Asian Journal of Chemistry Vol. 13, No. 4 (2001), 1565–1568

Structural and Biological Studies of Some Copper(II) Macrocyclic Complexes

JITENDRA AMBWANI*, N.L. BANSAL† and KSHAMA KAUSHIK
Department of Chemistry, Government Girls College, Morena, India

Two new macrocyclic complexes were synthesized having the formulae $Cu[DPAODAH](BF_4)_2$ and $Cu[DPATDPH](BF_4)_2$ {where [DPAODAH] = diphenyl diacetic acid-N-oxy diacetic acid dihydrazone and [DPATDPH] = diphenyl diacetic acid-N-thiodipropionic acid dihydrazone and BF_{4_2} = Tetrafluoroborate. The complexes were characterized using molar conductance, magnetic studies and infrared and electronic spectral data and have been assigned octahedral geometries. The complexes were screened for their biological studies against bacteria *S. aureus* and *E. coli* and fungi *A. flavus* and *C. albicans*. The complexes were found to have intense antimicrobial activity as contrasted with ligand fragments.

INTRODUCTION

The recent era of complexation studies has witnessed tremendous rise in the synthesis and applications of macrocyclic compounds. The manifold applications of these compounds include the anticancerous[1], antiviral[2–4], anti-tubercular[5, 6], anti-convulsant and anti-neoplastic activities.

Research studies have been undertaken recently on copper(II) complexes of a 12-membered homologue, 1,4,7,10-cyclotridecane (l^5).[7, 8] This N-containining analogue of 18-crown-6 has been investigated with reference to its metal complexes[9–12]. It was also used as an extracting agent for different metal ions[13, 14]. Studies on electrical properties of phthalocyanines date back to 1948 when Ley and Vartayayan discovered the unusual temperture dependence of the resistivities of the phthalocyanines and their metal derivatives[15–18].

The template synthesis which affects the course of reactions has helped in the development of a variety of new macrocycles[19, 20]. The synthesis, structures and electro chemical redox properties of macrocyclic metal complexes of tetraaza, pentaaza and hexaaza Me_4 cyclopean and Ph_4 cyclopean ligands have been described earlier[21, 22]. Also, many important vital enzymatic reactions are catalysed by transition metals present in these macrocyclic structures.

In view above cited applications and activities of macrocyclic compounds, two new macrocyclic complexes have been synthesized by condensing oxydiacetic acid dihydrazide and thiodipropionic acid dihydrazide in presence of copper(II) ions.

---

†Dept. of Chemistry, Govt. P.G. College, Morena, India.

EXPERIMENTAL

All the chemicals used were of AR grade. The purity of the complexes was ascertained by preliminary investigations, *viz.*, repeated melting point determination and TLC method for single spot.

Synthesis of metal complexes

(1) Cu[DPAODAH]$(BF_4)_2$: Equimolar amounts of oxydiacetic acid dihydrazide (0.01 M), copper acetate (0.01 M) and diphenyl di acetic acid (0.01 M) were mixed in ethanol with continuous stirring. The solution thus obtained was refluxed over a water bath for around 6 h. Subsequently, it was concentrated to one-third of its original volume. Then, a little of sodium tetrafluoroborate was added and the solution was cooled overnight, when dark green crystals separated out. The crystals were filtered, washed with alcohol, ether and then dried in vacuum over anhydrous $CaCl_2$ in a desiccator.

The other complex was also synthesized by similar procedure when greenish-black crystals were obtained.

The synthesized complexes were tested for their purity by melting point determination, TLC method for single spot and CHN analysis. Metal contents were estimated by standard procedures[23]

RESULTS AND DISCUSSION

All these complexes are crystalline, coloured, solid and stable at room temperature. These are insoluble in water and most of the common organic solvents, *viz.*, methanol, ether and acetone are soluble in propylene, glycol, DMSO and DMF.

The results obtained from the analytical data (Table-1) indicate 1 : 2 (metal to ligand) stoichiometry for copper(II) complexes.

The analytical data of ligand fragments and metal complexes are presented in Table 1.

TABLE-1
ANALYTICAL DATA OF Cu(II) MACROCYCLIC COMPLEXES

S.No.	Compound (Colour) (m.f.)	m.p. (°C)	% Analysis, found (calcd.)			
			C	H	N	Cu
1.	[ODADH] (White) $[C_4H_{10}O_3N_4]$	124	29.22 (29.62)	6.10 (6.17)	33.85 (34.56)	–
2.	[TDPHD] (Yellowish white) $[C_6H_{14}O_2N_4S]$	121	34.65 (34.95)	6.65 (6.79)	26.95 (27.18)	–
3.	Cu[DPAODAH]$(BF_4)_2$ (Dark green) $Cu[C_{20}H_{20}O_5N_4](BF_4)_2$	275	37.85 (38.00)	3.09 (3.16)	8.75 (8.86)	9.88 (10.05)
4.	Cu[DPATDPH]$(BF_4)_2$ (Greenish black) $Cu[C_{22}H_{26}O_4N_4S](BF_4)_2$	282	38.85 (38.96)	3.13 (3.83)	8.10 (8.26)	8.99 (9.37)

Infrared Spectra

The IR spectra of all the ligand fragments exhibited sharp and prominent bands at 3090, 1740 and 1580 cm^{-1}. These were assigned to the presence of ν(NH), ν(C=O) and ν(NH_2) groups respectively. Intense bands were observed at 2686 and 2670 cm^{-1} in spectra of ODADH and TDPDH due to ν(NH_2) group. In addition to these peaks, ν(N—N) transitions were observed around 1090 cm^{-1}, thus supporting the formation of ν(Cu—N) and ν(Cu—O) bonds in the complexes. Another band in the complexes was observed around 330–315 cm^{-1}. This band was attributed to the presence of (Cu—S) bond in the complexes.

Electronic Spectra

The electronic absorption spectra of Cu(II) complexes show a strong band in the region of 25500–24400 cm^{-1}. These absorption bands can be assigned to the charge transfer transitions. A diffused reflectance spectrum suggests the appearance of this band in a similar range. The other weak band appearng in the range 13,430–12,500 cm^{-1} can be assigned to the d-d transition responsible for $^2E_g \rightarrow {}^2T_{2g}$ transitions suggesting an octahedral geometry of the complexes.

Antimicrobial Study

The biocidal activity of dihydrazides and their macrocyclic complexes has been observed by various workers. Benzoyl hydrazides or isonicotinoyl hydrazides were tested *in vitro* against bacteria *S. aureus* and *E-coli* and fungi *A. flavus* and *C. albicans*.

The biological activity data show that antimicrobial activity of ligands enchances several folds on complexation. This increase in antimicrobial activity is probably either due to faster diffusion of metal complexes as a whole through the cell membrane or due to the combined activity effect of the metal and ligand. The 'MIC' values of the compounds have been represented in Table-2.

TABLE-2

'MIC' VALUES OF THE LIGAND FRAGMENTS AND THE COMPLEXES (× 10^{-4})

S.No.	Compounds	*E. coli*	*S. aureus*	*A. flavus*	*C. albicans*
1.	[ODADH]	4.230	4.220	4.095	4.350
2.	[TDPDH]	4.220	4.210	4.080	4.260
3.	$Cu[DPAODAH](BF_4)_2$	0.253	0.259	0.166	0.256
4.	$Cu[DPATDPH](BF_4)_2$	0.237	0.241	0.175	0.310

The results of the antimicrobial studies follow the order given below:

Against bacteria:

$Cu[DPATDPH](BF_4)_2 > Cu[DPAODAH](BF_4)_2 >$ TDPDH > ODADH.

Against fungi:

$Cu[DPAODAH](BF_4)_2 > Cu[DPATDPH](BF_4)_2 >$ TDPDH > ODADH.

REFERENCES

1. R.C. Sharma, G. Mohan, S.P. Tripathi, and R.K. Shrivastava, *Indian Drugs*, **23**, 490 (1986).
2. M. Mathew, L.J. Palemic and G.R. Clerk, *Inorg. Chem.*, **12**, 446 (1973).
3. F.A. French and E.J. Blanz, *J. Med. Chem.*, **9**, 585 (1966).
4. H.G. Petering, H.H. Buskirk and G.E. Underwood, *Cancer Res.*, **64**, 367 (1964).
5. H.M. Mokhtar, *Pharamzie*, **34**, 130 (1971).
6. Q. Albert, *Nature*, **9**, 370 (1973).
7. M. Kodama and E. Kimura, *J. Chem. Soc., Chem. Commun.*, 326 (1975).
8. ———, *J. Chem. Soc., Dalton Trans.*, 116 (1976).
9. Y. Yochikawa, *Chem. Lett.*, **15**, 109 (1978).
10. H. Ray, B. Jeragh, S.P. Lincoln and G.H. Searle, *Inorg. Nucl. Chem. Lett.*, **14**, 435 (1978).
11. A. Bencini, L. Fabrizzi and A. Poggi, *Inorg. Chem.*, **20**, 2544 (1981).
12. K. Miysohi, H. Tanaka, E. Kimura, S. Tsuboyama. S. Murata, H. Shimizu and K. Ishizu, *Inorg, Chim. Acta*, **78**, 23 (1983).
13. S. Arpadjan, M. Mitewa and P.R. Bontchev, *Talanta*, **119**, 878 (1987).
14. P. Fux, J. Lagrange and P. Lagyrange, *J. Chem. Phys.*, **81**, 321 (1984).
15. J.P. Tandon, *Everyman's Science*, **22**, 29 (1987).
16. N.F. Curtis, *Coord. Chem. Rev.*, **3**, 3 (1986).
17. K.R. Adam, D.S. Baldwin, H.S. Duckworth, P.A. Lindoy, L.F. McPartilin, M. Bashhall, A. Powell and H.R.S. Taskepra, *J. Chem. Soc., Dalton Trans.*, **3**, 1127 (1992).
18. K.R.K. Adam, M. Baldwin, D.S. Brigden, H.S. Duckworth, P. Alindoy, L.P.K. Bashhall, A.M.C. Parthen and M.R. Taska, *J. Chem. Soc., Dalton Trans.*, **12**, 1869 (1992).
19. Rin Yzianoring, *J. Inorg. Biochem.*, **37**, 61 (1989).
20. D.H. Busch, *Helv. Chem. Acta*, 174 (1969); N.F. Curtis, *Coord. Chem. Rev.*, **3**, 3 (1969).
21. D.H. Busch, K. Farmery, V. Goedken, V. Katovic, A.C. Moelny, S.R. Sperati, S. Tokel and N. Aduan, *Chem. Ser.*, **100**, 44 (1979).
22. Bhagirathi Sahoo and J.S. Chakraborty, *Indian J. Chem.*, **23A**, 209 (1989).
23. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, 3rd Edn., Longmans, London, p. 1162 (1968).

(*Received:* 28 May 2001; *Accepted:* 30 August 2001) AJC-2414