

SYNTHESIS, CHARACTERIZATION AND CHELATING PROPERTIES OF PERIMIDINE-QUINOLINE BISHETEROCYCLIC LIGAND

Patel Sheetal Ashwinbhai¹, F. B. Bux¹ and Arun Singh^{2*}

¹P.G.Department of Chemistry Govt. Geetanjali Girls College Bhopal, India

²Joint Director, Rajya Siksha Kendra, Pustak Bhawan, B-wing, Arera Hills, Bhopal, India

*E-mail: dr.arunsingh@rediffmail.com

ABSTRACT

The treatment of 2-Chloro-1-(2, 3-dihydro-perimidin-1-yl)-ethanone with 5-amino-8-hydroxy quinoline afford a 2-(8-Hydroxy-quinolin-5-ylamino)-1-(5-methyl-4-methylene-1,4-dihydro-2H-quinazolin-3-yl)-ethanone(PEHQ). The transition metal complexes of PEHQ with Cu²⁺, Co²⁺, Ni²⁺, Mn²⁺ and Zn²⁺ metal ions have been prepared and characterized by elemental analyses, spectral studies, magnetic moment determination, molar conductivity and microbicidal activity.

Keywords: 2-Chloro-1-(2,3-dihydro-perimidin-1-yl)-ethanone, 5-amino-8-hydroxy quinoline, metal chelates, spectral studies, magnetic moment, antibacterial and antifungal activity.

INTRODUCTION

Perimidene derivatives are of wide interest because of their diverse biological activated and chemical applications¹⁻³. Several classical synthetic methods have been reported for the synthesis of perimidine derivatives⁴⁻⁶. The general method for the preparation of perimidine is the cyclocondensation reaction of 1, 8-diaminonaphthalene with carboxylic acid under reflux condition. The reaction between perimidine derivatives with 8-hydroxy quinoline has not been reported so far. Though 8-hydroxy quinoline has an excellent antibacterial effect⁷⁻⁹, antifungal activity¹⁰⁻¹³ and may all act as good chelating ligand with better microbicidal activity. Hence it was thought interesting to prepare the ligand having perimidine - quinoline moieties. Thus the present communication comprises the studies on perimidine-quinoline bis heterocyclic molecule and its metal chelates. The research work is illustrated in scheme-I.

EXPERIMENTAL

Materials

2-Chloro-1-(2,3-dihydro-1H-perimidin-2-yl)-ethanone and 5-amino-8-hydroxy quinoline were prepared by method reported in literature^{14,15}. All other chemicals used were of analytical grade.

Synthesis of 2-(8-Hydroxy-quinolin-5-ylamino)-1-(5-methyl-4-methylene-1,4-dihydro-2H-quinazolin-3-yl)-ethanone (PEHQ)

A mixture of 2-chloro-1-(2,3-dihydro-perimidin-1-yl)-ethanone (PY) (0.02 mole) and 5-amino-8-hydroxy quinoline (AHQ) (0.02 mole) in ethanol (70 ml) was heated under reflux for 4h. Subsequently ethanol was distilled off and the solid mass obtained. It was triturated with petroleum ether (40-60° C). The solid designated as PEHQ was isolated and dried in air. Yield was 79%. It's m.p. was 192-94°C (uncorrected).

Synthesis of metal chelates of PEHQ

The Cu²⁺, Co²⁺, Ni²⁺, Mn²⁺ and Zn²⁺ metal ion chelates of PEHQ have been prepared in a similar manner. The procedure is as follow.

To a solution of PEHQ (24.5 g, 0.1 mole) in acetic acid-formic acid (1:1v/v) mixture (150 ml). 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. by water and was known as stock solution. 25 ml of the stock solution (which contains 0.01 mole PEHQ) was added drop wise to the solution of metal salt (0.005 mole for divalent metal ions) in water at room temperature. Sodium acetate or ammonia was added up to complete precipitation. The precipitates were digested on water bath at 80° C for 2h. The digested precipitates of chelates were filtered washed with water and air dried. It was amorphous powder. Yield was almost quantitative. The detail are given in Table-1

Measurements

The elemental analysis for C, H and N were carried out on elemental analyzer TF-EA.1101 (Italy). IR spectra of PEHQ and its metal complexes were scanned on a Nicolet 760 FTIR spectrophotometer in KBr. The NMR spectrum of PEHQ was scanned on Bruker NMR3 spectrophotometer using DMSO solvent. 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 literature ¹⁶. Magnetic susceptibility measurement of all the metal complex was carried out at room temperature by the Gouy method. Mercury tetrathiocyanatocobaltate (II) Hg [Co(NCS)₄] was used as a calibrant. The diffused reflectance spectra of solid metal complex were recorded on a Beckman DK Spectrophotometer with a solid reflectance attachment, MgO was employed as the reflectance compound. The electrical conductivity of all the complexes was measure in acetonitrile at 10⁻³ M concentration.

Elemental Analysis: C ₂₂ H ₁₇ O ₂ N ₄ (369)	C%	H%	N%
Calculated:	71.54	4.60	15.17
Found :	71.5	4.5	15.1
Hydroxy value:	Theoretical: 151.7 mg /1g. Sample		
	Found: 152 mg/1g Sample		
IR Features:	1638,1575,1560,1475 cm ⁻¹	8-Hydroxy quinoline moiety	
	3030, 1520,1650 cm ⁻¹	Aromatic	
	1680 cm ⁻¹	CO	
	2850-3600 cm ⁻¹	OH	
	3400 cm ⁻¹	Sec.NH	
	2850, 2920 cm ⁻¹	CH ₂	
NMR: δ ppm (DMSO)	7.1 – 7.7 (6H)	Multiplet	Aromatic
	6.5-8.1 (5H)	Multiplet	Quinoline
	2.1 (2H)	Singlet	CH ₂
	3.9 (2H)	Singlet	CO-CH ₂ -NH
	3.8 (1H)	Singlet	OH
	2.9 (1H)	Singlet	NH

Antifungal activity

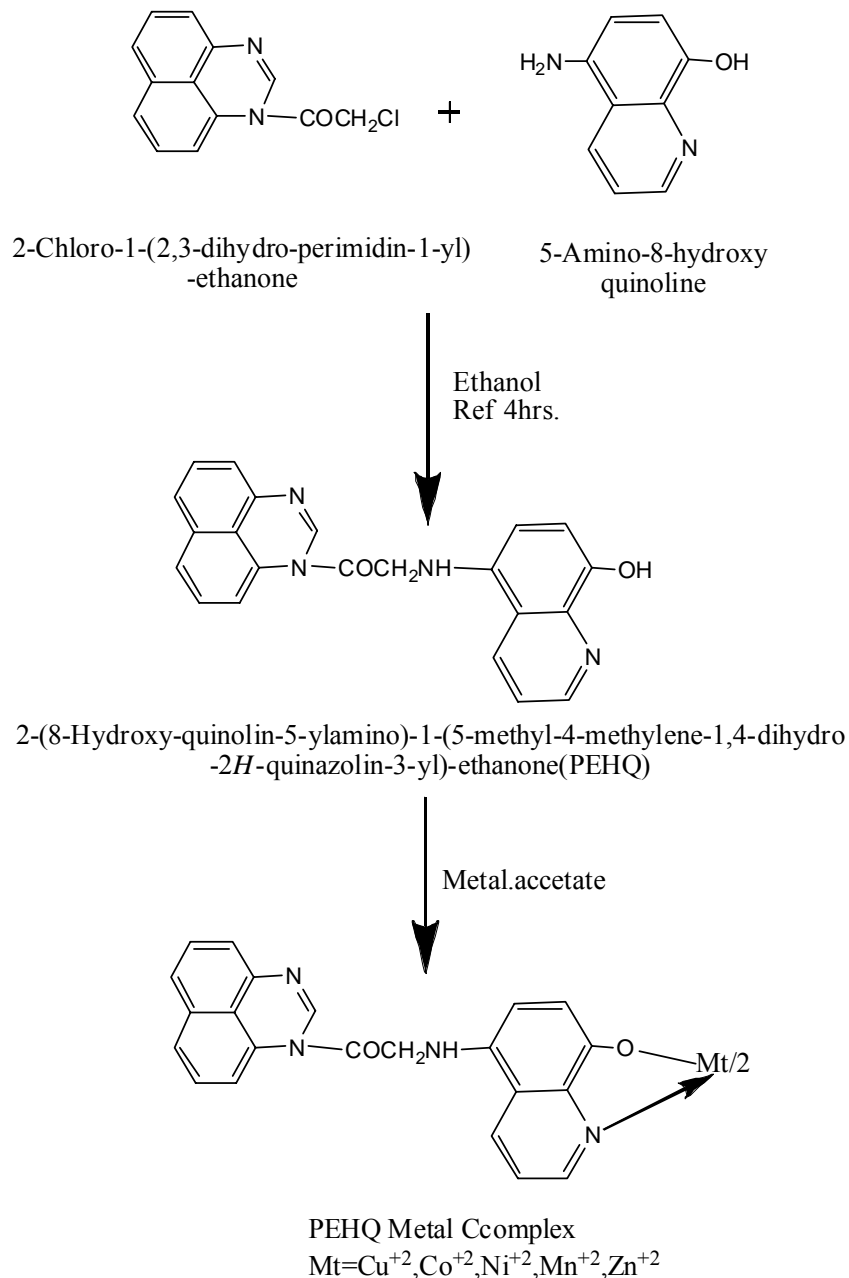
The fungicidal activity of all the compounds was studied at 1000 ppm concentration in vitro plant pathogenic organisms listed in Table-3. The antifungal activities of all the samples were measured by cup plate method ¹⁷. Each of the plant pathogenic strains on potato dextrose agar (PDA) medium. Such 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-

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

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.



Scheme-1

RESULTS AND DISCUSSION

The parent ligand PEHQ was an amorphous brown powder, soluble in various solvents like dioxane, DMSO and DMF. The results of elemental analysis of the ligand are reported in experimental part. They are consistent with the predicted structure as shown in Scheme-1.

Examination of IR spectrum (not shown) of PEHQ reveals that broad band of phenolic hydroxyl stretching is observed at 2800-3600 cm^{-1} as well as additional absorption bands at 1634, 1575, 1560, 1470 cm^{-1} are characteristics of the 8-Hydroxy quinoline moiety. The strong bands at 1680 cm^{-1} for C=O and band at 3400 cm^{-1} for sec. NH. The NMR data (shown in experimental part) also confirm the structure of PEHQ.

The Metal chelate of PEHQ with 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 Scheme-1, the molecular formula of the PEHQ ligand is $\text{C}_{22}\text{H}_{17}\text{O}_2\text{N}_4$. This upon complexation coordinates with one central metal atom at four coordination sites and with two water molecules. Therefore the general molecular formula of the resulting metal chelate is $[\text{C}_{22}\text{H}_{16}\text{O}_2\text{N}_4]_2 \text{M} \cdot 2\text{H}_2\text{O}$ for divalent metal ions. This has been confirmed by results of elemental analysis reported in Table-1. The data are in agreement with the calculated values.

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

One of the significant differences to be expected between the IR spectrum of the parent ligand and its metal chelates is the presence of more broadened bands in the region of 3200-3600 cm^{-1} for the metal chelates as the oxygen of the O-H group of the ligands forms a coordination bond with the metal ions¹⁷⁻¹⁹. This is explained by the fact that water molecule might have strongly absorbed to the metal chelates samples during their formation. Another noticeable difference is that the bands due to the CO at 1730 cm^{-1} in the IR spectrum of the each metal chelates. The band at 1400 cm^{-1} in the IR Spectrum of HL assigned to inplane OH determination²¹⁻²³ is shifted towards higher frequency in the spectra of confirmed by a weak bands at 1095 cm^{-1} corresponding to C-O-M stretching¹⁷⁻¹⁹. Thus all of these characteristics features of the IR studies suggested the structure of the metal chelates as shown in scheme.

Examination of data of the metal content in each compound revealed a 1:2 metal: ligand (M: L) stoichiometry in all of the chelate of divalent metal ions. Magnetic moment (μ_{eff}) of each of the metal chelates is given in Table-2. Examination of these data reveals that all chelates other than that of Zn^{2+} , are Para magnetic while those of Zn^{2+} are diamagnetic.

The diffuse electronic spectrum of the $[\text{CuHL}(\text{H}_2\text{O})_2]$ metal complex shows broad bands at 15962 and 22787 cm^{-1} due to the ${}^2\text{T} \rightarrow {}^2\text{T}_2\text{g}$ transition and charge transfer, respectively suggesting a distorted octahedral structure²⁰⁻²² for the $[\text{CuHL}(\text{H}_2\text{O})_2]$ complex. Which is further confirmed by the higher value of μ_{eff} of the $[\text{CuHL}(\text{H}_2\text{O})_2]$ complex. The $[\text{NiHL}(\text{H}_2\text{O})_2]$ and $[\text{CuHL}(\text{H}_2\text{O})_2]$ complex gave two absorption bands respectively at 14792, 23085 and 15962, 22787 cm^{-1} corresponding to ${}^4\text{T}_{1\text{g}} \rightarrow {}^2\text{T}_{1\text{g}}$ and ${}^4\text{T}_{1\text{g}}$ (p) transitions. Thus absorption bands at the diffuse, reflectance spectra and the value of the magnetic moments μ_{eff} indicate and octahedral configuration for the $[\text{NiHL}(\text{H}_2\text{O})_2]$ and $[\text{CuHL}(\text{H}_2\text{O})_2]$ complex. The spectra of $[\text{MnHL}(\text{H}_2\text{O})_2]$ shows weak bands at 15476, 17751 and 23062 cm^{-1} assigned to the transitions ${}^6\text{A}_{1\text{g}} \rightarrow {}^4\text{T}_{1\text{g}}$ (4G), ${}^6\text{A}_{1\text{g}} \rightarrow {}^4\text{T}_{2\text{g}}$ (4G) and ${}^6\text{A}_{1\text{g}}$ (F) $\rightarrow {}^4\text{T}_{1\text{g}}$, respectively suggesting an octahedral structure for the $[\text{MnHL}(\text{H}_2\text{O})_2]$ chelate. The high intensities of the bands suggests that they might be charge transfer in origin μ_{eff} is found to be lower than normal range. In the absence of low temperature moments it is difficult to give any significance. As the spectrum of the $[\text{ZnHL}(\text{H}_2\text{O})_2]$ polymer is not well resolved, it is not interpreted but it is μ_{eff} value shows that it is diamagnetic as expected.

Conductivities of all the complexes were measured in acetonitrile solvent and all the complexes were found to be electrolytic²⁷ in nature of 1:2 type and molar conductivity values are in the range of 36.2-37.8 $\text{Ohm}^{-1} \text{Cm}^{-1}$.

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 chelates is more toxic than other. These compounds almost inhibit the fungi about 77%. Hence produced metal chelates can be employed as garden fungicides. Further work in the direction is in progress.

ACKNOWLEDGMENT

Authors are thankful to the authorities of P. G. Department of Chemistry, Govt. Geetanjali Girls College Bhopal, India and Rajya Siksha Kendra, Pustak Bhawan, Bhopal, India for providing basic facilities for the present work.

Table-1: Analytical Data of the Metal Chelates of HL₁ (i.e. PEHQ)

Compd.	Empirical Formula	Mol. Cal. Gm/mol	Yield (%)	Elemental Analysis							
				C%		H%		N%		M%	
				Cald	Found	Cald	Found	Cald	Found	Cald	Found
HL (PEHQ)	C ₂₂ H ₁₇ N ₄ O ₂	369	79	71.54	71.5	4.60	4.5	15.17	15.1	--	--
(L) ₂ Cu ²⁺	C ₄₄ H ₃₂ N ₈ O ₄ Cu ²⁺ 2H ₂ O	835.54	73	63.19	63.1	4.30	4.2	13.40	13.3	7.60	7.5
(L) ₂ Co ²⁺	C ₄₄ H ₃₂ N ₈ O ₄ Co ²⁺ 2H ₂ O	830.94	68	63.54	63.5	4.33	4.3	13.47	13.4	7.09	7.0
(L) ₂ Mn ²⁺	C ₄₄ H ₃₂ N ₈ O ₄ Mn ²⁺ 2H ₂ O	826.94	69	63.84	63.8	4.35	4.3	13.54	13.5	6.64	6.6
(L) ₂ Ni ²⁺	C ₄₄ H ₃₂ N ₈ O ₄ Ni ²⁺ 2H ₂ O	830.71	65	63.56	63.5	4.33	4.3	13.48	13.4	7.06	7.0
(L) ₂ Zn ²⁺	C ₄₄ H ₃₂ N ₈ O ₄ Zn ²⁺ 2H ₂ O	837.38	70	63.05	63.0	4.29	4.2	13.37	13.3	7.80	7.7

Table -2: Magnetic Moment and Reflectance Spectral data of Metal Chelates of PEHQ ligand

Sample	Zone of inhibition of fungus at 1000ppm (%)						
	PE	BT	N	T	RN	AN	TL
HL1	64	64	65	67	67	58	68
(HL1)-Cu ²⁺	76	81	79	85	78	73	77
(HL1)-Co ²⁺	76	75	77	78	74	77	75
(HL1)-Mn ²⁺	67	74	73	74	73	72	76
(HL1)-Ni ²⁺	73	77	78	82	79	74	78
(HL1)-Zn ²⁺	72	80	74	78	73	72	72

Zn²⁺ Diamagnetic in Nature.

Table -3: Antifungal Activity of Ligand HL₁ and its metal chelates.

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

Metal chelate	Magnetic Moment μ_{eff} (B.M.)	Molar Conductivity $\Omega\text{m ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$	Absorption band (cm ⁻¹)	Transitions
Cu-HL	1.94	37.7	22787 15962	C.T ² T→ ² T _{2g}
Ni-HL	3.85	36.4	14792 23085	3 A _{2g} → 3T _{1g} (p) 3 A _{1g} → 3T _{1g} (F)
Co-HL	4.52	35.9	15477 22818	4 T _{1g} (F)→ 4T _{2g} (F) 4 T _{1g} (F)→ 3A _{2g}
Mn-HL	5.10	37.5	15476 17751 23062	6 A _{1g} → 4T _{1g} (4Eg) 6 A _{1g} → 4T _{2g} (4G) 6 A _{1g} → 4T _{1g} (4G)

AN= *Aspergillus niger*; TL= *Trichoderma lignorum*

REFERENCES

1. G.Calindo, R.Carlo, R.Meli and E.Perissuti, *J.Med.Chem.*,**28**,969(1993).
2. X.Bu, L.W.Deady, G.J.Finaly, B.C.Baguley and W.A.Denny, *J.Med.Chem.*,**44**,2004(2001).
3. J.L. Di-Martino, P.Jacquault, J.P. Bazureau and Hamelin, J.,*Bull.Soc.Chimique*,**133**,587(1996).
4. J.B. Hendrickson and M.S.Hussoin, *J.Org.Chem.*,**52**,4137(1987).
5. N.Morita, J.I.Dickstein and S.I.Miller, *J.Chem.Soc.Perkin Trans* **1**,2003(1979).
6. L.W. Deady and Rodemann, *J. Heterocycl.Chem.*,**35**,1417(1998).
7. V.D.Warner, *J.Periodont*,**47**,664,(1976).
8. K.A.Oster,M.J.Golden, *J.Am.Pharm.Assoc.Sci.Ed.*,**37**,283(1947).
9. J.P. Philips, *Chem.Review*,**56**,271,(1984).
10. W.Jadassohn and co-workers, *Schweiz.Med.Wochschr.*,**74**,168,(1944).
11. K.Sigg, *Schweiz.Med.Wochschr.*,**77**,123,(1947).
12. S.S.Block, *Agr. and Food Cchem.*,**3**,222,(1955).
13. M.Abdel and A.Shawkat, *J.Chinese Chem.Soc.*,**50(5)**,1055,(2005).
14. A.I.Vogel, *Textbook of Quantitative Chemical Analysis*, ELBS,5th Edn.London,617(1996).
15. A.V.Below and V.M.Nicchvoloda, *Russ.Org.Chem.*,**40**,93,(2004).
16. W. R. Baily and E. G. Scott,*Diagnostic Microbiology*,The C.V.Moshy Co.St.Lovis, 257,(1966)
17. R. M.Silverstein, *Spectrometric Identification of organic compounds*,5th Ed., John wiley(1991).
18. W.Kemp,*Organic Spectroscopy*, ELBS.(Macmillan' UK)(1998).
19. K.Nakamoto, *Infrared Spectra of Inorganic and Co-Ordination Compound*, Wiley, NY(1970).
20. A.B.F.Lever,*Inorganic Electronic Spectroscopy*,Elsevier Publ. Co., New York, N.Y.318.(1968).
21. B.N.Figgis,J.Lewis,*Prog.Inorg.Chem.*,**6**,97, (1969).
22. R. N. Carlin and A. J. Van Dryneveldt, *Magnetic properties of Transition Metal Compound*, Springer-Berlag, NY (1997).
23. F. A. Kettle, *Coordination Compounds*, Thomas Nelson & Sons (1975).

(Received: 1 May 2010

Accepted: 16 June 2010

RJC-525)

If you think that you may be a potential reviewer in field of your interest, write us at rasayanjournal@gmail.com with your detailed resume and recent color photograph.

Adopt **GREEN CHEMISTRY**

Save Our Planet.

We publish papers of Green Chemistry on priority.