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Spectroscopic, potentiometric and Antimicrobial Activity of Ni(II) and Cu(II) Complexes with Schiff base Derived from salicylaldehyde and 2-aminophenol

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ABSTRACT

The Schiff base chelate of Cu(II) and Ni(II) derived from condensation reaction of salicylaldehyde and 2-aminophenol have been synthesized and investigated by different physicochemical techniques. The resulting complexes were characterized by elemental analysis, molar conductance, FT-IR, melting point or decomposition measurements, solubility in different solvent. The elemental analysis data show the formation of 1:1 metal to ligand ration. The Schiff base act as a tridentate ligand, coordinated through daprotonated phenolic oxygen and azomethine Nitrogen atom. The synthesized chelates were assayed for antibacterial activity against some pathogenic bacteria:Staphylococcus aureus, and Escherichia coli, and the fungi: Aspergillums niger and Candida albican, using dics diffusion method. The synthesized Schiff base complexes exhibit higher antimicrobial activity than the free Schiff base due to the chelation.

Introduction

Schiff base compounds have been widely studies and used attracting much attention to both organic synthesis and metal ion complexation reaction. Schiffbases are obtained from condensation reaction of either an aldehyde or ketone with an amine to form stable compound containing of –C=N group called Imine (Pierre, 1987). The Schiff bases are characterized by the resultant imine functional group and for binding metals ion via the N-atom lone pair especially in combination with one or more donor atoms to form polydentate or chetating ligand. The importance of Schiff base is due to its versatile nature and ability to react with metals generally. Schiff bases and their transition metals complexes have been known, the complexes are form by the interaction between metal ions and ligands (Schriver*et al.*, 1994). This is done by the donation of one or more lone pair(s) of electrons in the ligand to the metal empty d-orbital of suitable energy. The coordination result in the formation of neutral cationic and anionic complexes (Hridia*et al.*, 1995).Tsumaki, (1983) reported [Co(sal$_2$-en) Complex which received a great attention following to its ability toundergo reversible adduct formation with molecular oxygen. The oxygenation ability of the complex was first recognized by Hassan *et al*, (1998), however, the mechanism for the oxygenation process was not well understood until recently with the advent of modern physical techniques. Inanother report, Xishi*et al.* (2003) described the synthesis and spectroscopic properties of manganese(II), cobalt (II) and copper (II) complexes with novel Schiff base ligand derived from 2, 2' bis(p-methoxylphenylamine) and salicylic aldehyde.Transition metal Schiff base complexes are used in various fields, such as medicine, agriculture, industries etc. Example, [Co(acac$_2$-en)] in dimethylformamide, pyridine and substitutedpyridines proved to be involved in oxygen metabolism (Hanna and Mona, 2001).The family of Schiff bases is important intermediates for the synthesis of some bioactive compounds such as β-lactam (Thomas, 2007). Furthermore, they are reported to show a variety of interesting biological actions including antibacterial (Jarrahpour*et al.*, 2004; Baluja*etal.*, 2006) and antifungal (Dhakery and Saxena, 2007; Dash *et al.*, 1987; Patel and Jejurka, 1994) and catalysts (Nashinaga*et al.*, 1998). Oxovanadium Complexes have been found strongly active, against some type of Leukemia (Dong et al, 2002). Transition metal complexes derived from a number of amino acids have been reported to have biological activity (Zahid et al, 2007).A method for controlling bacterial and fungal diseases in plants by applying chelate complexes is used to control fungal infection which course pre-harvest damage to crops by killing them so as to decrease yield and render the plants susceptible to other infection. Recent advance in research in Schiff base and their transition metals complexes has shown that, Vanadium containing compounds have utility as insulin is also suggested that Vanadium compounds has acted as anti-tumor agent. This stimulated their designed and synthesis for biological significance and natural process transfer (Tuoviren*etal.*, 1988).

This paper reports synthesis, spectroscopic, potentiometric and biological activity of nickel (II) and copper (II) complexes with schiff base derived from Salicylaldehyde and 2-aminophenol

Experimental

All chemicals used in this work were reagent grade obtained from Sigma Aldrich, United Kingdom and used without further purification. All weighing were observed on electrical mettle balance model AB54, pH measurement were performed using a jenway pH meter model 3320. Conductivity was measure using jenway conductivity meter model 4010. Infra-red spectral analysis were recorded using Perkin Elmer spectrum 100fourier transformer IR spectrometer model within the range of 500-400cm^{-1}. The invitro antimicrobial activity were performed using disc diffusion method, the two pathogenic bacteria viz*Escherichia coli and staphylococcus aurous* and two fungi *Aspergillum nigerand Candida albican* were obtained from

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Preparation of Schiff base

Schiff base was prepared by reacting 1.7g (0.014mol) of Salicylaldehyde in 20cm^3 absolute ethanol and 1.5g of O-aminophenol in 30cm^{3}absolute ethanol. The mixture was concentrated by heating to 25cm^{3}and then cooled in an ice-bath. An orange crystalline product was formed, washed with hot ethanol before recrystallizing from ethanol and drying in vacuum desiccators over phosphorus pentoxide for two days (Islam *et al.,* 2001).

Preparation of Copper (II) and Nickel (II) Complexes

A 25cm^3 of ethanolic solution of Cu(II) or Ni(II) chloride was added to 30cm^3 of ethanolic solution of the prepared Schiff base. The resulting mixture was boiled on a water bath for 5 min and cooled. The complex was separated, washed with hot ethanol and dried in vacuo over P_4O_{10} for two days. (Islam *et al.,* 2001)

Determination of dissociation constant of Schiff base

To a 400cm^3 beaker, 90cm^3 of distilled water was added followed by 100cm^3 of 0.2moldm^{-3} KNO_3, 10cm^3 of 0.4moldm^{-3} solution of the Schiff base and the solution of NaOH (0.48moldm^{-3}) was added gradually and the corresponding pH value recorded after each addition. The dissociation constantpka of the Schiff base was calculated using equation (Gregory *et al.,* 1978)

Determination of dissociation constant of the complexes

Into a 40cm^3 beaker 100cm^3 of 0.2m KNO_3, 1mmole of Cu(II) or Ni(II) chloride, 0.1m HNO_3 and 90cm^3 of distilled water were added, respectively. A magnetic stirring bar and sodium salt of the Schiff base prepared by neutralizing a known quantity of the Schiff base with calculated amount of standardized NaOH solution. After each 0.2cm^3 aliquot addition the corresponding pH of the stirred reaction mixture was recorded. From the result obtained, stability constant of the complex compound and the number of the coordinate ligands per metal ion were determined (Gregory, *et al.,* 1978)

Antibacterial and Antifungal activity

The paper discs were impregnated with 1000, 2000 and 3000µg concentration of the Schiff base and its metal (II) complexes. Two loopfuls of the standard inoculumswere evenly streaked on the plates in duplicates. Discs containing the impregnated quantities of the complexes as well as the control discs (with only DMSO) were placed firmly on the surface of the medium by means of sterile syringe needle at 40mm apart. For the bacteria the plates were incubated at 37^{o}C for one day (shamsuddeen*et al.,* 2008). For the fungal activity, it was incubated at room temperature for two days (Hassan, *et al.,* 2006). Each of the plates was examine for clear zone of inhibitions. The diameters of the zone of inhibitions were measured with millimeter rule and the mean recorded in the nearest millimeter.

Result and discussion

The Schiff base ligand was prepared as orange crystalline solid. The percentage yield recorded was 81.38 as shown in Table 1. Solubility test (Table 2) carried out on the ligand and its Ni(II) and Cu(II) complexes in some common solvents showed that, it is soluble in ethanol, methanol and DMSO but insoluble in water, Benzene and Ether, while in Toluene is slightly soluble. The molar conductance of synthesized complexes (Table 3) was measured using 10^{-3}M DMSO solvent at room temperature. The conductivity values are in the range of 3.00-5.00 Ohm^{-1} cm^2 mol^{-1}.These values are too low to account for any dissociation of the complexes in DMSO and the obtained value were taken as a good evidence of the existence of a non-electrolytic in nature of the complexes (Geary, 1972). The important IR frequencies exhibited by the Schiff base ligand and their complexes are tabulated in Table 4, the ligand shows broad band at 3510cm^{-1} due to the phenolic hydroxyl group, which show shift in frequency in complexes, indicating the coordination through metal atom (Synmal*et al.,* 1984) the band in the 1600cm^{-1} are observed due to *v*(C=N) which has been shifted toward lower region at around 1550-1565cm^{-1} in the complexes indicating the participation of the azomethine group in the complexes formation (Makode*et al.,* 2004).The sharp band at 3540 and 3530cm^{-1} for Ni(II) and Cu(II) Schiff based complex are due to *v*(O-H)stretching vibration indicating the presence of coordinated water (Byeong-Goo *et al*., 1996). The appearance of the two new band in the region 749-750 and 596-610 cm^{-1} in the metal chelates suggests the formation of M-O and M-N bonds respectively (Saleen*et al.,* 2003). The dissociation constant of the Schiff base determined (Table 8) is 10.27 indicating that it is a weak acid (Gregory 1978). The potentiometric analytical result of Ni(II) and Cu(II) Schiff base complex established 1:1 metal –Schiff base ratio(Table 9 and 10), while the stability constants of the Ni(II) and Cu(II) complexes determine are 5.7544 x 10^6 and 3.4673 x 10^7 and the corresponding change in Gibb's free energy are -3.8546 10^{-1} and -4.2994 10^{-1} KJmol^{-1} respectively (Table 5).The antibacterial activity tested for the Schiff base and the metal (II) complexes (Table 6) have been determined. The diameter of inhibition zone (mm) was measured for each treatment. The Schiff base ligand has less activity in comparison with their complexes against *Escherichia coli and Staphylococcus aureus*this is due to the fact that the metal chelates have more antibacterial activity than uncomplexed ligand because of the chelation theory (Mandal*et al.,* 2002). Sensitivity of fungal isolate (*Aspergillusniger and Candida albican)*show that the Schiff base and complexes is more active against Aspergillusniger than Candida albican especially at higher concentration (Table 7). The result for both antibacterial and antifungal studies shows that the complexes show more activity than the ligand under similar experimental conditions. This would suggest that chelation considerably reduces the polarity of the metal ion mainly because of partial sharing of its positive charge with the donor groups and possible electron delocalization over the whole chelate ring. Such chelation could also enhance the lipophilic character of the central metal atom, which subsequently favors its permeation through the lipid layer of the cell membrane (sudo et al., 1997).

From the result of the analyses carried out the general formula below is suggested.

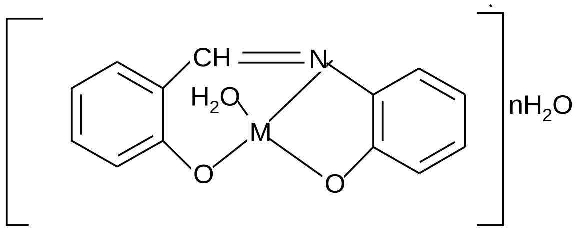

Figure 1: Proposedstructure of the complex

Where M is Ni(II) or Cu(II). And n is the number of coordinated water molecules.

Reference

- A.Syamal and M.M. Bari Niazi, *J-Indian chem.*, soc.sec-A., 1984, 23,163.
- Baluja S., Solanka, A. and Kachdia, N. (2006) "Evaluation of Biological Activities of someSchiff bases and metal complexes" J. IranianChem., Soc., Vol.3, No.4, pp. 312 -317.

Table 1: Physical properties of Schiff base and its complexes

Compound	Colour	M.P(^{O}C)	Decomposition Temp(^{o}C)	% Yield
Schiff base	Orange	96	-	81.38
[Ni(L)]. $2H_2O$	Pale yellow	-	110	58.10
[Cu(L)]. $2H_2O$	Black	-	136	68.54

Table 2: Solubility of Schiff base and its complexes

Compound	Distilled water	Benzene	Toluene	Ethanol	DMSO	Ether	Methanol
Schiff base	IS	IS	SS	S	S	IS	S
[Ni(L)]. $2H_2O$	IS	IS	SS	S	S	IS	S
[Cu(L)]. $2H_2O$	IS	IS	SS	S	S	IS	S

KEY: S= Soluble, SS= Slightly Soluble, IS= Insoluble.

Table 3: Molar conductance measurement

Compound	Electrical conductance Ohm^{-1}	Molar conductance ($Ohm^{-1} cm^2 mol^{-1}$)
[Ni(L)]. $2H_2O$	3.55×10^{-6}	3.6
[Cu(L)]. $2H_2O$	4.76×10^{-6}	4.8

Table 4: Infrared spectral data of ligand and its complexes

Compound	v(O-H)(cm^{-1})	v(C=N)(cm^{-1})	v(M-O) (cm^{-1})	v(M-N) (cm^{-1})
Schiff base	3510	1600	-	-
[Ni(L)]. $2H_2O$	3540	1550	749	596
[Cu(L)]. $2H_2O$	3530	1565	750	610

Table 5: Stability constant and Gibb's free energy

Compound	Stability constant	Gibb's free energy
[Ni(L)]. $2H_2O$	5.7544×10^{6}	$-3.8546\ 10^{-1}$ $KJmol^{-1}$
[Cu(L)]. $2H_2O$	3.4673×10^{7}	$-4.2994\ 10^{-1}$ $KJmol^{-1}$

Table 6: Antibacterial effect of ligand and its complexes

Compound	*Escherichia coli*			*Staphylococcus aureus*		
	1000µg/ml (mm)	2000µg/ml (mm)	3000µg/ml (mm)	1000µg/ml (mm)	2000µg/ml (mm)	3000µg/ml (mm)
Schiff base	-	-	5	5	10	12
[Ni (L)]. $2H_2O$	9	13	15	-	-	-
[Cu (L)]. $2H_2O$	10	14	15	9	11	16

Table 7: Antifungal effect of ligand and its complexes

Compound	*Aspergillusniger*			*Candida albican*		
	1000µg/ml (mm)	2000µg/ml (mm)	3000µg/ml (mm)	1000µg/ml (mm)	2000µg/ml (mm)	3000µg/ml (mm)
Schiff base	6	9	9	-	10	10
[Ni (L)]. $2H_2O$	7	11	17	-	-	17
[Cu (L)]. $2H_2O$	-	-	12	-	-	-

Table 8: Dissociation Constant (pKa) of the Schiff Base

S/N	Volume of NaOH (cm^3)	Ph	[H^+]	[OH^-]	[Na^+]	A_{tot}	pKa
1.	0.5	9.85	$9.4515 x10^{-11}$	$7.7625 x10^{-5}$	$1.1970 x10^{-3}$	$1.9950 x10^{-2}$	11.2504
2.	1.0	9.87	$9.0261 x10^{-11}$	$8.1283 x10^{-5}$	$2.3881 x10^{-3}$	$1.9900 x10^{-2}$	10.9268
3.	1.5	9.91	$8.2319 x10^{-11}$	$8.9125 x10^{-3}$	$3.5732 x10^{-3}$	$1.9851 x10^{-2}$	10.7564
4	2.0	9.98	$7.0065 x10^{-11}$	$1.0471 x10^{-4}$	$4.7525 x10^{-3}$	$1.9802 x10^{-2}$	10.6678
5	2.5	10.05	$5.9635 x10^{-11}$	$1.2303 x10^{-4}$	$5.9259 x10^{-3}$	$1.9753 x10^{-2}$	10.6054
6	3.0	10.11	$5.1940 x10^{-11}$	$1.4125 x10^{-4}$	$7.0936 x10^{-3}$	$1.9704 x10^{-2}$	10.5476
7.	3.5	10.14	$4.8473 x10^{-11}$	$1.5136 x10^{-4}$	$8.2555 x10^{-3}$	$1.9656 x10^{-2}$	10.4684
8.	4.0	10.19	$4.3202 x10^{-11}$	$1.6982 x10^{-4}$	$9.4118 x10^{-3}$	$1.9608 x10^{-2}$	10.4143
9	4.5	10.26	$3.6771 x10^{-11}$	$1.9953 x10^{-4}$	$1.1707 x10^{-2}$	$1.9512 x10^{-2}$	10.4143
10	5.0	10.31	$3.2772 x10^{-11}$	$2.2307 x10^{-4}$	$1.1707 x10^{-2}$	$1.9512 x10^{-2}$	10.3322
11	5.5	10.38	$2.7893 x10^{-11}$	$2.6303 x10^{-4}$	$1.2847 x10^{-2}$	$1.9512 x10^{-2}$	10.2265
12	6.0	10.43	$2.4860 x10^{-11}$	$2.9512 x10^{-4}$	$11.3981 x10^{-2}$	$1.9417 x10^{-2}$	10.2265
13	6.5	10.47	$2.2673 x10^{-11}$	$3.2359 x10^{-4}$	$1.5109 x10^{-2}$	$1.9370 x10^{-2}$	10.1360
14	7.0	10.51	$2.0678 x10^{-11}$	$3.5481 x10^{-4}$	$1.6232 x10^{-2}$	$1.9324 x10^{-2}$	10.0211
15	7.5	10.54	$1.9297 x10^{-11}$	$3.8019 x10^{-4}$	$1.7349 x10^{-2}$	$1.9277 x10^{-2}$	9.8481
16	8.0	10.56	$1.8429 x10^{-11}$	$3.9811 x10^{-4}$	$1.8462 x10^{-2}$	$1.9231 x10^{-2}$	9.5448
17	8.5	10.59	$1.7199 x10^{-11}$	$4.2658 x10^{-4}$	$1.9568 x10^{-2}$	$1.9185 x10^{-2}$	8.1218

Average Dissociation Constant (pKa)) = 10.27

Table 9: Estimation of number of coordinated ligands in Nickel (II) Complex

S/N	Volume of sodium liganate (cm^3)	P^H	$[H^+]$	$[OH^-]$	Log [A]	M_{TOTAL}	N
1.	1.4	3.03	6.2445×10^{-4}	1.1588×10^{-11}	-3.6374	0.0049603	0.5643
2.	1.6	3.08	5.5654×10^{-4}	1.3001×10^{-11}	-3.6595	0.0049504	0.5786
3.	1.8	3.13	4.9602×10^{-4}	1.4588×10^{-11}	-3.6651	0.0049505	0.6981
4.	2.0	3.19	4.3202×10^{-4}	1.6749×10^{-11}	-3.6570	0.0049456	0.7651
5.	2.2	3.21	4.1257×10^{-4}	1.7539×10^{-11}	-3.6516	0.0049407	0.8411
6.	2.4	3.26	3.6771×10^{-4}	1.9679×10^{-11}	-3.6336	0.0049358	0.9119
7.	2.6	3.32	3.2026×10^{-4}	2.2594×10^{-11}	-3.36050	0.0049261	0.9367
8.	2.8	3.36	2.9208×10^{-4}	2.4774×10^{-11}	-3.5827	0.0049213	1.0562
9.	3.0	3.42	2.5439×10^{-4}	2.8445×10^{-11}	-3.5452	0.0049213	1.0985
10.	3.2	3.48	2.2156×10^{-4}	3.2659×10^{-11}	-3.5039	0.0049164	1.1654
11.	3.4	3.52	2.0678×10^{-4}	3.4995×10^{-11}	-3.4821	0.0049116	1.1895
12.	3.6	3.57	1.9009×10^{-4}	4.0179×10^{-11}	-3.4365	0.0049068	1.2065
13.	3.8	3.63	1.5686×10^{-4}	4.6132×10^{-11}	-3.3886	0.004902	1.2750
14.	4.0	3.88	$8.1283X10^{-5}$	$8.1283X10^{-11}$	-3.1725	0.0048972	1.3116
15.	4.2	4.02	$6.3899X10^{-5}$	$1.220X10^{-10}$	-3.0440	0.0048924	1.3733
16.	4.6	4.10	$5.3149X10^{-5}$	$1.3489X10^{-10}$	-2.9689	0.0048876	1.3884
17.	4.8	4.04	$6.1024X10^{-5}$	$1.1749X10^{-10}$	-3.0254	0.0048828	1.4078
18.	5.0	4.27	$3.5934X10^{-5}$	$1.9953X10^{-10}$	-2.8068	0.004878	1.4631
19.	5.2	4.29	$3.4356X10^{-5}$	$2.0893X10^{-10}$	-2.8068	0.0048733	1.4974
20.	5.4	4.32	$3.2026X10^{-5}$	$2.2387X10^{-10}$	-2.7880	0.0048685	1.5153
21.	5.6	4.34	$3.0584X10^{-5}$	$2.3442X10^{-10}$	-2.7586	0.0048638	1.5829
22.	5.8	4.35	$2.9888X10^{-5}$	$2.3988X10^{-10}$	-2.7392	0.0048591	1.5973
23.	6.0	4.38	$2.7893X10^{-5}$	$2.5704X10^{-10}$	-2.70041	0.0048544	1.6422
24.	6.2	4.39	$2.7258X10^{-5}$	$2.6303X10^{-10}$	-2.7295	0.004897	1.6881
25.	6.4	4.41	$2.6032X10^{-5}$	$2.7542X10^{-10}$	-2.6906	0.004845	1.7263
26.	6.6	4.44	$2.4294X10^{-5}$	$2.9512X10^{-10}$	-2.6713	0.0048403	1.8654
27.	6.8	4.46	$2.3201X10^{-5}$	$3.1623X10^{-10}$	-2.6420	0.0048356	1.9356
28.	7.0	4.47	$2.2673X10^{-5}$	$3.1623X10^{-10}$	-2.6225	0.0048309	2.0316
29.	7.2	4.48	$2.2156X10^{-5}$	$3.2659X10^{-10}$	-2.6128	0.004863	2.3582
30.	7.4	4.49	$2.1652X10^{-5}$	$3.3113X10^{-10}$	-2.6029	0.0048216	2.4609

Average n value = 1.3711

Table 10:Estimation of number of coordinated ligands in Copper (II) Complex

S/N	Volume of sodium liganate (cm^3)	P^H	$[H^+]$	$[OH^-]$	Log [A]	M_{TOTAL}	N
1.	1.2	2.69	1.3662×10^{-3}	5.2966×10^{-11}	-3.9664	0.0049652	0.6339
2.	1.4	2.71	1.3047×10^{-3}	5.5463×10^{-12}	-3.8665	0.0049603	0.6543
3.	1.6	2.76	1.1628×10^{-3}	6.2230×10^{-12}	-3.5444	0.0049554	0.6934
4.	1.8	2.82	1.0127×10^{-3}	7.1449×10^{-12}	-3.3765	0.0049505	0.7356
5.	2.0	2.88	8.8206×10^{-3}	8.2035×10^{-12}	-3.2844	0.0049456	0.7589
6.	2.2	2.93	7.8614×10^{-4}	9.2045×10^{-12}	-3.4928	0.0049407	0.7887
7.	2.4	2.96	7.3367×10^{-4}	9.8628×10^{-12}	-3.5581	0.0049358	0.8263
8.	2.6	2.99	6.8470×10^{-4}	1.0568×10^{-11}	-3.6014	0.004931	0.8649
9.	2.8	3.05	5.9634×10^{-4}	1.2133×10^{-11}	-3.6487	0.0049261	0.8981
10.	3.0	3.07	5.6950×10^{-4}	1.2705×10^{-11}	-3.6487	0.0049261	0.9351
11.	3.2	3.09	5.4388×10^{-4}	1.2705×10^{-11}	-.6587	0.0049213	0.9775
12.	3.4	3.11	5.1939×10^{-4}	1.3305×10^{-11}	-3.6618	0.0049116	1.0648
13.	3.6	3.12	5.0757×10^{-4}	1.4256×10^{-11}	-.6650	0.0049068	1.2546
14.	3.8	3.15	4.7369×10^{-4}	1.5276×10^{-11}	-3.6639	0.004902	1.2740
15.	4.0	3.17	$4.5238X10^{-4}$	$1.5849X10^{-11}$	-3.6612	0.0048972	1.2903
16.	4.2	3.18	$4.4208X10^{-4}$	$1.6218X10^{-11}$	-3.6593	0.0043924	1.3164
17.	4.6	3.22	$4.0318X10^{-4}$	$1.7783X10^{-11}$	-3.6485	0.0048876	1.3765
18.	4.8	3.23	$3.9400X10^{-4}$	$1.8197X10^{-11}$	-3.6451	0.0048828	1.4174
19.	5.0	3.24	$3.8503X10^{-4}$	$1.8620X10^{-11}$	-3.6415	0.004878	1.4673
20.	5.2	3.25	$3.7627X10^{-4}$	$1.9055X10^{-11}$	-3.6377	0.0048733	1.5386
21.	5.4	3.26	$3.6771X10^{-4}$	$1.1949X10^{-11}$	-3.6336	0.0048685	1.6268
22.	5.6	3.27	$3.4445X10^{-4}$	$1.9953X10^{-11}$	-3.6248	0.0048638	1.6972
23.	5.8	3.28	$3.5115X10^{-4}$	$2.0417X10^{-11}$	-3.6202	0.0048591	1.7086
24.	6.0	3.29	$3.4316X10^{-4}$	$2.1086X10^{-11}$	-3.6153	0.0048544	1.8122
25.	6.2	3.30	$3.3535X10^{-4}$	$2.1379X10^{-11}$	-3.6050	0.0048497	1.8759
26.	6.4	3.32	$3.2026X10^{-4}$	$2.2387X10^{-11}$	-3.5827	0.004845	1.9247
27.	6.6	3.36	$2.9208X10^{-4}$	$2.4547X10^{-11}$	-3.5582	0.0048403	1.9788
28.	6.8	3.40	$2.6638X10^{-4}$	$2.6915X10^{-11}$	-3.5110	0.0048356	2.1530
29.	7.0	3.47	$2.2672X10^{-4}$	$3.1623X10^{-11}$	-3.3805	0.0048309	2.2751
30.	7.2	3.64	$1.5329X10^{-4}$	$4.6774X10^{-11}$	-3.2263	0.0048263	2.4623

Average n value = 1.3427

Byeong-Goo J, Chae-Pyong R, Hee-Nam C, Ki-Hyung C, Yohng-Kook C (1996). Synthesis and Characterization of Schiff base derived from 2- hydroxy-1-naphthaldehyde and Aliphatic Diamines Bulletin of Korean Chemical Society 17(8), 687 – 693.

- Dash B., Mahapatra P. K., Panda D. and Patnaik J.M. (1987) "Fungicidal Activities of Schiff base Derived from phydroxybenzaldehydesand their Derivatives" J.Indian Chem. Soc., Vol.61, pp.1061 – 1064.
- Dhakery R. and Saxena G. (1987) "Sythesis of Ni(II) complexes with Heterocyclic Aldehyde Schiff base" J. Indian Chem. Soc., Vol.64, pp. 685 – 686.
- Dong, Y; Narla, RK; Sudbeck, E; (2002) Synthesis, X-ray structure, and antileukemic activity of oxovanadium (IV) complexes, journal of Inorganic Biochemistry Vol. 78, pp 321-330.
- Geary WJ, Coord.chem. Rev, 1972, 1, 81.
- Gregory S, Thomas BR, Robert JA (1978). Synthesis and techniques in inorganic chemistry 3rd edition, Longman publishers, London. . 119-126.
- Hanna Wageih G., Moawaad Mona (2001). Synthesis, characterization and antimicrobial activity of Co(II), Ni(II) and Cu(II) with new asymmetrical Schiff base, transition metal chemistry 26(6), 644-651.
- Hassan SW, Umar RA, Lawal M, Bilbis LS, Muhammad BY (2006).Evaluation of antifungal Activity of ficussycomorus L. (moraceae). Best Journal 3 (2), 18-25.
- Hassan, A.M.A. (1998). Co (II) and Fe (III) chelates drived from Isatin and some amines journal of Islamic academy sciences, 4(4), 271-274.
- Hridia W. Fande and Mathir (1995) *Journalof transition metal sale Drugs 20* 146-148.
- J.T.Makode and A.S. Aswar.,*Indian J.chem*. 2004, 43(A), 2120-2125.
- Jarrahpour A.A., Motamedifar, M., Hadi, N. and Zerei, M. (2004) "Synthesis of Novel azoSchiff bases and their Antibacterial andAntifungal Activitioes", molecules, Vol.9, pp.815– 824.
- Nashinaga A., Yamada T., Fujisawa H. and Ishizaki K. (1998) "Catalysis by cobalt Schiffbase complexes in the oxygenation of Alkeneson the Mechanism of Ketonization" J. Mol.Catal., Vol.48, pp. 249 – 264.
- Patel V. K. and Jejurka C.R (1994) "Mixed Schiff base complexes and their Applications as Pigments and Antimicrobacterial agents", Bioor. Med. Chem. Letters Vol.16,pp. 1514 – 1517.
- Pierre L (1987). Organic reactions, Johnsons Wiley Pub., New York USA, pp 73 – 79.
- S. Mandal and K. Nag, *J. chem. soc. Dalton Trans, 1983, 2429.*
- Saidul Islam M. Akhter M. Farrouque M.A.K Bodruddoza M. AshikMosaddik and M. ShahidulAlam (2001).*Online Journal of Biological Science* 1 (8) 711 – 713.
- Saleem, H. S., El-Shetary, B. A. and Khalil S. M. (2003) "Potentiometric and Spectrophotometric Studies of Complexation of Schiff base Hydrazine containing the pyrimidine moity" J. Serb. Chem. Soc., Vol.68, No.10, pp.729 – 748.
- Shamsudden U, Mukhtar MD, Salisu M (2008). Comparative in-vitro study of Activity of Methanolic and Ethanolic extracts of onion seeds on gram-negative and gram-positive bacteria, Best journals. 5(3)17-20.
- Sudo k., Masumato Y., Mastushima M., fajwara M., Kunno K., Shimatohno K., Shigerta S. and Yokora T. (1997): Novel Hepatitis C virus Protease Inhibitors Thiozolidine Derivatives, Biohem. Biophys Res. Comm., 238, 643-647.
- Thomas T. (2007) Schiff bases and century of β-*Lactam*, synthesis Angew, Chem. Int. ed., 46; 2 – 4.
- Tsumaki T. (1983). Synthesis and characterization of bis(salicyl)ethylenediiminatocobalt(II) complex, Bull. Chem… soc. Jap, 13, 254.
- Tuoviren, P.K. Solomon and Farstner Eds. 1988 Heavy Metals in Dredge Materials and Mine.
- Zahid H. Chohan, Arif M., Akhtar A. and Claudiu T. Supuran (2007).Bioinorg chem. And Appl. Article 1D 83131, pp 1-13.