Research Article

Synthesis, Characterization and Biological Activity of Schiff Base Metal Complexes

Indu Singh

Department of Chemistry, Janta Vedic PG College,
Baraut (Baghpat), Uttar Pradesh, India-250611.

ABSTRACT

New coordination complexes of Co, Ni and Zn with Schiff base N'-((2-thioxo-1,2-dihydroquinoline-3-yl)methylene) pyridine-4-carbohydrazide have been synthesized and characterized by several techniques using elemental analysis (C, H, N), IR spectra and ^{1}HNMR spectra. The new Schiff base has been synthesized by the reaction of pyridine-4-carbohydrazide and 2-thioxo-1,2-dihydroquinoline-3-carbaldehyde. The Schiff base behaves as tridentate ONS donor ligand and exhibited octahedral geometry. The Schiff base ligand and complexes were tested for their antibacterial activity against Staphylococcus aureus, Escherichia coli and Proteus vulgaris to assess their inhibiting potential. In screening medium was nutrient agar and biological screening were performed by employing cup plate method. Antibacterial activity of the ligand and its metal complexes is compared with the standard drug ciprofloxacin. In this series Co (II) complexes showed high antibacterial activity and the other complexes showed moderate antibacterial activity against different bacteria.

Keywords: Schiff base, Metal complexes, antibacterial activity, ciprofloxacin.

INTRODUCTION

The chemistry of coordination compounds with heterocyclic ligands containing oxygen and nitrogen as donor atoms has attracted the attention of chemists in recent years. It is well known that such ligands coordinate to metal atom in different ways in different media. Transition metal complexes with Schiff base have played an important role in many biological system in nature[1-3]. The chelating properties of Schiff base display manifold applications in medicine and industry. Pyridine moieties have been reported to possess antimicrobial[4], anti-inflammatory[5] and anticonvulsant[6] etc. Quinoline derivatives have been reported to possess antibacterial[7], antimicrobial[8], anti-inflammatory[9] and anticancer[10] etc. In view of these findings we have synthesized some metal complexes with a new Schiff base N'-((2-thioxo-1,2-dihydroquinoline-3-yl)methylene) pyridine-4-carbohydrazide which was prepared by the reaction between pyridine-4-carbohydrazide and 2-thioxo-1,2-dihydroquinoline-3-carbaldehyde.

EXPERIMENTAL

All reagents and solvents used in this work were analytical grade and used directly. The melting points were determined in open glass capillaries tubes. Purity of the compounds was checked by thin layer chromatography (TLC) on silica gel G plates and spots were located by using iodine chamber. Elemental analysis (C, H, N) of all the synthesized compounds were determined by perkin-Elmer 2400 elemental analyzer. The IR spectra were recorded on a Beckman Acculab-10 spectrometer (v□ max in cm^{-1}) and the ^{1}H NMR spectra were recorded by Brucker DPX-300 MHz using $CDCl_3$ as solvent.

Synthesis of Schiff base

The Schiff base (ligand) was prepared by the reaction of pyridine-4-carbohydrazide (0.282 gm, 0.001 mol) and 2-thioxo-1,2-dihydroquinoline-3-carbaldehyde (0.185 gm, 0.001 mol) in the presence of catalytic of glacial acetic acid (1-3 drops) under reflux for 7-8 h on the water bath. The reaction mixture was cooled at room temperature. The precipitate was then removed from the reaction mixture by filtration, washed with ethanol, dried and recrystallized from appropriate solvent. The synthesis of Schiff base have been shown in **scheme 1**

Synthesis of complexes

Schiff base N'-((2-thioxo-1,2-dihydroquinoline-3-yl)methylene) pyridine-4-carbohydrazide (0.908 gm, 0.002 mol) in ethanol (30 ml) and stirred gently for one hour to give homogeneous solution and added ethanolic solution (10 ml) of respective metal chlorides (0.002 mol). The resulting solution was refluxed for 5 h on steam bath and then sodium acetate (0.5 gm) was added to it and refluxed for 2 h. It was poured into distilled water. The solid complexes were collected by filtration, washed with distilled water and dried in a vaccum over anhydrous calcium chloride in a desicater. The synthesis of metal complexes is given in **scheme 2** and physical analytical data of ligand and its complexes are given in **table 1.**

IR, ^{1}HNMR Spectra of Ligand

The IR spectrum of ligand showed peak at 1635 cm^{-1} due to carbonyl group and three absorption band at 3115 and 3060 cm^{-1} due to amide NH and NH of quinolone moiety. The bands observed at 1635, 1562 and 1161 cm^{-1} are due to carbonyl C=O, azomethene C=N and C=S function at 2-position of quinoline moiety respectively. The ^{1}HNMR spectra of the Schiff base in d_6 DMSO at room temperature showed signal at δ 12.6 (s,1H, quinoline NH), δ 11.4 (s, 1H, CONH), δ 8.10 (s, 1H, N=CH) and δ 7.20-8.30 (m, 9H, Ar-H) due to protons of quinolone NH, amide NH, azomethine N=CH and aromatic protons respectively.

IR Spectral data of the complexes of ligand

IR spectral data of ligand. and its complexes are given in **table 2.** The IR spectrum of ligand was compared with those of the complexes of metal ions Co (II), Ni (II) and Zn (II) in order to study the binding mode of schiff base to the metal ions. In the IR spectra of ligand the band appeared at 1635 cm^{-1} assigned to carbonyl group (C=O) has disappeared in its complexes the above metal ions suggesting the involvement of carbonyl oxygen atom in coordination by the deprotonation after its enolization. All the complexes except Zn (II) complex of the ligand under the present study displayed broad bands in the region 3425-3410 cm^{-1} indicating the presence of lattice or coordinated water molecules. The peak observed at 3060 cm^{-1} due to quinolone NH has appeared at about the same region 3020-3075 cm^{-1} in all the complexes indicates the non-involvement of quinolone NH in complexation. Absorption band at 1562 cm^{-1} in case of ligand due to C=N of azomethine function has been found to be shifted towards the lower frequency side 1536-1515 cm^{-1} in all the complexes indicates the metal ions have coordinated to azomethine nitrogen. A band at of all the complexes indicating the coordination of metal ions with sulfur of C=S function. The bands of weak intensity in the region 545-515 cm^{-1} in case of all the complexes of the ligand are assigned M-O vibrations and the bands in the region 457-410 cm^{-1} to M-N vibration.

Pharmacological Studies

Antibacterial Activity

All the newly synthesized metal complexes were tested for their antibacterial activity. Antibacterial activity was determined by agar cup plate method [11] against the following organism- Staphylococcus aureus, Escherichia coli and Proteus vulgaris. The zone of inhibition of each strain was recorded. Antibacterial activity of the ligand and its metal complexes was compared with the standard drug ciprofloxacin. The variation in the activity of different metal complexes against different micro-organism depends on their impermeability of the cell or the differences in ribosomes in microbial cell. The lipid membrane surrounding the cell favors the passage of any lipid soluble materials and it is knows that lipo solubility is an important factor controlling antibacterial activity.

RESULTS AND DISCUSSION

The results showed (**table-3**) that ligand exhibits moderate activity against all tested bacteria. Co (II) complex showed high antibacterial activity against S. aureus, E. coli and P. vulgaris. Ni complex exhibited moderate activity against S. aureus and E. coli but highly effective against P. vulgaris. Zn complex exhibited moderate activity against S. aureus but showed good activity against E. coli and P. vulgaris microorganism. Antibacterial activity of the ligand and its metal complexes is compared with the standard drug ciprofloxacin. The variation in the activity of different metal complexes against different micro-organism depends on their impermeability of the cell.

CONCLUSION

A new ligand N'-((2-thioxo-1,2-dihydroquinoline-3-yl)methylene) pyridine-4-carbohydrazide and its complexes have been synthesized and characterized by IR and ^{1}HNMR spectral data which includes that all the complexes exhibited octahedral geometry. Some of these complexes have exhibited good antibacterial activity.

ACKNOWLEDGEMENTS
We are thankful to SAIF Punjab University, Chandigarh India for spectral and analytical analysis. We are also thankful to Department of Microbiology LLRM Medical College Meerut U.P for their antibacterial activity.

Table 1: Physical and analytical data of ligand and its complexes

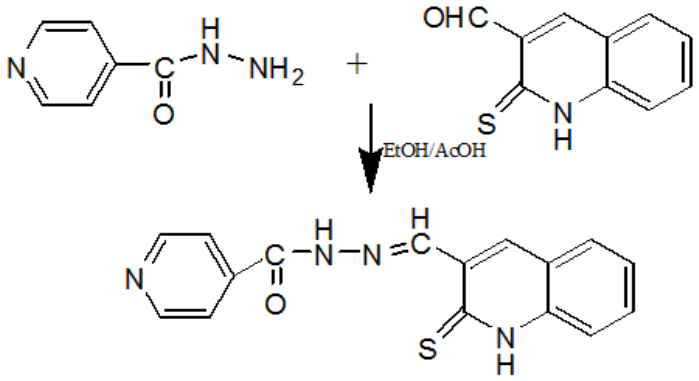
Compounds	Molecular formula	Mol. Wt	M. P.	Elemental analysis (%) Calcd (Found)			
				M	C	H	N
Ligand	$C_{16}H_{12}N_4OS$	308.36	312-316	-	62.32 (62.35)	3.92 (3.90)	18.17 (18.14)
Co- complex	$Co[C_{34}H_{28}N_8O_2S_2]\ 2H_2O$	703.70	330-335	8.37 (8.35)	58.03 (58.06)	4.01 (4.03)	15.92 (15.95)
Ni- complex	$Ni[C_{34}H_{28}N_8O_2S_2]\ H_2O$	703.46	367-370	8.34 (8.32)	58.05 (58.02)	4.01 (4.03)	15.93 (15.90)
Zn- complex	$Zn[C_{34}H_{28}N_8O_2S_2]$	710.18	346-349	9.21 (9.18)	57.50 (57.53)	3.97 (3.96)	15.78 (15.80)

Table 2: IR data of ligand and its complexes

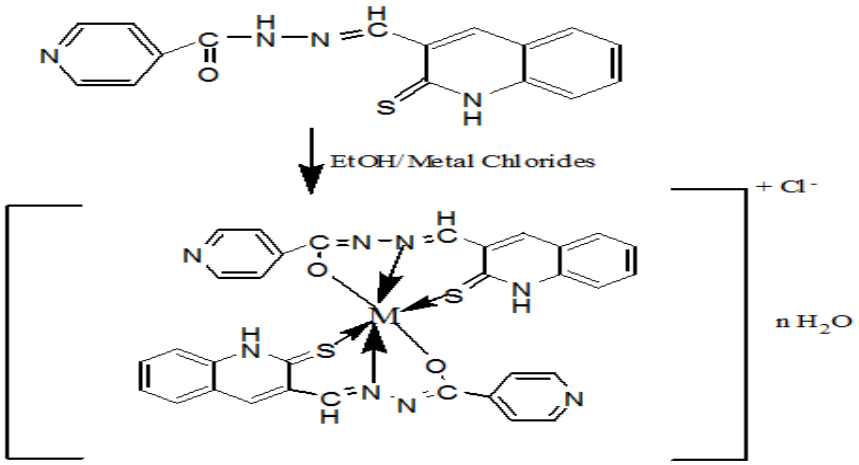
Compound	ν_{H2O}	AmideNH	Quinoline NH	$\nu_{C=O}$	$\nu_{C=S}$	$\nu_{C=N}$	ν_{M-O}	ν_{M-N}
Ligand	-	3115	3060	1635	1161	1562	-	-
Co-complex	3410	-	3025	-	1145	1536	515	457
Ni- complex	3425	-	3020	-	1135	1542	520	453
Zn-complex	-	-	3075	-	1160	1515	545	410

Table 3: Antibacterial activity of ligand and its complexes

Compounds	Bacterial inhibition zone/mm		
	S. aureus	E. coli	P. vulgaris
Ligand	13	16	14
Co-complex	19	20	19
Ni- complex	14	13	18
Zn-complex	12	18	19
Ciprofloxacin	20	22	20



Scheme 1- Synthesis of ligand



Scheme 2 Synthesis of metal complexes

REFERENCES

1. Mohmoud WH, Mohamed GG and El-Dessouky MMI. Synthesis, characterization and in vitro biological activity of mixed transition metal complexes of lornoxicam with 1,10-phenanthroline. Inter J Electrochem Sci. 2014;9:1415-1438.
2. Eissa HH. Synthesis, characterization and antibacterial activity of macrocyclic Schiff bases based on 1,3-docarbonyl phenyl dehydrazide 1,4-docarbonyl phenyl dehydrazide. Organic Chemistry Current Research. 2013;2(3):1-8.
3. Bhagat SM and Deshpande MM. Synthesis and antimicrobial activity of some transition metal ion chelates of 2-(cinnamyl)-4-bromo-6-methyl benzothiazolyl hydrazones. Journal of Chemical and Pharmaceutical Research. 2012;4(3):1454-1456.
4. Patel NB, Agraval SN and Shaikh FM. Synthesis and antimicrobial activity of new pyridine derivatives. Med. Chem. Research. 2011;20:1033-1041.
5. Al-Omar MA, Amr A-G and Al-Salahi RA. Antiinflammatory, analgesic, anticonvulsant and antiparkinsonian activities of some pyridine derivatives using 2,6-disubstituted isonicotinic acid hyrazides. Arch Pharm. 2010;343(11-12):648-656.
6. Pattan SR, Dighe NS, Musmade DS, Tambe SK, Kale SH, Craware VM and Chavan PA. Synthesis and evaluation of some new substituted 1,4-dihydropyridine derivatives and their anticonvulsant activity. J Chem Parm Res. 2010;2(1):246-252.
7. Holla BS, Poojary KN, Poojary B, Bhat KS and Kumari NS. Synthesis, characterization and antibacterial activity studies on some fluorin containing quinoline-4-carboxylic acids and their derivatives. Indian Journal of Chemistry. 2005;44B(10):2114-2119.
8. Ozyanik M, Demirci,S, Bektas H, Demirbas N, Dermirbas A and Karaoglu SA. Preparation and antimicrobial activity evaluation of some quinoline derivatives containing an azole nucleus. Turk J Chem. 2012;36:233-246.
9. Marroni O, Esposito G, Diurno MV, Brancoccio D, Carotenuto A, Grieco P, Novellino E and Filippelli,W. Synthesis and pharmacological evaluation of some 4-oxoquinoline-2-carboxylic acid derivatives as anti-inflammatory and analgesic agents. Archiv Der Pharmazie. 2010; 343(10):561-569.
10. Kouznetsov VN, Rojas Ruiz FA, Vargas Mendez LY and Gupta MP. Simple C-2-substituted quinolines and their anticancer activity. Letters in Drug Design & Discovery. 2012;9: 680-686.
11. Smith QE. In pharmacological screening tests progress in medicinal chemistry. Butterworths London. 1960;1:1-33.