21	21.16	21.01	7.98	7.98	10.29	2.01
[Ni(FMP-SC)$_2$(m-T)$_2$]	67	57.80	57.28	5.36	4.98	21.29	20.97	7.43	7.49	9.82	2.80
[Co(FMP-SC)$_2$(m-T)$_2$]	65	57.79	57.08	5.36	4.96	21.29	20.91	7.45	7.45	3.98	4.38
[Cu(FMP-SC)$_2$(p-T)$_2$]	71	57.79	57.47	5.36	5.02	21.29	20.88	7.45	7.42	3.74	1.96
[Ni(FMP-SC)$_2$(p-T)$_2$]	73	57.80	57.49	5.36	5.29	21.29	21.22	7.43	7.39	8.89	3.01
[Co(FMP-SC)$_2$(p-T)$_2$]	76	57.79	57.08	5.36	4.98	21.20	20.78	7.45	7.45	3.74	4.51

Table 2: Electronic Spectra Data of Co(II),Ni(II) and Cu(II) Chelates (cm^{-1})

Metal Chelates	Observed transition energies $^4A_{1g}(F)\rightarrow$					
	$^4T_{2g}(F)$*	$^4A_{2g}(F)$*	$^4T_{1g}(P)$	B_{35}	β35	$\surd_2/\surd_1$
[Cu(FMP-SC)$_2$(m-T)$_2$]	15384	-	-	-	-	-
[Ni(FMP-SC)$_2$(m-T)$_2$]	11169	17239	27395	720	0.691	1.54
[Co(FMP-SC)$_2$(m-T)$_2$]	9949	17005	21592	1162	1.196	1.70
[Cu(FMP-SC)$_2$(p-T)$_2$]	15151	-	-	-	-	-
[Ni(FMP-SC)$_2$(p-T)$_2$]	11420	17392	26315	685	0.658	1.52
[Co(FMP-SC)$_2$(p-T)$_2$]	8900	16666	20551	928	0.955	1.87s

Table 3: Infrared spectra of FMP-SC and adducts of its Co(II) ,Ni(II) and Cu(II) complexes (cm^{-1})

Ligands and it's complexes	$\surd_{N-H}$	$\surd_{C=H}$	$\surd_{C=N}$ (Azo methine)	$\surd_{C=N}$ (adduct)	$\surd_{N-N}$	$\surd_{M-N}$	δ_{O-H}
[Cu(FMP-SC)$_2$(m-T)$_2$]	3440(w,br)	2925(w,sh)	1622(w,sh)	1585(w,sh)	960(w,sh)	530(w,sh)	1210(w,sh)
[Ni(FMP-SC)$_2$(m-T)$_2$]	3380(w,br)	2932(w,sh)	1600(w,sh)	1582(w,sh)	980(m,sh)	540(w,sh)	1220(w,sh)
[Co(FMP-SC)$_2$(m-T)$_2$]	3420(w,br)	2925(w,sh)	1605(w,br)	1595(w,br)	975(m,sh)	465(w,sh)	1210(w,sh)
[Cu(FMP-SC)$_2$(p-T)$_2$]	3435(w,br)	2930(w,sh)	1610(w,sh)	1590(w,sh)	995(w,sh)	535(w,sh)	1208(w,sh)
[Ni(FMP-SC)$_2$(p-T)$_2$]	3455(w,br)	2918(w,sh)	1622(w,sh)	1590(w,sh)	950(w,sh)	540(m,sh)	1205(w,sh)
[Co(FMP-SC)$_2$(p-T)$_2$]	3460(w,br)	2930(w,sh)	1600(w,sh)	1595(w,sh)	1000(w,sh)	525(w,sh) 485(w,br)	1205(w,sh)

* $\surd_{O-H}$(H-bonded):2800-3350

Table 4: Antifungal activity of fmp-sc ligand and its metal chelates with its adducts

Compounds	Zone of inhibition of fungus at 1000 ppm (%)						
	BT	N	RN	AN	AF	AA	AK
[Cu(FMP-SC)$_2$(m-T)$_2$]	53	56	54	60	59	66	69
[Ni(FMP-SC)$_2$(m-T)$_2$]	85	68	71	80	76	76	80
[Co(FMP-SC)$_2$(m-T)$_2$]	81	69	69	70	69	79	79
[Cu(FMP-SC)$_2$(p-T)$_2$]	63	70	70	67	72	72	80
[Ni(FMP-SC)$_2$(p-T)$_2$]	76	72	67	72	75	73	81
[Co(FMP-SC)$_2$(p-T)$_2$]	77	63	59	71	79	81	78

BT= *Botrydeplaia thiobromine* N= *Nigrospora Sp*. RN= *Rhisopus Nigricans*
AN= *Asperginus niger* AF= *Aeprogines funigalus* AA= anida Albicans
AK= Andida krusegios candida grabrataHO5

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