Research Article [Borhade, 3(1): Jan., 2012]
ISSN: 0976-7126

INTERNATIONAL JOURNAL OF PHARMACY & LIFE SCIENCES

Synthesis, characterization and antimicrobial activity of copper (II) with 2-chloroquinoline-3-carbaldehyde thiosemicarbazide {1-((2-chloroquinolin-3-yl)methylene) thiosemicarbazide (2-chloro-QAT)

Shobha Sakharam Borhade
Department of Chemistry, S.M.B.S.T College Arts, Science and Commerce Sangamner,
University of Pune Sangamner, Ahmednagar, (MH) - India

Abstract

Synthesis of 2-Chloroquinoline-3-carbaldehyde Thiosemicarbazide {1-((2-Chloroquinolin-3-yl) methylene} Thiosemicarbazide (2-Chloro-QAT), Melting point Elemental analysis, XRD, Effect of diverse ion and Antimicrobial Activity are studied. A simple,sensitive and specific spectrophotometric method for the determination of Cu (II) is developed based on the colour reaction between Copper (II) and 2-Chloroquinoline-3-carbaldehyde thiosemicarbazide{1-((2-Chloroquinolin-3-yl)methylene) thiosemicarbazide (2-Chloro-QAT). The optimum condition for complete colour development has been established by studying parameters like effect of medium, reagent concentration, time period. Stability constant, Dissociation constant and Change in free energy of the complex are determined. Composition of metal and ligand has been determined by Job's variation and mole ratio method. Application of this 2-Chloro-QAT for antimicrobial activity has been performed.

Key-Words: Copper (II), 2-Chloroquinoline-3-carbaldehyde, Thiosemicarbazone (2-Chloro-QAT), Spectrophotometry, Antimicrobial Activities

Introduction

The abundance of copper is 70 parts per million in the igneous (Volcanic) rocks of the earht's crust. Copper is not abundant but it is widely distributed as metal in sulfides, arsenides, chloride and carbonates. The commonest mineral is chalcopyrite $CuFes_2$. Metal complexes of some peptide derivative complex formation of copper (II) with N-benzensulfonamides of some dipeptides have been reported [1]. Detection of Copper (II) & Cadmium (II) without cyanide in qualitative analysis have been done by Chakraborty [2]. Equillibrium study on the mixed ligand complex formation of copper (II) with boric acid & (N, N) bidentate ligands have been studied by Mukherjee [3].The complex of copper (II), nickel (II) & cobalt (II) with schiffs base derived from 2-thiophenecarboxaldehyde & 2-monopropanolamine have been prepared [4].

* Corresponding Author
E-mail: borhadeshobha@gmail.com
Mob.: +919960872151

Copper (II) compound has a distorted octahedral geometry. Studies on complexes of copper, cobalt, nickel, zinc & cadmium with Schiff base derived from 3-aminodibenzofuran and salicyaldehyde have been studied by Kriza [5].Studies on the solution equilibra involved in some copper (II) & zinc (II) Schiff base complex systems have been carried out [6] .Complexation of nickel,cobalt & copper (II) with L-3,4-dihydroxy-phenylalanine kinetic studies have been reported[7].

Synthesis,structural & electrical studies of cobalt,nickel,copper & zinc (II) polymeric complexes have been studied[8] .Synthesis & antibacterial activity of copper (II) complexes with 2-(Thiomethyl-2'-benzimidazolyl)-1,3 diazacyclopentadec-Δ'-ene have been studied [9]. Chealting resin containing s-bonded dithizone for the separation of copper (II) was studied by Shah[10] .Potentiometric study of copper (II) complexation with two high molecular weight poly (acrylic acids) have been done [11] .Potentiometric studies of copper (II) with 5-aryl-1-phenyl-4-pentene-1,3-diones have been done by Venugopalan [12].Complexation kinetics

ISSN: 0976-7126

of copper (II) with L-α-Amino-δ-guanidinovaleric acid have been studied by Malhotra [13] .Patnaik [14] have studied the complex formation of copper with D (+) – Saccharic acid. Synthesis and characterization of copper complexes of morin have been studied [15] .The simultaneous determination of copper in human plasma & urine by inductively coupled plasma mass spectrometry (ICPMS) is discussed [16].Copper (II) complexes of Schiff bases with N or S donar sites have been studied [17] .

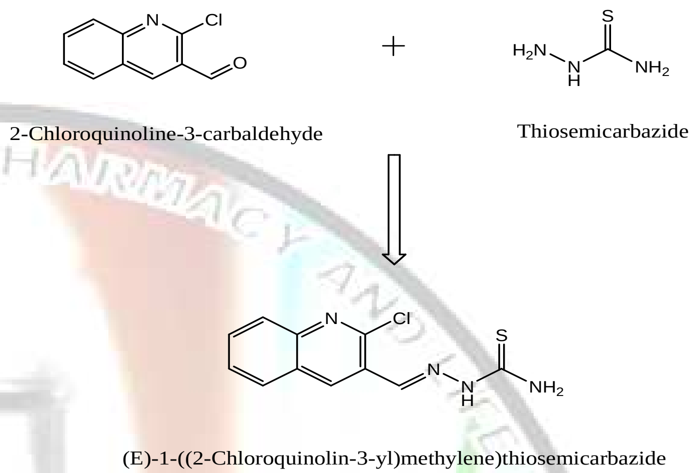
Thiosemicarbazones usually react as chelating ligands with tranisition metal ions by bonding through sulphur and nitrogen atoms [18]. Thiosemicarbazones have been frequently used for spectrophotometric determination of inorganic ions and their analytical potentialities have been reviewe[19,20]. Thiosemicarbazone are important organic analytical reagents for the determination of metal ions in microgram quantities. They form coloured complexex with many metal ions and act as good chealating agents. In addition to the analytical utility [21, 22] Metal complexes formed with these reagents are of great medicinal value in the treatment of diseases like influenza [23], protozoa [24], smallpox [25]. Tumors [26] and pesticides [27]. A large number of thiosemicarbazides have been found to posses good antibacterial[28],antifungal[29],herbicidal[30],andantiacetylchlinesterase[31,32]activities.Thepharmacological importance of metal complex with heterocyclic thiosemicarbazones [33] .

Methodology

An Elico UV-visible spectrophotometer model UV-SL-164 equipped with 1 cm quartz cell used for spectrophotometeric measurements. An Elico pH meter LI-610 is used for the pH measurements. The chemicals used are of AR grade. X-RD was taken on PW 3710 diffractometer using CuK_2 radiation has been taken on the instrument BRUKER AC 300F.Elemental analysis and antimicrobial activity was done in Laboratory approved by Central Government for AGMARK.

Synthesis of 2-Chloro-QAT

2-Chloroquinoline-3-Carbaldehyd Thiosemicarbazide{1-((2-Chloroquinolin-3-yl)methylene) thiosemicarbazide (2-Chloro-QAT) is prepared by taking equimolar quantity of 2-Chloroquinoline-3-Carbaldehyde & thiosemicarbazide in methanol and reflux 74 hours or more. It was allowed hydroxide to stand at room temp until the yellowish crystals were found.



The crude product is crystallized in methanol. The recrystallized product has melting point is 227^0C and molecular weight by formula is 252.5.

Characterization of 2-Chloro-QAT

Absorption Spectra of 2-Chloro-QAT was recorded against a blank solution containing buffer (pH=2) and is shown in fig 1. Absorption spectra were recorded in the wave length range 250-570 nm. The complex shows an absorption maximum at 285 nm. At 285 nm wavelength the molar absorptivity of 2-Chloro-QAT is 0.9750 x 10^3 L.mol^{-1}.cm^{-1}.

Elemental analysis of 2-Chloro-QAT

The elemental analysis of 2 -Chloro-QAT was done in Laboratory approved by Central Government for AGMARK. It shows the result of elemental analysis in Table 1.

X-RD of 2-Chloro-QAT

X-RD spectra of 2-Chloro-QAT was taken on PW 1710 diffractometer using CuK_2 radiation (Wavelength 1.54060 to 1.54438 A^0) .The X-RD diffraction of 2-Chloro-QAT was recorded at angle 2Ø from 20.000-80.000. The data of X-ray diffraction of 2-Chloro-QAT were presented in Table 2. And X-ray spectrum in fig.2. For the determination of structure Hesse-Lipson procedure is used [34].

Antimicrobial Activity of 2-Chloro-QAT

Antimicrobial Activity of 2-Chloro-QAT has been done in the Laboratory approved by Central Government through AGMARK. The results are noted in Table 3.

Effect of Reagent concentration

Effect of Reagent concentration was studied by taking varying amount of reagent and fixed amount of Cu (II). Optimum pH of solution was maintained 1.988. It was noted that 0.13 ml reagent is sufficient for complete colour development. However by adding excess of reagent there is no substantial change in the absorbance value. Effect of reagent shown in fig. No.3.

ISSN: 0976-7126

Validity of Beer's Law

For the study of Beer's law the solutions were prepared which containing different amounts of Cu (II), same amount of 2-chloro-QAT and 1 ml of pH 2. It indicates that the validity of Beer's law obeys upto 10 ppm.is shown in fig.No. 4.

Composition of Complex

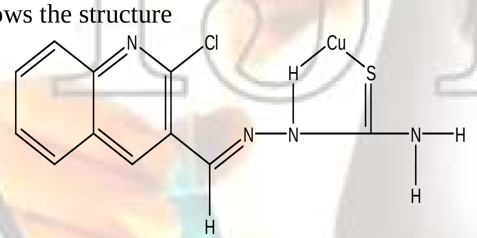
The composition of the Cu (II)-2-chloro-QAT complexes is found to be 1:1. It was determined by studying Job'S method. The ratio of metal ion to ligand molecule in the coloured complex was found to be 1:1.Composition of complex shown in fig No.5.

Physico-chemical Characteristic of Cu (III)-2-chloro-QAT

Physico-chemical and Analytical Characteristic of Cu (II)-2-chloro-QAT was studied and given in Table 4.and Tolerance limit of diverse ions in the determination of 2-Chloro-QAT shown in Table No. 5.

Results and Discussion

The Cu (II)- 2-ChloroQAT shows an absorption maximum at 285 nm. At 285 nm wavelength the molar absorptivity of 2-Chloro-QAT is 0.9750 x 10^3 $L.mol^{-1}.cm^{-1}$. The 0.13 ml reagent is sufficient for complete colour development. And the Beer's law obeys upto 10 ppm. The ratio of metal ion to ligand molecule in the coloured complex was found to be 1:1. The stability constant, Dissociation constant and change in free energy are 3.3400 x 10^8, 2.994 x $10^{-9}$and -11623.48 Cal /mole respectively. The Sandell's Sensitivity is 0.003321 µg $/cm^2$.The XRD- of complex shows the structure



References

1. G. N. Mukherjee and P. K Chakraborth. (2002). *J. Indian Chem. Soc*., **79**:137-141.
2. Anupam Chakraborty, Arindam Chakraborty and A.K. Chakravarti (2002). *J. Indian Chem. Soc.*, **79**: 98,197.
3. Mukherjee C.N., Das Ansuman (2000). J. Indian Chem. Soc., **77**: 62-65.
4. Angela Kriza, Cezar Spinu and Maria Pleniceanu. (2000). *J. Indian Chem. Soc.*, **77**: 83-84.
5. S. Sujatha, T.M. Rajendiran, R. Kannappan, R. Venkatesan and P. Sambasiva Rao (2000). *Pro. Indian Acad. Sci*. (*Chem. Sci*.), **112**:559-572.
6. Yadollah Yamini and Atefeh Tamaddon (1999). *Talanta*, **49**:119-124.
7. I. H. Scheinberg, A.G. Morell, Ceruloplasmin and G.I. Eichhorn (Edn.) (1973). *Inorganic Biochemistry*, Elsevier New York, 1: 306-343.
8. L Mishra and Ragini Singh (1999). *J. Indian.Chem. Soc*., **76**:500-502.
9. Rupal Shah and Surekha Devi (1999). *Talanta*, **45**:1089-1096.
10. Catherine Morlay, Monique Cromer and Yolande Mouginot (1998). *Olivieri Talanta*, **45**: 1177-1188.
11. P Venugopalan and K. Krishankutty (1998). *J. Indian Chem. Soc.*, **75**:98-99.
12. Masaaki Tabata and Hirofumi Morita (1997). *Talanta*, **44**:151-157.
13. H.C. Malhotra and Amita Kumar (1997). *J. Indian Chem. Soc.*,**74**: 220-221.
14. S. Patnaik and C. Panda (1997). *J. Indian Chem. Soc.*, **74**:216-217.
15. J. Szpunar, J. Bettmer, M. Robert, H. Chassaigne and K. Cammann (1997). *Talanta*, **44**:1389-1396.
16. C.K. Bhaskare and P.P. Hankare (1995). *J. Indian Chem. Soc*., **72**: 585-587.
17. N.Agnihotri, R. Das and J.R. Mehta (1999). *J. Indian Chem. Soc*., **76**: 165-167.
18. A.Wasey, B.K. Puri, M.C. Mehra, M. Satake and M. Katyal (1984). *Curr. Sci*, **53**: 745.
19. K. Singh, R.K. Sharma and S.K. Sindhwani (1986). *Bull.Chem. Soc*., **59:** 1223.
20. K.M.M.S. Prakash, L.D. Prabhakar and D.V. Reddy (1987). *Anal.Let*, **20**: 959**.**
21. G.V.R. Murthy and T.S. Reddy (1993). *Asian J.Chem.*, **5**:1133**.**
22. Hong Liang, Rui-Xiang Hu and Kai-Bei Yu (2000). *J.Indian Chem. Soc.*, **77**: 486-487**.**
23. R.P. Bhamaria and C.V. Deliwala (1968). *Indian J. Exp.Biol***.**, **6**: 62.
24. J.M. Vender Kerk (1968). *Proc.Brit Insectic Fungi Conf.*4th, **2**:562.
25. C.W. Pluygers (1966). *Sijpeslejn Kaars Ann.Appl.Biol.*, **57**: 465**.**
26. W.E. Anthrolini and J.M. Knight Petrl (1976). *J.Med.Chem.*, **19**:339.
27. Silvera Scaccia (1999). *Talanta*, **49**: 467-472**.**
28. M.S. Baydanova ans G.N. Pesshin (1988). *Russ Phar Toxic*, 348.
29. K. Buter (1968). U.S.Patent No., **3**: 382.
30. D. J. Buter (1963). *Lancet*, **20**: 494.

31. C.W. johson,Antibiotics and Chemotherapy **(1992),** 2,636.
32. F. Hao, B. Paull and R.P. Hadded (1996). *Chromatographia*, **42**: 690.
33. N. G. Gavande, P.N. Mandhare, G.V. Shinde and M.S.Shingare (1987). *Anta Giencia Indica*, Vol.XII C. No.**, 2**:109.
34. C.L. Jain, P.N. Mundley and R. Bajaj (1992). *J. Indian Chem. Soc.***, 69**:777**.**
35. K. Devendra, Dwivedi, V. Badro, S. Agarwala and K. Dey (1990). *J. Indian Chem. Soc*, **67**: 339-340**.**
36. Merrill and Wicox (1968). *J. Oried. Chem.*, **11**: 171**.**
37. S .S. Tiwari, A.K. Sengupta and J. Kumar (1974). *J. Indian Chem. Soc*., **51**: 402.
38. Z.Guo, P.J. Sadlar Metals in Medicine and Angew Chem (1974). *Int. Ed. Engl*., **38:** 1512.
39. L.V. Azdroff and M.J. Buerger (1958). The Powder Method-Analytical Method for indexing power photography, MC Graw Hill Book Co. Inc., NY, 83.
40. P. Job (1928). *Ann.Chim*, Paris, 113.
41. L .H. Yoe and A. K. Jones (1944). *Ind. Eng.Chem. Anal.Ed.*, 16:111**.**
42. A.I. Vogel (2000). *Vogel's Qualitative Inorganic Analysis*,6th Edn. Rev. by G. Svehla.
43. L. D. Lee (1983). *A New Concise Inorganic Chemistry*, 3rd Edn 411-413.

Table 1: Elemental analysis of 2-chloro-QAT

S/No.	Chemical Analysis	Percentage Found	Percentage Expected
1	Carbon	48.38	47.52
2	Hydrogen	04.02	03.56
3	Sulphur	13.24	12.67
4	Nitrogen	22.60	22.18
5	Chlorine	14.33	14.06

Table 2: XRD for 2-chloro-QAT (Powder method)

S/No.	2Ø	hkl	Sin^2 Ø Observed	Sin^2 Ø Calculated	d (A^0) Observed	d (A^0) Calculated
1	25.695	211	0.04960	0.05162	3.4556	3.9556
2	28.350	211	0.04653	0.05068	3.8159	4.0556
3	30.950	220	0.07102	0.07998	2.8901	2.9102
4	35.500	222	0.08065	0.07225	2.4279	2.3093
5	44.730	210	0.03950	0.03950	4.6603	3.8753
6	50.775	211	0.05980	0.04780	4.4828	4.5220
7	53.330	110	0.06321	0.06821	3.8984	3.8779
8	72.520	111	0.07881	0.07328	3.9806	3.9857
9	74.720	111	0.08341	0.08333	4.0525	4.9765

a = 9.3682 b = 6.8990 c = 8.2506

Table 3: Antimicrobial activity of **2-Chloro-QAT**

S/ No.	Antimicrobial	Activity
1	Klebsiella Pneumoniae	Nil
2	Vibriae Cholerease	Nil
3	Bacillus Megaterium	Nil
4	Salmonalla typhi	Nil
5	Shigella Flexneri	Nil

Table No. 4. Physico-chemical and analytical characteristic of **2-chloro-QAT**

S/No.	Characteristics	Result
1	Absorption Spectra	285 nm
2	Molar absorptivity	0.9750×10^{3} Lit. mol^{-1}. cm^{-1}
3	pH range (optimum)	2.0
4	Reagent required for maximum complexation	0.13ml
5	pKa	6.587×10^{8}
6	Beer's law validity range (ppm)	10 ppm
7	Composition of complex (M : L)	1:1
8	Stability Constant	3.3400×10^{8}
9	Dissociation Constant	2.994×10^{-9}
10	Change in free energy	-11623.48 Cal /mole
11	Sandell's Sensitivity (μg /cm^2)	0.003321 μg /cm^2

Table 5: Tolerance limit of diverse ions in the determination of 2-chloro-QAT

S/ No.	Metal ion	Salt	Interference
1	Mg (II)	$MgSo_4$	76
2	Au (II)	$CuSo_4$	98
3	Cd (II)	$CdCl_2$	54
4	Mn (II)	$MnCl_2$	27
5	Co (II)	$CoSo_4$	Interferes
6	Ce (IV)	$Ce (So_4)_2$	43
7	Ba (II)	$BaCl_2$	42
8	Cr (III)	$K_2Cr_2O_7$	06
9	Hg (II)	$HgCl_2$	09
10	Ti (V)	K-titanyl oxalate	18
11	Ni (II)	$NiCl_2$	14
12	Sn (II)	$SnCl_2$	23
13	Pb (II)	$PbSo_4$	54
14	V (v)	V_2O_5	Interferes
15	Zn (II)	$ZnSo_4$	36
16	Al (III)	$AlCl_3$	Interferes
17	Pd (II)	$PdCl_2$	Interferes
18	Ni (II)	$NiCl_2$	23

ISSN: 0976-7126

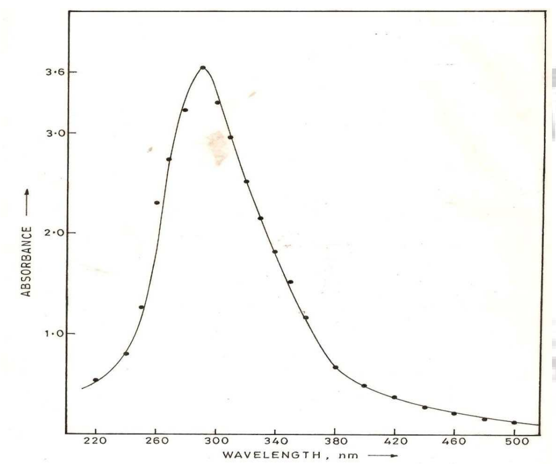


Fig. 1: Absorption spectra of 2-chloro-QAT

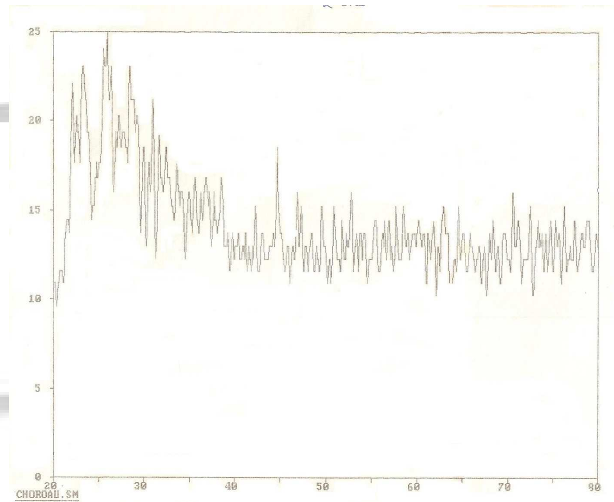


Fig. 2: X-RD of 2-chloro-QAT

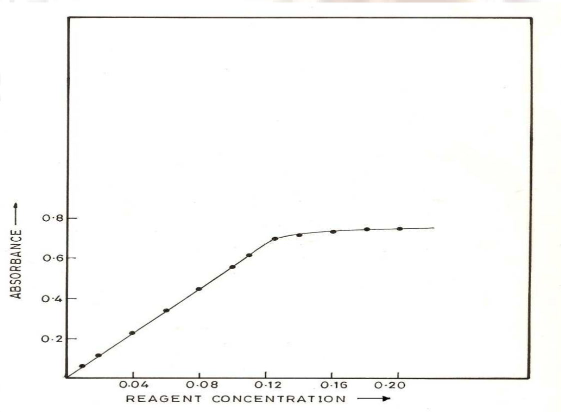


Fig. 3: Effect of Reagent concentration

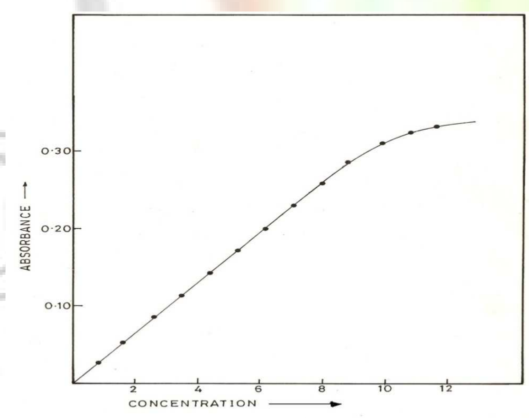


Fig. 4: Validity of Beer's Law

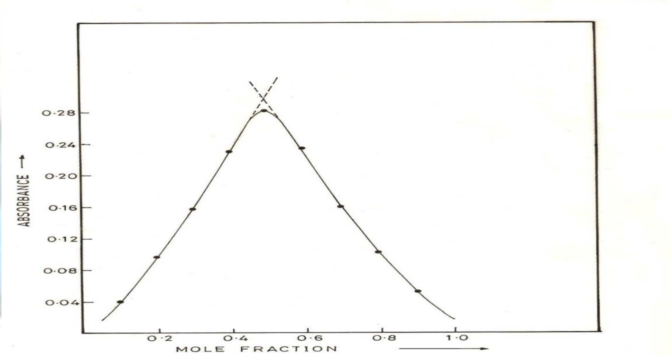


Fig. 5: Composition of Complex