A NEW METHOD OF SYNTHESIS OF THE LIGAND 2- AMINO -4- (P- DIHYDROXY PHENYL) THIAZOLE AND CHARACTERIZATIN OF ITS NICKEL (II), COBALT (II) AND COPPER (II) COMPLEXES

Dinkar Malik, Punam Yadav*, Sandeep Kumar
Department of Chemistry, M. S. College, Saharanpur U.P.

***Corresponding address*: Dr. Punam Yadav, New Madhonagar Saharanpur-247001 (U.P.)**

,

ABSTRACT

The ligand complexes of Ni(II), Co(II) and Cu(II) with 2 - amino -4- (p- dihydroxy phenyl) thiazole have been synthesized and characterized with the help of their elemental analysis, IR, electronic and magnetic susceptibility studies. From the analytical and spectral data the stoichiometry of these complexes have been found to be of the type ML_2X_2 (where M = Cu (II), Co (II) and Ni (II)}. It is found that Ni(II), Cu(II) and Co(II) complexes exhibit octahedral geometry. The fungicidal activities of ligands and metal complexes were screened by growth method against various fungi i.e. Drechslere setramera, Fusarium oxyporum, Macrophomera phaseoli at different concentrations. It is found that the activity decreases with decrease of concentration and the metal complexes are less toxic than the parent ligand.

Key Words: Thiazole Complexes, Heterocyclic Compounds, Toxicity, Fungicidal activity, Pharmacological Compounds**.**

INTRODUCTION

A wide variety of heterocyclic compounds have been explored for developing and designing pharmacologically important compounds, which can be preferred as therapeutic agents. These compounds display diverse pharmacological properties like anti-fungal, anti-viral, anti-bacterial, anti-tubercular etc. Prompted by such reports and in continuation of our work on heterocyclic compounds we report the synthesis and characterization of Cu(II),Co(II) and Ni(II) complexes with 2-amino-4-(p-dihydroxy phenyl) thiazole ligand. Heterocyclic compounds are cyclic compound containing a hetero atom in the ring. The common hetero atoms are oxygen, nitrogen and sulphur. Thiazole derivatives have attracted the interest because in addition to nitrogen atom, it has also sulphur atom which acts as donor site. The Schiff's base derived metal complexes were synthesized from divalent transition metals[1]. Schiff's base derived complexes of derivatives of DHA were also studied by many workers[2]. Several transition metal complexes of the ligand 2-amino-4-(p-hydroxy phenyl) thiazole were synthesized and screened for their fungicidal activities.[3]. Similar experiments on fungicidal and antimicrobial activites of Cu (II), Co (II) and Ni (II) Complexes with O, N, and S donor, their EPR and electronic spectral studies were also conducted by many workers[4-8]. Schiff's base derived complexes of derivatives of DHA, their spectra and synthesis under microwave irradiation were also studied by many workers[9-10]. The present paper deals with the preparation and characterization of Cu(II),Co(II) and Ni(II) complexes with 2-amino-4-(p-dihydroxy phenyl) thiazole. Metal complexes play an important role in biological activity. In many cases metal complexes are more potent than free ligands. The newly prepared complexes were also screened for their antifungal activity against different fungi at different concentrations[11].

EXPERIMENTAL

Materials and methods:

All the chemicals and reagents used were of anlytical grade; otherwise they were purified before use. Organic solvent used was absolute alcohol. IR spectra of the ligand and complexes are recorded in nujolmull. The fungicidal activity of ligands as well as complexes was determined by using the Growth method. The electronic spectra were recorded in MgO at room temperature on VSU-22 spectrophotometer. The measurements were carried out Guru Nanak Dev University, Amristar. Metal and oxygen contents of these complexes were estimated using the standard procedures reported in literature[12-13]. The estimation of carbon, hydrogen and nitrogen were carried out at BHU, Varanasi and

CDRI, Lucknow and results are given in Table 1. Magnetic measurements were carried out at IIT Roorkee at room temperature using Co [Hg (CNS)$_4$] as a calibrant.

Table 1

Elemental Analysis Data

Complexes	%Calc./ Obs.					
	C	H	N	S	O	M
$C_9H_8N_2O_2S$	51.92 51.80	3.84 3.79	13.46 13.41	15.37 15.31	15.38 15.33	-----
$[Cu(C_9H_8N_2O_2S)_2Cl_2]$	39.20 39.11	2.87 2.82	10.10 10.05	11.58 11.51	11.55 11.49	11.51 11.44
$[Ni(C_9H_8N_2O_2S)_2Cl_2]$	39.51 39.46	2.88 2.81	10.24 10.21	11.69 11.63	11.66 11.60	10.79 10.73
$[Co(C_9H_8N_2O_2S)_2Cl_2]$	39.49 39.43	2.89 2.83	10.22 10.17	11.70 11.64	11.68 11.61	10.77 10.74
$[Cu(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	44.16 44.10	3.66 3.62	9.35 9.29	10.69 10.64	21.40 21.36	10.59 10.55
$[Ni(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	44.50 49.48	3.68 3.62	9.41 9.36	10.75 10.70	21.57 21.51	9.91 9.88
$[Co(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	44.48 49.43	3.66 3.61	9.42 9.40	10.77 10.75	21.54 21.51	9.93 9.91
$[Cu(C_9H_8N_2O_2S)_2Br_2]$	33.78 33.72	2.48 2.41	8.77 8.72	10.08 10.04	10.06 10.01	9.31 9.28
$[Ni(C_9H_8N_2O_2S)_2Br_2]$	34.00 39.92	2.50 2.46	8.80 8.75	10.05 10.01	10.08 10.00	9.29 9.25
$[Co(C_9H_8N_2O_2S)_2Br_2]$	34.06 34.02	2.47 2.39	8.82 8.79	10.02 9.97	10.04 10.01	9.34 9.30

The ligand 2-amino-4-(p-dihydroxy phenyl) thiazole was prepared using the procedure reported in the literature[14].

Table 2

Characteristic IR bands of ligands and complexes

Complexes	IR Bands (cm^{-1})					
	vN-H	**vC-S**	**vC-H**	**vC=C**	**vC=N**	**vM-S**
$C_9H_8N_2O_2S$	3425-3265	685-675	3100-3060	1630-1570	1636-1590	--
$[Cu(C_9H_8N_2O_2S)_2Cl_2]$	3268-3152	655-649	3110-3080	1628-1572	1633-1595	256-230
$[Ni(C_9H_8N_2O_2S)_2Cl_2]$	3271-3149	657-651	3105-3075	1627-1571	1640-1599	270-250
$[Co(C_9H_8N_2O_2S)_2Cl_2]$	3273-3145	660-652	3108-3088	1621-1568	1637-1601	264-255
$[Cu(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	3274-3155	656-650	3107-3082	1632-1580	1628-1596	255-232
$[Ni(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	3273-3153	659-654	3108-3082	1626-1577	1636-1596	272-251
$[Co(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	3271-3149	661-655	3104-3094	1624-1571	1625-1594	266-257
$[Cu(C_9H_8N_2O_2S)_2Br_2]$	3270-3151	651-649	3105-3075	1634-1582	1630-1599	253-231
$[Ni(C_9H_8N_2O_2S)_2Br_2]$	3269-318	655-652	3109-3067	1629-1574	1638-1600	270-249
$[Co(C_9H_8N_2O_2S)_2Br_2]$	3273-3155	658-650	3106-3070	1627-1569	1629-1598	264-252

A shift in the vC-S and vN-H band frequencies is observed in all the complexes. This shows that the lone pair of electron presents on the sulphur atom of thiazole ring and nitrogen atom of free amino group is taking part in co-ordination (Table 2).

Table 3

(a) Electronic reflectance spectral data and their assignments of Ni(II) complex

Complexes	v_1	v_2	v_3	Dq	B	v_2/v_1	v_3(Calc.)
$[Ni(C_9H_8N_2O_2S)_2Cl_2]$	9988	16518	26500	999	1031	1.65	30146
$[Ni(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	10015	16514	26520	1002	1007	1.64	25997
$[Ni(C_9H_8N_2O_2S)_2Br_2]$	9997	16510	26534	1000	1019	1.65	26189

$v_1 = {}^3A_{2g}(F) \rightarrow {}^3T_{2g}(F)$, $v_2 = {}^3A_{2g}(F) \rightarrow {}^3T_{1g}(F)$ and $v_3 = {}^3A_{2g}(F) \rightarrow {}^3T_{1g}(P)$.

(b) Electronic reflectance spectral data and their assignments of Co(II) complex

Complexes	v_1	v_2	v_3	Dq	B	v_2/v_1	v_2(Calc.)
$[Co(C_9H_8N_2O_2S)_2Cl_2]$	9120	15245	18080	1010.6	663	1.67	19226
$[Co(C_9H_8N_2O_2S)_2(CH_3COO^-)_2]$	9098	15234	18070	1010.1	665	1.67	19199
$[Co(C_9H_8N_2O_2S)_2Br_2]$	9110	15340	18085	1010.9	664.0	1.68	19219

$v_1 = {}^4T_{1g}(F) \rightarrow {}^4T_{2g}(F)$, $v_2 = {}^4T_{1g}(F) \rightarrow {}^4A_{2g}(F)$ and $v_3 = {}^4T_{1g}(F) \rightarrow {}^4T_{1g}(P)$.

(c) Electronic reflectance spectral data and their assignments of Cu(II) complex

Complexes	v_1	v_2	v_3	Dq	B	v_2/v_1	v_2(Calc.)
$[Cu(C_9H_8N_2O_2S)_2Cl_2]$	15100	--	--	1510	--	--	--
$[Cu(C_9H_8N_2O_2S)_2(CH_3COO)_2]$	15084	--	--	1508	--	--	--
$[Cu(C_9H_8N_2O_2S)_2Br_2]$	15092	--	--	1509	--	--	--

$v_1 = {}^2E_g \rightarrow {}^2T_{2g}$.

CZ-record UV-Viz. spectrometer provided with an automatic recorder was used to record the electronic spectra of the complexes in ethanol at room temperature (Table 3).

Preparation of metal complexes

In general all these complexes were synthesized by refluxing the respective metal salts with ligand 2-amino-4-(p-dihydroxy phenyl) thiazole in 1:2 molar ratio in ethanolic medium on water bath for one hour. The solution was concentrated to half of its volume then it was kept for some time. The crystals of complexes separated out which were filtered, washed with alcohol and dried in vacuum. Similarily some complexes of thiazole were also synthesized by many workers[15-22].

RESULTS AND DISCUSSION

Adducts of all the complexes were prepared by refluxing the respective metal salts with ligands in 1:2 molar ratio in ethanolic medium. The crystals of complexes separated out which were filtered, washed with alcohol and dried in vacuum.

IR Studies: The v (C=N) band frequencies in the free ligand are completely unaffected on complexation. The unchanged position of the band indicates that the ring nitrogen does not take any part in the coordination. The band observed at 650 cm^{-1} in the free ligand assigned to asymmetric v (C-S) is shifted to lower frequency after complexation. But the symmetric v (C-S) frequency obtained at 685-675 cm^{-1} completely disappears or intensity of this band is reduced after complexation. These facts confirm that the ring sulphur is taking part in complex formtion. The v(N-H) asymmetric and symmetric stretching frequencies appearing in the region 3425 and 3265 cm^{-1} respectively, also decreases in the complex. This shows that the lone pair of electron available on nitrogen atom took part in coordination. From the above observation it is clear that the nitrogen of the $–NH_2$ group and ring sulphur take part in coordination.

Electronic Reflectance Spectral Studies: The observed electronic reflectance spectra of Ni (II) complexes are similar to those reported in the adducts of Ni complexes. The bands around 10015 – 9988 cm^{-1}, 16518-16519 cm^{-1} and 26534- 26500 cm^{-1} are assigned to the $^3A_{2g}$ (F) → $^3T_{2g}$(F) (v_1) , $^3A_{2g}$(F) → $^3T_{1g}$ (F) (v_2) and $^3A_{2g}$(F) → $^3T_{1g}$ (P) (v_3) transitions respectively (Table 3a). The ratio v_2/ v_1 which lies around 1.8 for perfectly octahedral Ni(II) complexes is found to lie at 1.65. The ratio was expected to lie still lower because of the large value of Dq but this is not so because the environment is tetragonal which splits the two T_{2g}(F) and T_{1g}(F) terms into E + B_2 and A_2 + E terms. The repulsion between the two E terms is expected to raise the value of $v_2/ v_.$ The value is however is raised only to a small extent suggesting that the splitting is weak and that the environment is quite close to an octahedral one[23]

.

The electronic reflectance spectra observed for Co (II) complexes are similar to spectra of those complexes in which Co (II) ion has been reported to be in an octahedral environment. Various band positions, their assignments and some of the evaluated parameters are given in table 3b. Observed bands around 9120 – 9098 $cm^{-1}$and 15245-15234 cm^{-1} have been assigned to $^4T_{1g}$ (F) → $^4T_{2g}$(F)(v_1) and $^4T_{1g}$(F) → $^4A_{2g}$ (F)(v_2) transitions respectively. The band due to the third transition $^4T_{1g}$ (F) → $^4T_{1g}$ (P) (v_3) is partially hidden under the strong band due to π-π* transition. The theoretically calculated value of v_2 lie higher than the values assigned from the spectra. The ratio v_2/ v_1 which lies around 1.8 for perfectly octahedral Co(II) complexes is found to lie at 1.67.

The magnetic moment values of Cu (II) complexes are in the range of 1.81-2.09 B.M. These values supported the distorted octahedral and square planar configuration respectively. The electronic spectra of 15092-15100 cm^{-1} assignable to ^2E_g → $^2T_{2g}$ (v_1) transition supporting octahedral configuration.

The fungicidal activities of the ligand as well as of metal complexes were screened against different fungi at different concentrations 100, 50 and 20 ppm in Czapek's dox agar medium. It has been observed that the fugitoxicity of the metal complexes are lesser than the free ligand. This might be due to the fact that the group which is responsible for toxicity is not free in complexes due to co-ordination however it is free in ligand. The ligand as well as the metal complexes is most toxic at higher concentration i.e. the fungicidal activity decreases with the decrease of concentration.

Acknowledgement

We gratefully acknowledge to Dr. K.K. Sharma, Principal M. S. College, Saharanpur (U.P.) for providing necessary facilities.

REFERENCES

1. Khamamkar Ashwini, Pallapothula Rao Venkateshwar. Synthesis, Spectral Characterization and Biological activity of Schiff's base derived metal complexes. J. Ind. Council Chem.2012; .29(1&2); 71-76.
2. Mane PS, Shirodkar SG, Arbad BR, Chondhekar TK I. JC, Sec A; Inorganic, Bio-inorganic, Physical & Analytical Chemistry, 2001; 40A(6); 648.
3. Malik Dinkar, Yadav Punam, Kumar Sandeep, Malik Vijai Studies on Structural and biological aspects of transition metal complexes of the ligand 2-amino-4-(p-hydroxy phenyl) thiazole. Discovery Pharmacy 2013; 5(15); 15-17.
4. Shriodkar SG, Mane PS, Chondhekar TK Synthesis and fungitoxic studies of Mn(II), Co(II), Ni(II) and Cu(II) with some heterocyclic Schiff base ligands, *Indian J. Chem,2001;* (40A); 1114-1117.
5. Chandra S, Sangeetika J. EPR and electronic spectral studies on copper(II) complexes of some N-O donor ligands, *J. Indian Chem*. *Soc*.2004; 81; 203.
6. Belaid S. Landreau A. Benali-Baitich O. Khan M.A., Bouet G Synthesis, characterisation and antifungal activity of a series of cobalt(II) and nickel(II) complexes with ligands derived from reduced N, N'-ophenylenebis (salicylideneimine), *Trans. Met. Chem.*2008; 33, 511.
7. Ravanasiddappa M, Sureshg T, Syed K, Radhavendray SC, Basavaraja C, Angadi S D Transition Metal Complexes of1, 4(2'-Ethoxyphenyl-1-yl) di-iminoazine: Synthesis, Characterization and Antimicrobial Studies, *E-J. Chem*. 2008; 5(2); 395-403.
8. Mapari AK, Mangaonkar KV. Synthesis, Characterization and Antimicrobial Activity of Mixed Ligand Complexes of N-(2-ethoxy-1-naphthylidene)-2,6-diisopropylaniline and N-(2-ethoxybenzylidene)-2,3-dimethylaniline with Co(II), Ni(II), Cu(II) and Zn(II) ions. *International Journal of ChemTech Research.*, 2011; 3(2); 636-641.
9. Manch W, Conard Fernelius W., The Structure and Spectra of Nickel(II) and Copper(II) Complexes, *Journal of Chemical Education.*1961; 38 (4); 192-201.
10. Naik B, Desai K. Novel approach for the rapid and efficient synthesis of heterocyclic Schiff bases and azetidinones under microwave irradiation, *Indian journal of chemistry.*, 2006; 45(B); 267-271.
11. Bharti SK, Nath G, Tilak R, Singh SK. Synthesis, anti-bacterial and anti-fungal activities of some novel Schiff bases containing 2,4-disubstituted thiazole ring. *Eur J Med Chem,* 2010; 45; 651-660.
12. Vogal AI. *Quantitative Organic Analysis*., 1958.
13. Vogal AI. *A Text Book of Quantitative Inorganic Analysis*. 3rd ed. (English Language Book Society and Longman)., 1961.
14. Dodson RM, King LC. The reaction of ketones with halogens and thiourea *J. Am. Chem. Soc.* 1945; 67; 2242.
15. Reddy V, Patil N, Angadi SD. Synthesis, Characterization and Antimicrobial Activity of Cu(II), Co(II) and Ni(II) Complexes with O, N, and S Donor Ligands, *E-J. Chem*.2008; 5(3); 577-583.
16. Karegoudar P, Karthikeyan MS, Prasad DJ, Mahalinga M, Holla BS, Kumari NS. Synthesis of some novel 2,4-disubstituted thiazoles as possible antimicrobial agents. *Eur J Med Chem,* 2008; 43; 261-267.
17. Khalil AM, Berghot MA, Gouda MA. Synthesis and antibacterial activity of some new thiazole and thiophene derivatives. *Eur J Med Chem.* 2009; 44; 4434-4440.
18. Aridoss G, Amirthaganesan S, Kim MS, Kim JT, Jeong YT. Synthesis, spectral and biological evaluation of some new thiazolidinones and thiazoles based on t-3-alkyl-r-2, c-6-diarylpiperidin- 4-ones. *Eur J Med Chem.* 2009; 44; 4199-4210.

19. Giri RS, Thaker HM, Giordano T, Williams J, Rogers D, Sudersanam V et. al. Design, Synthesis and characterization of novel 2-(2,4- disubstituted-thiazole-5-yl)-3-aryl-3H-quinazoline- 4-one derivatives as inhibitors of NF-IB and AP-1 mediated transcription activation and as potential anti-inflammatory agents. *Eur J Med Chem.* 2009; 44; 2184-2189.
20. Dawane BS, Konda SG, Mandawad GG, Shaikh BM. Poly(ethylene glycol) (PEG-400) as an alternative reaction solvent for the synthesis of some new 1-(4- (4-chlorophenyl)-2-thiazolyl)-3-aryl-5-(2-butyl-4-chloro-1H-imidazol-5yl)-2-pyrazolines and their in vitro antimicrobial evaluation. *Eur J Med Chem.* 2010; 45; 387-392.
21. Adibpour N, Khalaj A, Rajabalian S. Synthesis and antibacterial activity of isothiazolyloxazolidinones and analogous 3(2H)-isothiazolones. *Eur J Med Chem.,* 2010; 45;19-24.
22. Arshad A, Osman H, Bagiey MC, Lan CK, Mohamad S, Safirah A et. al.. Synthesis and antimicrobial properties of some new thiazolyl coumarin derivatives. *Eur J Med Chem,* 2011; 1-7.
23. Earnshaw A, Introductio to *Magnetochemistry*. Academic Press. New York.; 1968.