

Synthesis, Characterization, Metal Complexation Studies and Biological screening of some Newly Synthesized Metal Complexes of 1-(4-carboxy-3-hydroxy-N-isopropyl phenyl amino methyl) benzotriazole with Some Transition Metals

P.K.Patel* and P.D.Patel

Department of Chemistry M.G. Science Institute, Navrangpura, Ahmedabad-380 009
(Gujarat) India

*Corres.author: pkpatelyug@yahoo.co.in

Abstract: Aminomethylation of benzotriazole was carried out by treating benzotriazole with formaldehyde and N-isopropyl 4-aminosalicylic acid. The resultant compound namely was designed as CIPB 1-(4-carboxy-3-hydroxy-N-isopropyl phenylamino methyl)benzotriazole. The transition metal complexes of Cu^{2+} , Co^{2+} , Ni^{2+} , Mn^{2+} , and Zn^{2+} of CIPB have been prepared and characterized by Elemental analyser, spectral studies, magnetic moment determination, molar conductivity measurement and antimicrobial activity.

Keywords: Benzotriazole, N-isopropyl-4-aminosalicylic acid, metal complexes, spectral studies, magnetic moment, antibacterial and antifungal activity.

Introduction

One of the heterocyclic compound say 1-(H)-benzotriazole is found as an important heterocyclic compound. Its prime application is as corrosion inhibitors for copper or copper alloys^{1,2}. Ciba Geigy has introduced benzotriazole derivative under the trade name Trinvin-p³. It is applied as an UV light absorber for stabilizing plastics and other organic materials against discoloration determination³. It is also employed as photographic emulsion stabilizer⁴. In the peptide synthesis it acts in form of an active ester⁵. The area in which the amino methylation of benzotriazole by using aromatic amine having metal gripping group (i.e ligand) has not been developed. Hence it was thought to undertake such work. With this view, the present authors communicated the initial work recently⁶. In connection of this work⁶ the present paper describes the synthesis and characterization of benzotriazole, N-isopropyl-4-aminosalicylic acid clubbed molecule and its metal complexes. The work is illustrated in Scheme-1.

Experimental

Materials

Benzotriazole was prepared by method reported in literature⁷. N-isopropyl-4-aminosalicylic acid was prepared by method reported^{8,9}. All other chemicals used were of analytical grade.

Synthesis of 1-(4-carboxy-3-hydroxy-N-isopropyl phenylamino methyl)benzotriazole.

A mixture of 1-H Benzotriazole (0.02 mole), formaldehyde (0.02 mole) and N-isopropyl-4-aminosalicylic acid (0.02 mole) in ethanol (70 ml) was heated under reflux for 4h. Subsequently ethanol was distilled off and the lump mass obtained. It was triturated with petroleum ether (40-60 °C). The solid designated as CIPB was isolated and dried in air. Yield was 68%. Its m.p was 188°C. (uncorrected).

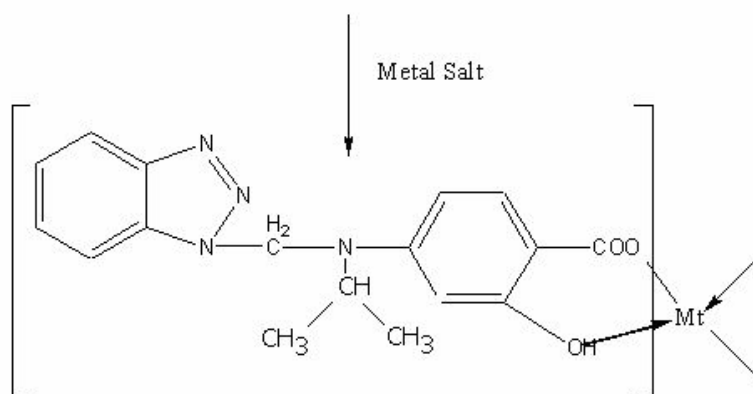
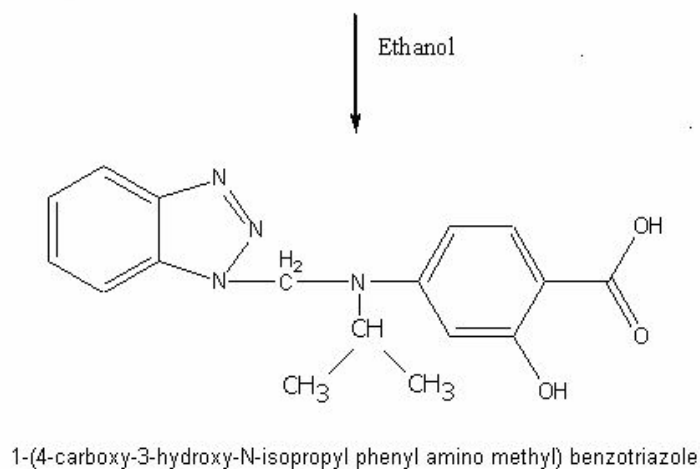
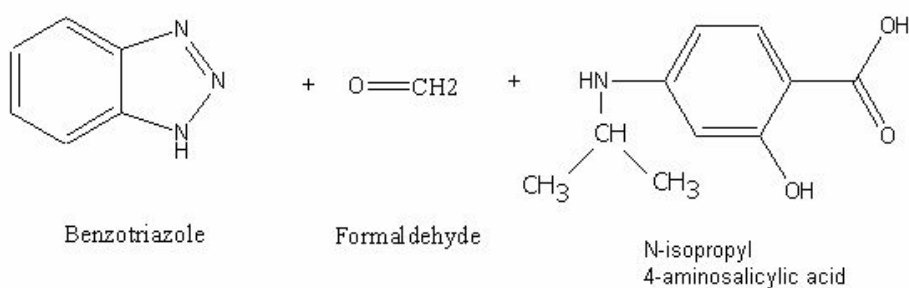
Elemental analysis :C₁₇H₁₈N₄O₃ (326 gm/mol)

	C%	H%	N%
Calculated:	62.57	5.52	17.17
Found:	62.45	5.40	17.09

IR Features:

1485-1522 cm ⁻¹	Benzotriazole ring
3030,1500,1600 cm ⁻¹	Aromatic
1680 cm ⁻¹	CO of COOH
3200-3600 cm ⁻¹	OH

2850,2920 cm ⁻¹	CH ₂
NMR : 7.1-7.7 ppm	Multiplet aromatic
(DMSO) 4.7 ppm (2H)	Singlet (CH ₂)
12.92 ppm (1H)	Singlet (COOH)
5.1 ppm (1H)	Singlet (OH)
1.2 ppm (6H)	Doublet(CH ₃)
2.97 ppm (1H)	Multiplet (CH)

Scheme -1

Synthesis of metal complexes of CIPB

Formation of CIPB metal complexes :

The Cu^{2+} , Co^{2+} , Ni^{2+} , Mn^{2+} , and Zn^{2+} metal ion complexes of CIPB have been prepared in a similar manner. The procedure is as follow.

To a solution of CIPB (0.1 mole) in ethanol-acetone (1:1) mixture (150 ml), 0.1 N KOH solution was added drop wise with stirring. The pasty precipitates were obtained at neutral PH. These were dissolved by addition of water up to clear solution. It was diluted to 250 ml of the stock solution (which contains 0.01 mole CIPB) was added drop wise to the solution of metal salt (0.005 mole for divalent metal ions and 0.0033 mole for Fe^{3+} ion) in water at room temperature. Sodium acetate or ammonia was added up to complete precipitation. The precipitation was digested on water bath at 80°C for 2 h. The digested precipitates of complex were filtered washed with water and air dried. It was amorphous powder. Yield was almost quantitative. The details are given in Table-1.

Measurements :

The elemental analysis for C, H, and N were carried out on elemental analyzer. IR spectra of CIPB and its metal complexes were scanned on a Nicolet 760 FTIR spectrophotometer in KBr. The metal content of the metal chelate were performed by decomposing a weighed amount of each metal complexes followed by EDTA titration as reported in literature¹⁰. Magnetic susceptibility measurement of all the metal complex was carried out at room temperature by the Gouy method. Mercury tetrathiocyanatocobaltate (II) $\text{Hg} [\text{Co} (\text{NCS})_4]$ was used as a calibrant. The diffused reflectance spectra of solid metal complex were recorded on a Backman DK Spectrophotometer with a solid reflectance attachment, MgO was employed as the reflectance compound.

Antifungal activity :

The fungicidal activity of all the compounds were studied at 1000 ppm concentration in vitro. Plant pathogenic organisms listed in Table-3 were used. The antifungal activity of all the samples were measured by cup plate method¹¹. Each of the plant pathogenic strains on a potato dextrose agar (PDA) medium contained potato 200gms, dextrose 20gms, agar 20gms, and water 1 litre, 5 days old culture were employed. The compounds to be tested were suspended (1000 ppm) in a PDA medium and autoclaved for 15 min. At 15 atm pressure. These medium were poured into sterile petri plate and the organisms were incubated after cooling the petri

plated. The percentage inhabitation for fungi was calculated after 5 days using the formula give below.

$$\text{Percentage of Inhibition: } \frac{100 (X-Y)}{X}$$

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.

Results and Discussion

The parent ligand CIPB was an amorphous yellow powdered, soluble in various solvents like dioxane, DMSO and DMF. The results of elemental analysis of the ligand are reported in Table-1. They are consistent with the predicted structure as shown in Scheme-1. The ligand was synthesized as shown in the scheme-1.

Examination of IR spectrum (not shown) of CIPB reveals that a broad band of phenolic hydroxyl stretching is observed at $3200\text{--}3600\text{ cm}^{-1}$ as well as additional absorption bands at 3030 cm^{-1} , 1500 cm^{-1} and 1600 cm^{-1} are characteristics of the salicylic acid¹²⁻¹³. The strong bands at 1680 cm^{-1} for $\text{C}=\text{O}$. The NMR data (shown in experimental part) also confirm the structure of CIPB. The metal complex of CIPB with the metal ions Cu^{2+} , Co^{2+} , Ni^{2+} , Mn^{2+} , and Zn^{2+} vary in colours. On the basis of the proposed structure as shown in schme-1, the molecular formula of the CIPB ligand is $\text{C}_{17}\text{H}_{18}\text{N}_4\text{O}_3$ which upon complexion coordinates with one central metal atom at four coordination sites and with two water molecules. Therefore the general molecule formula of the resulting metal complex is $[\text{C}_{34}\text{H}_{34}\text{N}_8\text{O}_6] \text{M} 2(\text{H}_2\text{O})$ for divalent metal ions. This has been confirmed by results of elemental analysis of all the five metal chelate 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.

Inspection of IR Spectra (not shown) of metal complexes reveals that all the spectra are identical in all respects. The comparison of IR spectrum of the parent ligand CIPB with that of its each metal complex has revealed certain characteristics differences.

One of the significant difference 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 $3200\text{--}3600\text{ cm}^{-1}$ for the metal complex as the oxygen of the O-H group of the ligands forms a coordination bond with the metal ions¹²⁻¹⁴. This is explained by the fact that water molecules might have strongly absorbed to the metal chelate sample during their formation.

Table-1 Analytical data of the metal chelates of CIPB

Compound	Emperical Formula	Mol. Cal Gm/mole	Yield (%)	Elemental Analysis							
				C%		H%		N%		Metal%	
				Calcd	Found	Calcd	Found	Calcd	Found	Calcd	Found
CIPB	$C_{17}H_{18}N_4O_3$	326	68	62.57	62.45	5.52	5.40	17.17	17.09	-----	-----
[CuCIPB (H ₂ O) ₂]	$C_{34}H_{34}N_8O_6Cu^{2+} \cdot 2(H_2O)$	749.54	64	54.43	54.33	5.07	5.03	14.94	14.90	8.48	8.42
[CoCIPB (H ₂ O) ₂]	$C_{34}H_{34}N_8O_6Co^{2+} \cdot 2(H_2O)$	744.94	68	54.77	54.75	5.10	4.95	15.03	14.99	7.91	7.86
[NiCIPB (H ₂ O) ₂]	$C_{34}H_{34}N_8O_6Ni^{2+} \cdot 2(H_2O)$	744.69	66	54.79	54.73	5.10	4.94	15.04	14.99	7.88	7.86
[MnCIPB (H ₂ O) ₂]	$C_{34}H_{34}N_8O_6Mn^{2+} \cdot 2(H_2O)$	740.93	63	55.06	54.74	5.13	5.06	15.12	15.08	7.41	7.40
[ZnCIPB (H ₂ O) ₂]	$C_{34}H_{34}N_8O_6Zn^{2+} \cdot 2(H_2O)$	751.39	65	54.30	54.26	5.06	5.03	14.90	14.80	8.70	8.61

Another noticeable difference is that the bands due to the COO⁻ anion at 1600 cm⁻¹ in the IR spectrum of the each metal complex. The band at 1400 cm⁻¹ in the IR spectrum of CIPB assigned to inplane OH determination¹²⁻¹⁴ is shifted towards higher frequency in the spectra of the metal complex due to the formation of metal oxygen bonds. This has been

further confirmed by a weak bands at 1105 cm⁻¹ corresponding to C-O-M stretching¹²⁻¹⁴. Thus all of these characteristics features of the IR studies suggested the structure of the metal complex as shown in scheme-1.

Table-2 Magnetic Moment & Reflectance data of the Metal Complexes

Complex	Magnetic Moment $\mu_{eff}(B.M)$	Absorption band (cm ⁻¹)	Transitions
Cu-CIPB	1.94	24616 14966	C.T $^2B_{1g} \rightarrow ^2A_{1g}$
Ni- CIPB	2.92	22314 15725	$^3A_{2g} \rightarrow ^3T_{1g}(P)$ $^3A_{1g} \rightarrow ^3T_{1g}(F)$
Co- CIPB	3.94	24936 19890 8417	$^4T_{1g}(F) \rightarrow ^4T_{2g}(F)$ $^4T_{1g}(F) \rightarrow ^4A_{2g}$ $^4T_{1g}(F) \rightarrow ^4T_{2g}(P)$
Mn- CIPB	5.68	23755 18408 16718	$^6A_{1g} \rightarrow ^4T_{1g}(4Eg)$ $^6A_{1g} \rightarrow ^4T_{2g}(4G)$ $^6A_{1g} \rightarrow ^4T_{1g}(4G)$
Zn- CIPB	Diamagnetic	-----	-----

Tbale-3 Antifungal Activity of Ligand CIPB and its metal complexes

Sample	Zone of inhibition of fungus at 1000ppm (%)				
	PE	BT	N	T	RN
(CIPB)-Mn ²⁺	54	45	47	46	49
(CIPB)-Co ²⁺	62	60	62	81	62
(CIPB)-Ni ²⁺	60	49	49	73	55
(CIPB)-Cu ²⁺	74	75	70	80	77
(CIPB)-Zn ²⁺	70	73	66	75	70
CIPB	54	52	60	49	50

PE= *Penicillium expansum*, BT= *Botrydepladia thiobromine*,
 N=*Nigrospra sp.*, T= *Trichothesium sp.* RN= *Rhizopus nigricans*

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. Magnetic moment (μ_{eff}) of each of the metal complex is given in Table-2. Examination of these data reveals that all complexes other than that of Zn²⁺ are paramagnetic while those of Zn²⁺ are diamagnetic.

The diffuse electronic spectrum of the [CuCIPB (H₂O)₂] metal complex shows broad bands at 14966 and 24616 cm⁻¹ due to the ²B_{1g}→²A_{1g} transition and charge transfer, respectively suggesting a distorted octahedral structure¹⁵⁻¹⁷ for the [CuCIPB (H₂O)₂] complex. Which is further confirmed by the higher value of μ_{eff} of the [CuCIPB (H₂O)₂] complex. The [NiCIPB (H₂O)₂] complex gave two absorption bands at 22314, 15725 corresponding to ³A_{2g}→³T_{1g}(P) and ³A_{1g}→³T_{1g}(F) transitions. [CoCIPB (H₂O)₂] complex gave three absorption bands at 24936, 19890 and 8417 cm⁻¹ Thus absorption bands at 24936, 19890 and 8417 cm⁻¹ corresponding to ⁴T_{1g}(F)→⁴T_{2g}(F), ⁴T_{1g}(F)→⁴A_{2g}, ⁴T_{1g}(F)→⁴T_{2g}(P) The diffuse, reflectance spectra and the value of the magnetic moments (μ_{eff}) indicate and octahedral configuration for the [NiCIPB (H₂O)₂] and [CoCIPB (H₂O)₂] complex. The spectra of [MnCIPB (H₂O)₂] shows

weak bands at 23755, 18408 and 16718 cm⁻¹ assigned to the transitions ⁶A_{1g}→⁴T_{1g}(⁴Eg), ⁶A_{1g}→⁴T_{2g}(⁴G) and ⁶A_{1g}→⁴T_{1g}(⁴G) respectively suggestion an octahedral structure for the [MnCIPB (H₂O)₂] chelate. As the spectrum of the [ZnCIPB (H₂O)₂] is not well resolved, it is not interpreted but it's μ_{eff} value shows that it is diamagnetic as expected.

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

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