Available online at **www.joac.info**

ISSN: 2278-1862

Journal of Applicable Chemistry
2019, 8 (2): 581-585
(International Peer Reviewed Journal)

Synthesis and Characterization of the Metal Complexes of Pyrazine-2-Carboxamide Schiff Base

E. Vijaya Sekhar[1]*, Mahesh Bhat[2] and Somu Srihari[3]

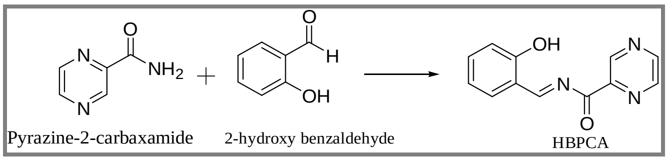
1. PG Dept of Chemistry, JSS College for Women, Saraswathipuram, Mysuru-570009, **INDIA**
2. PG Dept of Chemistry, Bangurnagar Arts, Science and Commerce College, Dandeli-581325, **INDIA**
3. Professor (Retd), Dept of Chemistry, Kakatiya University, Warangal-506009, **INDIA**
Email: vijaysekhare@gmail.com

Accepted on 14th February, 2019

ABSTRACT

The Fe(III), Ru(III), Co(II), Ni(II), Cu(II), Pd(II), Zn(II), Cd(II) and Hg(II) complexes of a Schiff base derived fromPyrazine-2-carboxamide and 2-hydroxybenzaldihyde (HBPCA) have been synthesized and structurally characterized by various physico-chemical data. The ligand acts as a mono negative, bidentate one towards the metal ions coordinating through azomethine nitrogen and phenolic oxygen. The geometry and the bonding characteristics associated with the complexes have been deduced from relevant spectral data. All the complexes are colored and stable towards air and moisture. Fe(III), Ru(III) Complexes are octahedral, Ni(II), Cu(II) and Pd(II) square planar complexes and Co(II), Zn(II), Cd(II) and Hg(II) complexes are tetrahedral in geometry. Further, the ligand and the metal complexes have been screened for their antimicrobial activities against two gram positive bacterial strains Basillus subtillus, Staphylococcus aurus and two gram negative bacterial strains Escherichia coli, Salmonella typhi, and two fungal strains Aspergillus niger and Penicillium rubrum by agar plate technique and the results are presented. Both the antibacterial and antifungal activities of the synthesized metal complexes were found to be more as compared to that of the ligand.

Graphical Abstract



Keywords: Pyrazine-2-carboxamide, 2-hydroxybenzaldihyde, Schiff's base, Metal complexes, Synthesis, Characterization.

INTRODUCTION

Pyrazinamide occurs as a white crystalline powder, practically insoluble in water, slightly soluble in acetone, alcohol and chloroform. Pyrazinamide is a mono cyclic compound consisting of a two para nitrogen situated pyrazine nucleus attached with an amide group. The pyrazine nucleus is a part of many polycyclic compounds of biological and /or industrial significance. The wide spread occurrence of pyrazine derivatives in nature, especially in the flavours of many food systems, their effectiveness even at very low concentrations as well as the still increasing applications of synthetic pyrazines in the flavour and fragrance industry are responsible for the high interest in these compounds [1].

Pyrazine is a weaker base than pyridine, due to the induction effect of the second nitrogen. Some pyrazines, especially dihydropyrazines, are essential for all forms of life [2]. Several pyrazine derivatives have been used as antioxidants [3]. These compounds have shown important therapeutic applications [4, 5]. In view of the importance of pyrazinamide, a study has been attempted on a Schiff base derivative of this moiety. Considering the importance of pyrazinamide and Schiff base derivatives we report the synthesis, characterization and antimicrobial activity of ligand and its metal complexes.

MATERIALS AND METHODS

Synthesis of the ligand (HBPCA): All the chemicals used were of AR or BDH grade. The ligand HBPCA was prepared by refluxing an equimolar mixture of pyrazinamide and 2-hydroxy benzaldehyde in methanol in presence of a few drops of acetic acid for about 3 hrs. The solid that separated was filtered, washed with water and recrystallized from methanol. The colour, yield (%), m.p. and elemental analysis (%) of HBPCA are respectively white, 75, 140°C [found C 63.10, H 3.58, N 16.54].

Synthesis of the metal complexes: The Fe(III), Ru(III), Co(II), Cu(II), Pd(II) and Hg(II) complexes of ligand were prepared taking metal chlorides and Ni(II), Zn(II) and Cd(II) complexes taking metal acetates. In the preparation of metal complexes, the metal and the ligand were combined in1:3 mole ratio in the case of Fe(III), Ru(III) and 1:2 mole ratio in the case of Co(II), Ni(II), Cu(II), Pd(II), Zn(II), Cd(II) and Hg(II) using required quantities of methanol so as to effect the solubility of the metal salts and the ligand. The contents were refluxed on a hot water bath for 2-3 hrs and the solid that separated was filtered, washed with water, hot methanol and ether and was vacuum dried over fused $CaCl_2$.

The elemental analyses(C,H,N) of the ligand and the complexes were carried out at C.S.M.C.R.I, Bhavanagar. Conductance measurements were made in DMF at 10^{-3} M concentration on a Digisun digital conductivity meter. Gouy balance calibrated with Hg $[Co(NCS)_4]$ was used to measure the magnetic susceptibility of metal complexes at room temperature. The IR spectra of the ligand and its metal complexes in KBr were recorded in the range 4000-450 cm^{-1} using Perkin Elmer 100 FT-IR spectrophotometer. The electronic spectra of metal complexes were recorded on Perkin Elmer UV-VIS spectrophotometer. WIN-EPR (BRUKER) spectrophotometer operating in the frequency 9.5 GHz was employed in recording the ESR spectrum of Cu(II) complex in DMF at LNT.

Considering the biological importance pyrazinamide derivatives and the possible synergistic effect of metal ion association with these compounds on their biological activity, the ligand : HBPCA and their Fe, Ru, Cu, Pd, Zn and Hg complexes have been studied Agar cup plate method for their activity against the two gram positive bacterial strains: *Staphylococcus aurus*, *Bacillus subtilis* and two gram negative bacterial strains: *Salmonella typhi*, *Escherichia coli* and two fungal strains: *Aspergillus niger and Penicillium rubrum.*

RESULTS AND DISCUSSION

The Fe(III), Ru(III), Co(II), Ni(II), Cu(II), Pd(II), Zn(II), Cd(II) and Hg(II) complexes of HBPCA are stable at room temperature and are non-hygroscopic. Upon heating, the complexes decompose without melting. The complexes are insoluble in water, slightly soluble in hot methanol and fairly soluble in dimethyl formamide and dimethylsulphoxide.

The elemental analyses show that the Fe(III)and Ru(III) complexes have 1:3 and the Co(II), Cu(II), Ni(II), Pd(II), Zn(II), Cd(II) and Hg(II) complexes have 1:2 metal-ligand stoichiometry. All the metal complexes are non electrolytes in DMF with the exception of Fe(III) and Ru(III) complexes which are 1:1 electrolytes. The magnetic studies made on the complexes indicate that the Fe(III), Ru(III), Co(II) and Cu(II) complexes are paramagnetic and that the Ni(II), Pd(II), Zn(II), Cd(II) and Hg(II) complexes are diamagnetic (Table 1).

Table 1. Analytical and physical data of metal complexes

Metal complex	Colour	Percent			Molar Conductance $\Omega^{-1}cm^2mol^{-1}$	μ_{eff} B.M.
		C	H	N		
$[Fe (C_{12}H_9N_3O_2)_3Cl_2]Cl$	Brown	63.18(63.26)	3.08(3.96)	18.72(18.48)	60	5.69
$[Ru (C_{12}H_9N_3O_2)_3Cl_2]Cl$	Dark brown	62.26(62.42)	3.08(3.80)	18.94(18.39)	51	1.78
$[Co (C_{12}H_9N_3O_2)\ _2Cl_2]$	Brown	60.21(60.57)	3.24(3.50)	18.68(18.49)	10	4.44
$[Ni (C_{12}H_9N_3O_2)_2(OAc)_2]$	Dark green	60.00(60.16)	3.15(3.60)	17.50(17.75)	14	--
$[Cu (C_{12}H_9N_3O_2)_2Cl_2]$	green	59.28(59.28)	3.36(3.48)	17.51(17.77)	09	1.91
$[Pd (C_{12}H_9N_3O_2)Cl_2]$	Grey	58.72(58.44)	2.68(2.79)	17.98(17.65)	20	--
$[Zn (C_{12}H_7N_3O_2)(OAc)_2]$	Yellow	58.06(58.96)	3.02(3.27)	17.68(17.49)	11	--
$[Cd (C_{12}H_9N_3O_2)(OAc)_2]$	Light yellow	57.22(57.55)	2.80(2.93)	17.56(17.38)	12	--
$[Hg (C_{12}H_9N_3O_2)Cl_2]$	Colour less	56.10(56.57)	3.38(3.44)	17.08(16.60)	09	--

Values in parenthesis are calculated ones.

IR spectral data: The IR spectral data of HBPCA and its complexes are presented in table 2. The ligand shows a medium intensity band appears at 3320 cm^{-1} that has been assigned to νO-H [6]. This band disappears in the spectra of its complexes indicating that deprotonation of of the group has taken place. Low intensity band appears at higher frequencies in the complexes has been assigned toνC=O.A band that shows up at 1610 cm^{-1} in the ligand due to azomethine group has been lower shifted by 20-40 cm^{-1} in the complexes indicating that the nitrogen of this group is coordinated to the metals [7, 8]. A large intensity band due to pyrazine ring appears at 1168 cm^{-1} in the ligand and it remains unshifted in the complexes indicating that the ring is not involved in coordination [9-11]. Thus, it may be concluded that the ligand acts towards the metals studied in a mono negative, bidentate manner, coordinating through the nitrogen of azomethine group and the phenolic oxygen.

Table 2. IR Spectral data of HBPCA and its complexes

S. No.	Compound	ν C=O	ν C=N	νM-N
1	HBPCA	1669	1610	--
2	Fe- HBPCA	1682	1577	468
3	Ru- HBPCA	1688	1576	472
4	Co- HBPCA	1690	1575	492
5	Ni- HBPCA	1700	1582	486
6	Cu- HBPCA	1702	1580	494
7	Pd- HBPCA	1708	1585	481
8	Zn- HBPCA	1732	1588	474
9	Cd- HBPCA	1690	1581	492
10	Hg- HBPCA	1688	1568	466

Electronic spectral data: The electronic spectral data of the Ru(III), Co(II), Ni(II), Cu(II) and Pd(II) complexes along with the assignment are furnished in table 3. These transitions are characteristic of octahedral geometry for Ru (III) (low spin) and a square planar geometry for the complexes Ni(II) , Pd(II) and Cu(II), tetrahedral geometry for the complex Co(II) [12-15].

The Fe(III) complex, owing to transitions in it being spin-forbidden and the Zn(II), Cd(II) and Hg(II) complexes due to filled configurations do not show d-d bands .Based on the other data obtained, Fe(III) complex has been assigned octahedral (high spin) geometry and the other three complexes, tetrahedral geometry[16, 17].

Table 3. Electronic spectral data

Complex	Frequency (cm^{-1})	Assignment
Ru- HBPCA	16230	$^2T_{2g} \rightarrow {}^4T_{1g}$
	18480	$^2T_{2g} \rightarrow {}^4T_{2g}$
	22650	$^2T_{2g} \rightarrow {}^2A_{2g}$
Co- HBPCA	12100	$^4A_2(F) \rightarrow {}^4T_1(F)$
	19950	$^4A_2(F) \rightarrow {}^4T_1(P)$
Ni- HBPCA	18000	$^1A_{1g}(D) \rightarrow {}^1B_{1g}(G)$
	22210	$^1A_{1g}(D) \rightarrow {}^1E_g(G)$
Cu- HBPCA	14855	$^2B_{1g} \rightarrow {}^2B_{2g}$
	20440	$^2B_{1g} \rightarrow {}^2E_g$
Pd- HBPCA	14620	$^1A_{1g} \rightarrow {}^1A_{2g}$
	19690	$^1A_{1g} \rightarrow {}^1B_{1g}$
	24550	$^1A_{1g} \rightarrow {}^1E_g$

ESR Spectral study: The ESR spectrum of the Cu(II)-FMPCA complex is of anisotropic nature from which $g_{\|}$ and $g_{\perp}$have been respectively calculated from the lower and higher field peaks as 2.19 and 2.06, the g_{av} ($g_{\|} + g_{\perp}/3$) being 2.12 [18]. Since $g_{\|}$ is greater than $g_{\perp}$for the complex, the unpaired electron is present in the metal $d_{x^2-y^2}$ orbital giving $^2B_{1g}$ as the ground state-a characteristic of square planar case.

Anti microbial activity: The antimicrobial activity of HBPCA and its complexes has been studied against bacteria *Bacillus megaterium* (Gram +ve), and *Klebsiella pneumonia* (Gram –ve) and fungi: *Pencilium rubrum* and *Aspergillus niger* wherein the zone of inhibition measured in the (Table 4). The results indicate that the complexes are in general more active than the free ligand. Further, Hg complex, of all the compounds, exerts highest activity on the bacteria as well as fungi studied [19, 20].

Table 4. Antimicrobial activity of HBPCA and its complexes

S.No	Compound	Zone of inhibition (mm)			
		Bacteria		Fungi	
		Bacillus Megaterium	*Klebsiella Pneumonia*	*Pencilium rubrum*	*Aspergillus niger*
1	HBPCA	20	22	-	-
2	Fe- HBPCA	-	35	12	18
3	Ru- HBPCA	26	29	22	20
4	Co- HBPCA	19	21	10	12
5	Ni- HBPCA	11	14	24	32
6	Pd- HBPCA	16	21	22	24
7	Cu- HBPCA	22	22	23	22
8	Zn- HBPCA	24	15	18	26
9	Cd- HBPCA	22	25	24	20
10	Hg- HBPCA	30	32	38	41

APPLICATION

Toxicity is the main problem to use metal complexes in the field of medicinal chemistry. In this research work we would like to find out the possible factors which are responsible for toxicity. It is well known that the properties of metal complexes strongly affected by the structure of ligands. Research on this type of metal complexes will be continued.

CONCLUSION

Based on the foregoing discussion, it may be concluded that the ligand acts in a mono negative, bidentate manner coordinating to the metals through nitrogen of azomethine group and phenolic oxygen. Fe(III), Ru(III) Complexes are octahedral, Ni(II), Cu(II) and Pd(II) square planar complexes and Co(II), Zn(II), Cd(II) and Hg(II) complexes are tetrahedral in geometry. Further, the ligand and the metal complexes have been screened for their antimicrobial activities against two gram positive bacterial strains *Basillus subtillus*, *Staphylococcus aurus* and two gram negative bacterial strains *Escherichia coli, Salmonella typhi*, and two fungal strains *Aspergillus niger and Penicillium rubrum* by agar plate technique and the results are presented. Both the antibacterial and antifungal activities of the synthesized metal complexes were found to be more as compared to that of the ligand.

ACKNOWLEDGEMENTS

The Authors sincerely thanks to JSS Mahavidyapeeta and JSS College for women, Saraswathipuram, Mysuru for providing research facilities to carry out this work.

REFERENCES

[1]. M. Dolezal, *Chem. Listy*, **2006**, 100, 959-966.

[2]. D. J. Brown, Wiley, *J, Sons, Inc., New York*, **2002**.

[3]. M. Dolezal, P. Cmedlova, L. Palek, J .Vinsova, V. Buchta, J .Jampilek, K. Kralova Substituted Pyrazine carboxamides, Synthesis and Their Biological Evaluation, *Molucules*, **2006**, 11(4), 242-256.

[4]. M. Miletin, J. Kunes, K. Kralova, Subsisted amides of pyrazine-2- carboxylic acids, their synthesis and biological activity, *Molecules*, **2002**, 7, 63-373.

[5]. N. D. Camper, S. K. Danald, Tissue and cell cultures as model system in herbicide Research, *Rev. Weed Sci.*, **1989**, 4, 169-190.

[6]. M. E. Elba, A. I. Darwish, N. M. Mamda, *J. Indian Chem. Soc*., **1997**, 74, 202-205

[7]. P. K. Sharma, A. K. Singh, *J. Indian Chem. Soc*., **1997**, 74, 446-447.

[8]. H. Chakra borty, N. Paul, M. L. Rahman, Catalytic activities of Schiff bases aqua complex of Cu (II) in the hydrolysis of amino acid esters. *Transition Metal Chemistry*, **1994**, 19, 524-526.

[9]. C. N. R. Rao, Chemical Application of Infra Red Spectroscopy, Academic Press, New York, **1963**, 2212.

[10]. L. J. Bellamy, The Infra Red Spectra of Complex Molecules, Methuen and Co Ltd., London, **1954**, 225.

[11]. A. Syamal, Kumar A Ahmed, *Indian J. Chem*., **1982**, 21A, 634.

[12]. M. R. Gajendragad, U. C. Aggarwala, *J. Inorg. Nucl. Chem.*, **1975**, 37(2), 2429.

[13]. L. Sacconi, Electronic structure and stereochemistry of Ni (II) in trans.met.chem. Ed.by Carlin, **1988**, 4(2), 199.

[14]. J. S. Dwivedi, U. C. Aggarwala, *Indian J. Chem*., **1972**, 10(1), 652.

[15]. M. Usharani, E. Akila, R. Rajavel, Mixed-ligand Schiff base complexes: Synthesis, Spectral Characterization and Antimicrobial activity, *International Journal of Recent Scientific Research*, **2013**, 4, 726-731.

[16]. A. B. P. Lever, Inorganic electronic spectroscopy, 2nd ed. Elsevier, **1988.**

[17]. N. Raman, Thangaraja C, Synthesis and Structural Characterization of a Fully Conjugated Macrocyclic Tetraaza (14)-Membered Schiff base and its Bivalent Metal Complexes, *Transition Metal Chemistry*., **2005**, 30, 317

[18]. R. L. Dutta, A. Syamal, Elements of magneto chemistry, Mc-Graw Hill, New York, **1962**,134.

[19]. S. Magaldi, S. Mata-Esayag, C. Perez, M .Colellae, Olaizola, Y. Ontiveros, *Int. J. Infectious,* **2004**, 8(4), 39.

[20]. J. Thomas, G. Parameswaran, Anti-tumour and thermogravimetric studies of transition metal complexes of the Schiff base, anthracene-9-carboxaldehyde thiosemicarbazone, *Asian Journal of Chemistry*, **2002**, 14(3-4), 1370-1382.