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Original Research Article

Preparation and Characterization of Some Transition Metal Complexes of New Tetradentate Schiff Base Ligand Type N_2O_2

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Abstract: Mn(II),Co(II) ,Ni(II),Cu(II)and Hg(II)metal complexes of Schiff base(2,2'-(1E,1'E)-(ethane-1,2-diylbis(azan-1-yl-1-ylidene))bis(phenyl methan-1-yl-1-ylidene)di benzoic acid)derived from 2-benzoylbenzoic acid and ethylene diamine have been synthesized and characterized by IR ,^{1}H-,^{13}C-NMR (only ligand) and electronic spectra, elemental analysis, in addition of magnetic moment measurements and molar conductance. It has been found that the Schiff base ligand behaves as tetradentate (N_2O_2) ligand forming chelates with 1:1 (ligand: metal) stoichiometry. The conductivity data for all complexes are consistent with those expected for non-electrolyte nature.It found that all complexes showed octahedral geometries. And in vitro tests for antibacterial and antifungal activity showed that most of the prepared compounds display a good activityto (*staphylococcus aureus*), (*Escherichia coli*), (*Bacillus subtilis*) and (*Pseudomonas aeruginosa*).

Keywords: Schiff base, Characterization, 2-benzoyl benzoic acid and ethylene diamine.

INTRODUCTION

Schiff bases, named after Hugo Schiff, are formed when any primary amine reacts with an aldehyde or a ketone under specific conditions[1, 2]. Structurally, a Schiff base (also known as imine or azomethine) is a nitrogen analogue an aldehyde and ketone in which the carbonyl group (C=O) has been replaced by an imine or azomethine group Schiff bases are some of the most widely used organic compounds[3, 4]. They are used as pigments and dyes catalysts[5], intermediates in organic synthesis[6], as polymer stabilizers [7], and separation of trace amount of metal ions [8]. Schiff bases have also been shown to exhibit a broad range of biological activities [9]. Imine groups are present in various natural, natural-derived, and non-natural compounds [10] .Generally ligands are Lewis bases that have lone pair on nitrogen, oxygen, etc and that bind with transition metals (Lewis acids) [11]. Ligands can be divided into monodentate, bidentate and multidentate types[12], according to the availability of one [13], two or more donor atoms bonding with metal [14].Active and well-designed Schiff base ligands are considered as ‘privileged ligands’ because they are easily prepared by the condensation between aldehydes or ketones and amines and are able to stabilize different metals in various oxidation states [15]. Metal complexes of Schiff bases have been widely studied due to the versatility of their steric and electronic properties, which can be fine-tuned by choosing the appropriate amine precursors and ring substituents [16]. N_2O_2- tetra dentate ligands (soft and hard donor) possess many advantages such as facile approach [17], relative tolerance[18], readily adjusted ancillary ligands [19], and tunable steric and electronic coordination environments on the metal center [20].They were well known that N and O atoms play a key role in the coordination of metals at the active sites of numerous metal bimolecular [21].Chelating ligands containing O and N donor [22]. Because of the tetra dentate N_2O_2 ligands and their transition metal complexes, act as catalyst[23].Thus, this group of compounds has attracted significant attention being relevant to their application in agrochemical and pharmaceutical industries[24].

Schiff base ligands are well known for their wide range of applications in pharmaceutical and industrial fields, dye industries, plastic, Agriculture, biochemistry, physiology and providing liquid crystal [25]. Schiff base and their complexes have received considerable scrutiny from both experimental and theoretical stand, which were used in several areas such as homogenous catalysis [26], Bio inorganic chemistry [27], and inorganic pharmacology [28]. Schiff bases are very important in development of coordination chemistry [29].The aim of the present research in the synthesis and antibacterial activity studies of(II), Cobalt (II), copper(II) and Mercury(II)complexes containing Schiff base derived from 2-benzoyl benzoic acid and ethylene diamine by available techniques.

EXPERIMENTAL

Materials and measurements: 2-benzoyl benzoic acid, ethylene diamine and glacial acetic acid were purchased from sigma Chemical Co. (USA). All other solvents used in this work were reagent grade (BDH/Aldrich) and used without further purification. The elemental analyses were carried out in Ahl-Al Bat University/ Jordan by means of Micro analytical unit of EA 300 AC.H.N Elemental analyzer. IR spectra were recorded using KBr discs 4000-400 cm^{-1}on FT-IR Test scan Shimadzu model 8000 UV-Vis spectra were recorded in DMSO on Shimadzu model 1700 UV-Vis spectrophotometer. Magnetic susceptibilities measurements were obtained at room temperature using Bruker BM6 instrument [16].Molar conductance measurements were determine in DMSO by using Alpha Digital conductivity meter model 800. Electro thermal malting point model 9300 was used to measure the melting points of the ligand and its complexes.

Preparation of Schiff base (H_2L)

The Schiff base (2,2'-(1E,1'E)-(ethane-1,2-diylbis(azan-1-yl-1-ylidene))bis(phenyl methan-1-yl-1-ylidene) dibenzoic acid) was prepared by adding (25mL) of 2-benzoyl benzoic acid ethanolic solution (0.002mmol) with 4drops from glacial acetic acid to the same volume of ethanolic solution of ethylene diamine (0.001mmol).The mixture was refluxed with stirring for (5-6) hrs. The resulting solution was evaporated to half volume and the precipitated product was collected by filtration, washed twice with (5mL) hot ethanol and dried. Condensation of ethylene diamine and 2-benzoyl benzoic acid in ethanol gives single product according to the following reaction shows in scheme (1).

Preparation of the complexes

A general method has been used for the preparation of all chelated complexes. A solution(0.001mmol)of ligand dissolved in (25 mL)of hot ethanol was added with stirring a stoichiometric mount (1:1) (ligand: metal) ratio for Mn(II), Co(II) ,Ni(II),Cu(II) and Hg(II) chloride salts and the mixture were refluxed for 30 min. They were filtered, washed with (5mL) ethanol and dried on cooling at room temperature, the coloured complexes precipitated out in each case, shows in scheme (2).

Biological Screening studies

The in-vitro biological screening effects of the investigated compounds were tested against the bacteria (*staphylococcusaureus*), (*Escherichia coli*), (*Bacillus subtilis*) and (*Pseudomonas aeruginosa*) by disc diffusion method using nutrients agar as the medium. All the blank discs were moistened with the solvent. The sample solutions (10^{-2}M) were prepared by dissolving the compounds in DMSO and the solutions were loaded on the wells of the culture and in culture incubated at 37°C for 24 h for the bacterial culture. During this period, the test solution was diffused and affected the growth of the microorganisms. Hence, the inhibition zones were developed on the plate around the disc.

RESULTS AND DISCUSSION

General

The ligand is pink powder, which was a soluble in common organic solvent except water. The reaction between the ligand and the metal ions mentioned above gives vary in colour solids, depending on the nature of metal ions. All complexes are quiet air-stable, but it's soluble in DMSO and DMF.Some physical and chemical properties for (H_2L) ligand and its cheated complexes with Mn (II), Co(II), Ni(II),Cu(II)and Hg (II) metal ions. The melting points of the complexes were different (higher) than that of the Schiff base ligand, an evidence for complexation. The complexes were in a good agreement with those required by the proposed formula[M(L)(H_2O)] where L=($C_{30}H_{24}N_2O_4$); M=Mn(II), Co(II), Ni(II), Cu(II) and Hg(II) that all the prepared complexes are agreement with the stoichiometric ratio (1:1) metal : ligand. The result of the elemental analysis of the prepared compounds which are recorded in Table (1)NMR spectrum for the ligand (L): ^{1}H-NMR spectrum of the ligand (L) in DMSO–d_6 illustrated in Fig. (5), Table (2) is multiples corresponding to aromatic protons at (6.86-7.67) ppm.[14]. The characteristic signal at (6.02) ppm.is assigned to HC=N. The COOH signal is found proton at (12.48) ppm. [5]. The DMSO signal appeared at (2.50) ppm.

^{13}C–NMR of the free ligand (L) Fig (2), Table (3) shows the COOH peak at (161.07) ppm, the HC=N peak at (143.50) ppm. carbon peaks for aromatic are appeared at (114.64-129.27) ppm and carbon peaks for aliphatic are detected at (47.41-55.78) ppm. the peak at (40.31) ppm. assigned to DMSO [6].

Infrared spectral Studies

In order to study the binding mode of the ligand with the metal ions, a comparison was made for the FT.IR spectra of the free ligand and this of the prepared complexes and the data was given in (Table-3). The IR spectral data of the ligand showed a band at 1627cm^{-1}, which is assigned to ν(C=N) stretching vibration, a feature found in Schiff bases [7]. This band was also showed at the range (1603-1614) cm^{-1} in the complex compounds, which was shifted to a lower frequency, indicating the involvement of –C=N nitrogen of the ligand in coordination with metal ions, resulting in the formation of the five complexes [8]. The free ligand (H_2L) exhibits strong absorption bond at (1695) cm^{-1} due to the stretching vibration of υ(C=O) of carboxylic group [9]. This band disappeared in the spectra of its complexes accompanied by the appearance in frequencies at (1519-1533) cm^{-1} and (1456 -1481) cm^{-1} due to $\upsilon_{asymm}(COO^{-})$ and to $\upsilon_{symm}(COO^{-})$ for all the complexes, ($\Delta\ \upsilon_{asym.}$- $\Delta\upsilon_{sym.}$)= (48-81) cm^{-1},supporting the idea that the ligand coordinate through deprotonated oxygen of carboxylate

[10].The new observed bands in the regions (489-520) cm^{-1}and (418-441) cm^{-1}are tentatively attributed to *v* (M-N) and*v* (M-O) (Metal-Ligand) stretching vibrations respectively, confirming the coordination of the Schiff base to the respective metal ions [11, 12].The IR spectrum of the ligand (L)(Fig-4) exhibited broad band in the regions (2520-3337) cm^{-1} was assigned to ν(OH) stretching frequency [13], absent this band in the spectra of all complexes, which indicated deprotonation and involvement of the oxygen of carboxylate in chelating [14]. The broad bands in the region (3321-3482) cm^{-1} and the weak bands at (829-810) cm^{-1}were indicate *v*(O-H) and δ(OH) for all the complexes [15], a feature indicating the presence of coordinated aqua (H_2O) (Table 4). The water analysis of the complexes suggested two water molecules per complex compound. Therefore from IR spectra, it is concluded that the ligand behave as anion tetra dentate and bind with the metal ions by two O atoms of carboxylate and the two N atoms of imine [16].

Molar conductivity

The molar conductance values of the complexes in DMSO lie in the range 10 to 17ohm^{-1}.cm^{2}mol^{-1} which is quite lower than that expected for an electrolyte and reveal their non-electrolytic nature as in Table(5) [17, 18, 19].

The electronic absorption spectral and magnetic studies

The spectral data of the compounds were presented in Table 1. The electronic absorption spectrum of the synthesized H_2L showed UV bands at 37735 and 30120 cm^{-1}. The bands at 37735 nm was attributed to $\pi \rightarrow \pi^*$ transitions of the aromatic ring, 37735 cm^{-1} is assigned to $n \rightarrow \pi^*$ transition of azomethine group [20, 21].This transition was also found in the spectra of the complexes, but they were shifted towards lower in range (30769 -28571) cm^{-1}[22].

In the present investigation, brownish Co(II) complexes generally exhibited absorption band 11792 cm^{-1} corresponding to(υ_1), which was attributed to the transitions $^4T_1g_{\ (F)} \rightarrow {}^4T_2g_{\ (F)}$ (υ_1) . This band was the characteristic of high spin octahedral Co (II) complex[23].

The greenish brown Ni(II) complexes exhibited two bands at 12626 and 15764cm^{-1}for the complex ,which are attributed to the $^3A_2g_{(F)} \rightarrow {}^3T_2g_{(F)}$ (υ_1) and$^3A_2g \rightarrow {}^3T_1g_{\ (F)}$ (υ_2) transitions respectively indicating octahedral geometry around Ni(II) ion [24].

The electronic spectrum of Cu (II) complex display one high intensity band with shoulder bidden at 13765 cm^{-1}for the complex is due to$Eg_{(F)} \rightarrow {}^2T_2g_{(F)}$ transition. On the basis of electronic spectra distorted octahedral geometry around Cu (II) ion is suggested[25].

The brown Mn(II) complex exhibited electronic transition at 12903 cm^{-1}for the expected for six-coordinated d^5 octahedral complexes. The electronic spectra of Mn(II) d^5 complex exhibits electronic transition at 12658 cm .This transition is assigned to $^6A_1g_{(F)} \rightarrow {}^4T_1g_{(D)}$($\upsilon_1$) for Mn(II) complexes in octahedral environment due to large crystal field splitting [26].

The electronic spectrum of the Hg (II) complex showed no d-d transitions in the visible region, indicating for Hg (II), this is mean electronic transitions happened octahedral geometry has been assigned to the Hg (II) complex. According to the elemental analysis Table (1) and FT-IR spectra, the structures of these complexes can be suggested octahedral[27].

The magnetic moment values are listed in Table 1. The magnetic moment values are found to be 4.71, 1.81, 2.85, 5.64, BM for Co(II), Ni(II),Cu(II) and Mn(II) complexes, respectively, suggesting an octahedral geometry [28,29].The Hg(II) complex is diamagnetic and according to its empirical formula, an octahedral geometry was proposed for this complex.

Biological Activities

We investigated the applicability disc diffusion method for determining the susceptibility of bacterial *(staphylococcus aureus*), (*Escherichia coli*), (*Bacillussubtilis*) and *(Pseudomonas aeruginosa)* species against newly synthesized tetradentate Schiff base ligand derived by the condensation of 2-benzoyl benzoic acid with ethylene diamine and itsMn(II), Co(II), Ni(II) Cu(II), and Hg(II) complexes. The minimum inhibition concentration value of the compounds against the growth microorganisms are summarized the Table 6. A comparison of the value of ligand with its complexes indicates that the metal chalets exhibited higher antimicrobial activity than ligand and the control sample. Such increased activity of the complexes can be explained based on the Overtone's concept and the Tweedy chelating theory [32]. According to the Overtone's concept of cell permeability, the lipid membrane that surrounds the cell favors the passage of only lipid soluble materials, due to which lip solubility is an important factor that controls antimicrobial activity [33]. On chelating, the polarity of the metal ion will be reduced due to the partial sharing of positive charges with donor groups. Furthermore, it increases the delocalization of π-electrons over the whole cheated ring that enhances the lipophilicity of the complexes [34].This increased lipophilicity enhances the penetration of the complexes into lipid membranes and the blocking of the metal binding sites in the enzymes of microorganisms[35]. Due to the presence of more functional groups (hydroxyl groups and azomethine groups), which forms hydrogen bonding with proteins present in the cell walls of the organisms, resulting in interference with the normal cell process[36]. Comparatively, Table (6) diameter of zone of inhibition.

Table 1: Some physical properties of prepared lignad (H_2L) and its complexes and weight of metal salts

Empirical Formula	Yield %	M.P° C	Colour	Metal salt	Weigh(g) 1mmol	Λ_m ohm.cm^{2}mole^{-1}	(Calc.)% Found			
							C	H	N	**Metal**
L=$C_{30}H_{24}N_2O_4$	87	121	Pink	-	-	-	(75.61) 75.15	(5.08) 5.00	(5.88) 6.04	**-**
[Co(L)(H_2O)$_2$].H_2O	89	<256	brownish	$CoCl_2$.6 H_2O	0.238	17	(67.55) 67.50	(4.16) 6.00	(5.25) 5.42	**(11.50) 11.20**
[[Ni(L)(H_2O)$_2$].2 H_2O	81	200	brown	$NiCl_2$.6 H_2O	0.238	10	(67.58) 77.50	(4.16) 5.40	(5.25) 8.42	**(11.01) 11.30**
[Mn(L)(H_2O)$_2$]. H_2O	82	232	greenth brown	$MnCl_2$.4 H_2O	0.198	15	(68.08) 67.98	(5.00) 49.40	(5.29) 5.42	**(10.38) 10.35**
[Cu (L)(H_2O)$_2$]. H_2O	78	194	Blue	$CuCl_2$.H_2O	0.170	12	(66.97) 66.50	(4.12) 4.40	(5.21) 5.02	**(20.03) 19.80**
[Hg(L)(H_2O)$_2$]	80	187	pale brown	$HgCl_2$	0.271	13	(53.37) 77.50	(5.00) 5.40	(6.04) 8.42	**(30.96) 30.41**

Table 2: ^{1}H-NMR Chemical Shifts for Ligand (H_2L) (ppm in DMSO)

HC=CH	DMSO	HC=N	COOH
6.68-6.96ppm.	2.46 ppm	6.02 ppm	12.67ppm

Table 3: ^{13}C-NMR Chemical shifts for Ligand (H_2L) (ppm in DMSO)

HC=CH	DMSO	H_2C-C=N	=C-C=N	COOH
142.69-145.22 ppm	40.30ppm	64.54ppm	166.07 ppm	169.69ppm

Table 4: Infrared spectral data (wave number υ) cm^{-1}for the ligand (H_2L), precursors and its complexes

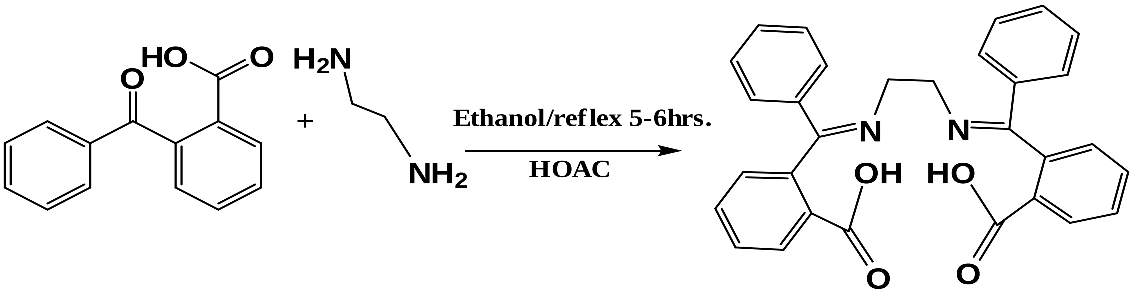
Compound	υ(OH)	υ(C-H)$_{arom.}$.	C=O carbonlate	υ(C-H)$_{aliph}$.	υ(HC=N)$_{imine}$	υ(C=O)$_{asym}$	Y (C=O)$_{sym}$	Δυ cm^{-1}	δ(OH)	M–N M–O
H_2L	2520-3337	3020	1695	2993	1627	-	-	-	-	-
[Co(L)(H_2O)$_2$].H_2O	3482	3018	-	2964	1612	1529	1467	62	810	489 421
[Ni(L)(H_2O)$_2$].2H_2O	3423	3082	-	2904	1614	1519	1467	52	810	493 412
[Mn(L)(H_2O)$_2$].H_2O	3321	3026	-	2993	1604	1529	1481	48	987	499 418
[Cu(L)(H_2O)$_2$]. H_2O	3367	3042	-	2910	1609	1533	1456	77	823	520 432
[Hg(L)(H_2O)$_2$]	3464	3111	-	2962	1603	1530	1462	68	821	495 441

Table 5: Electronic spectral data of the ligand (L) and its metal complexes

Compound	Λ_m ohm.cm^{2}mole^{-1}	μ_{eff}	λnm	υ'wave number cm^{-1}	Assignments	Proposed structure
H_2L	-	-	265	37735	π→π*	-
			332	30120	n→π*	
[Co(L)(H_2O)$_2$]. H_2O	17	4.71	312	32051	C.T	Octahedral
			848	11792	$^4T_1g_{(F)}\rightarrow{}^4T_2g_{(F)}$	
[Ni(L)(H_2O)$_2$]. 2H_2O	10	1.81	320	30769	C.T	Octahedral
			634	15764	$^3A_2g_{(F)}\rightarrow{}^3T_1g_{(F)}$	
			792	12626	$^3A_2g_{(F)}\rightarrow{}^3T_2g_{(F)}$	
[Cu(L)(H_2O)$_2$] H_2O	15	2.85	324	30864	C.T	Octahedral
			726	13765	$Eg_{(F)}\rightarrow{}^2T_2g_{(F)}$	
[Mn(L)(H_2O)$_2$] H_2O	12	5.72	325	30769	C.T	Octahedral
			775	12903	$^6A_1g_{(F)}\rightarrow{}^4Eg_{(D)}$	
[Hg(L)(H_2O)$_2$]	13	-	350	28571	C.T	Octahedral

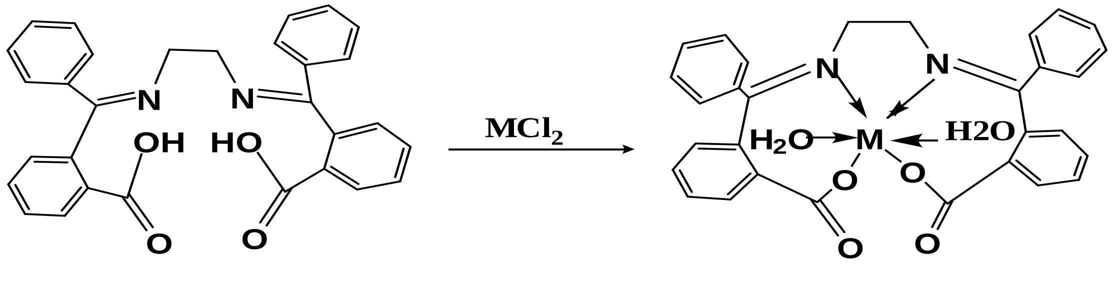
Table 6: Diameter of zone of inhibition (mm)

Compound	H_2L	$[Co(L)(H_2O)_2]H_2O$	$[Ni(L)(H_2O)_2].2H_2O$	$[Cu(L)(H_2O)_2]H_2O$	$[Mn(L)(H_2O)_2].H_2O$	$[Hg(L)(H_2O)_2]$
Escherichia coli	1	3	1	2	3	2
Staphylococcus aureus	4	6	6	5	7	8
Bacillussubtilis	3	2	3	4	5	1
Pseudomonas aeruginosa	1	2	3	1	2	5



2,2'-(1*E*,1'*E*)-(ethane-1,2-diylbis(azan-1-yl-1-ylidene))bis(phenylmethan-1-yl-1-ylidene)dibenzoic acid

Scheme (1): Synthetic route of the Schiff base ligand (H_2L)



M=Cu^{II},Ni^{II},Co^{II},Mn^{II} and Hg^{II}

Scheme (2): Synthetic route of the metal complexes

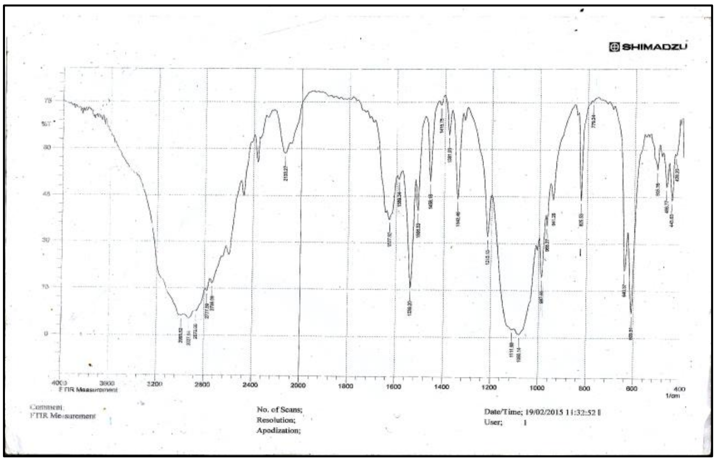


Fig. (1) Spectrum of complex (H_2L)

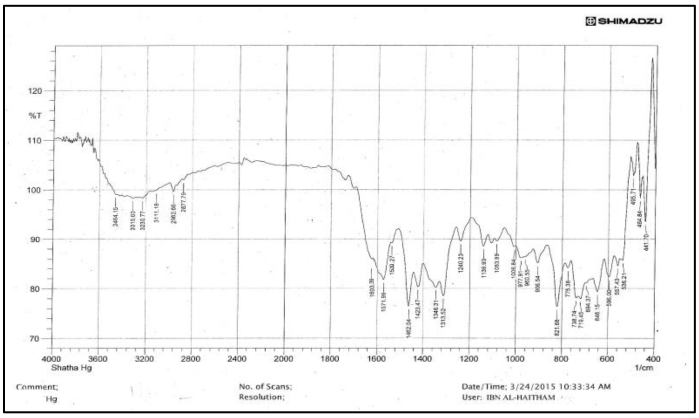


Fig. (2) Spectrum of complex $[Hg(L)(H_2O)_2]$

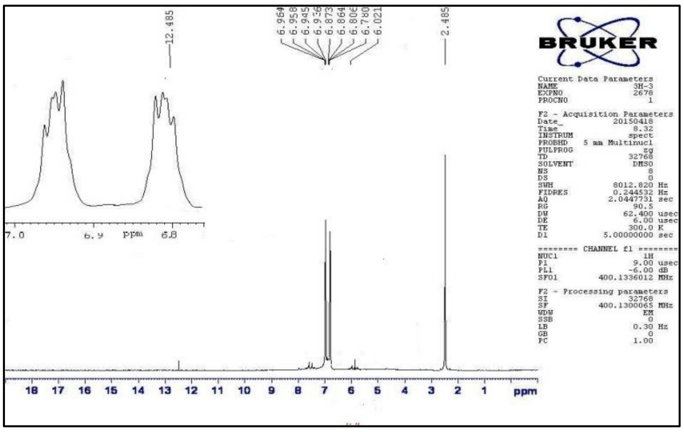


Fig.(3)^1***HNMR*** spectrum ***of Ligand***(H_2L)

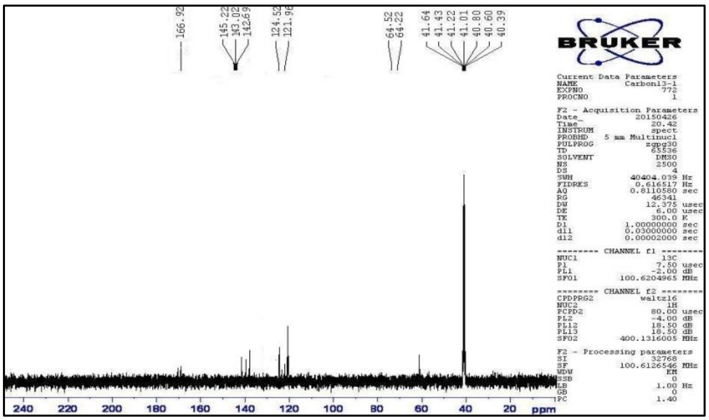


Fig.(4)^{13}***CNMR*** spectrum ***of Ligand*** (H_2L)

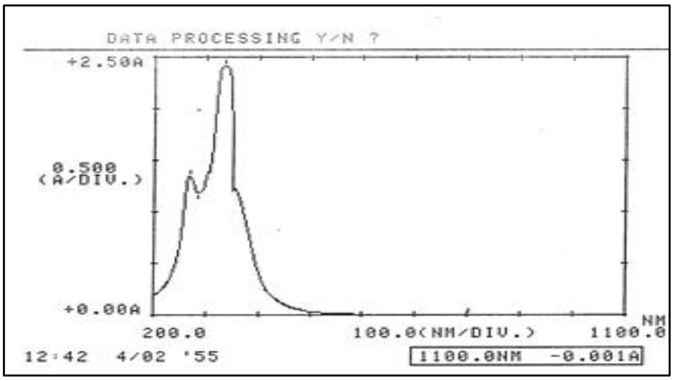


Fig.(5)UV-Vis spectrum ***of Ligand*** (H_2L)

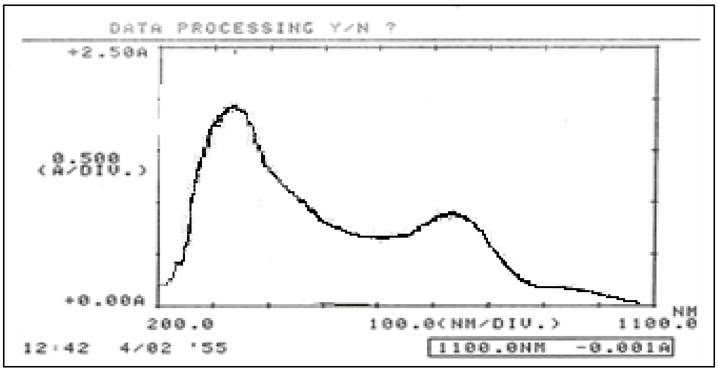


Fig.(6)UV-Vis spectrum *of Complex*[Co(L)(H_2O)$_2$

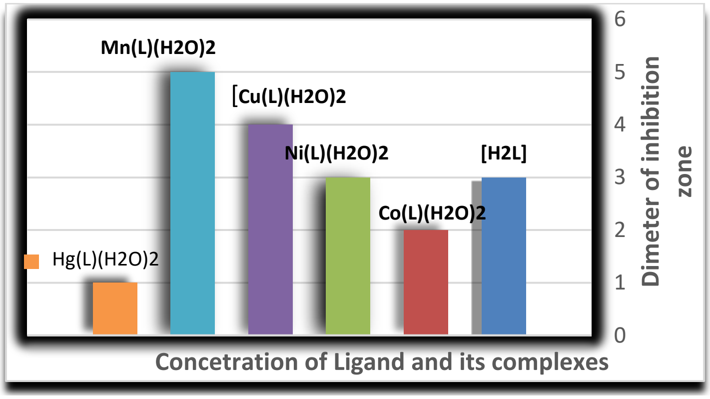


Fig.(7) Effect of *Escherichia colei*

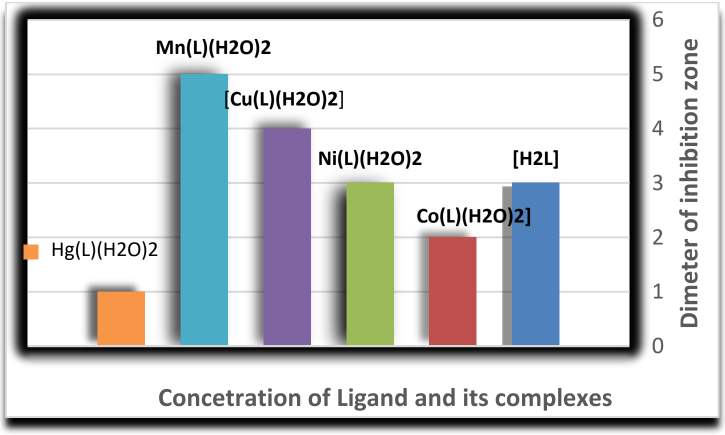


Fig.(8) Effect of *staphylococcus aureus*

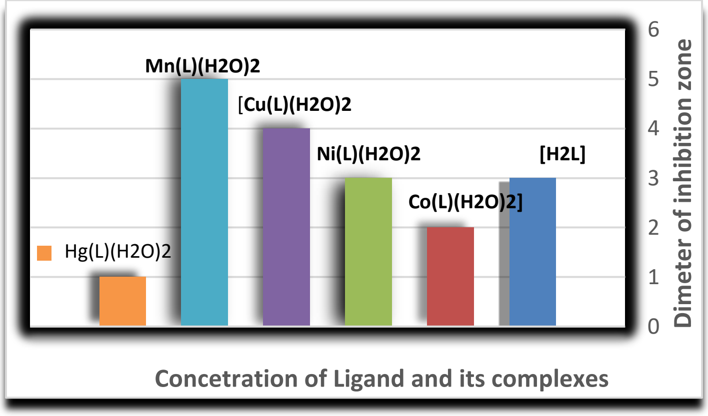


Fig.(9) Effect of *Bacllussubtilis*

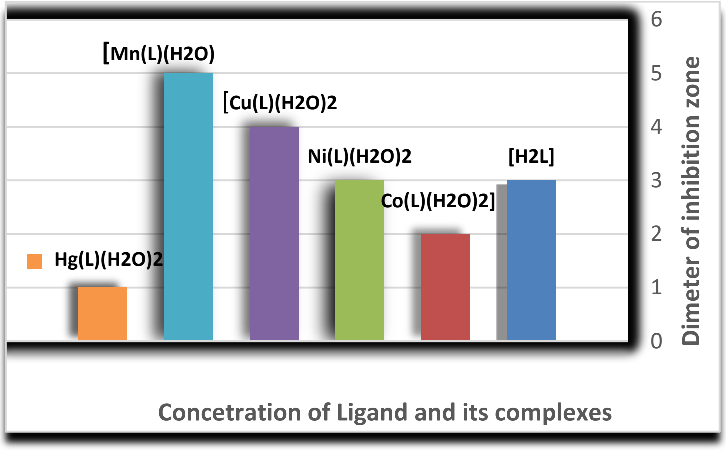


Fig.(10) Effect of *Pseudomonas aeruginosa*

CONCLUSION

The new Schiff ligand (L) and metal complexes were prepared $[Mn(L)(H_2O)_2]$,$[Co(L)(H_2O)_2]$, $[Ni(L)(H_2O)_2]$, $[Cu(L)(H_2O)_2]$ and $[Hg(L)(H_2O)_2]$. The metal (II) ions are coordinated by two N atoms for imine (H-C=N) groups and two O atoms for caboxylate (COOH) groups. Spectroscopic, structurical and magnetic data show that all complexes are six-coordinate metal complexes owing to the ligation of tetradentate ligand moieties with two coordinated water shows schemes (1&2).

REFERENCES

1. Mathur NN, A Kasana, Bargotya S, Manna B; Biological Activities of Some New Environmentally Safe 2-Aminobenzothiazole Complexes of Copper (II) Derived Under Microwave Irradiation. Int. Arch. App. Sci. Technol., 1995; 5(1):37-42.
2. Maurya RC, Verma R, Singh H; Synthesis and Physico-Chemical Studies of Some Mixed-Ligand Complexes of bis (Benzoylacetonato)copper(II) with Some Biologically Active Heterocyclic Chelating Donors. Synthesis and Reactivity in Inorganic and Metalorganic Chemistry, 2003; 33(6): 1063-1080.
3. Samir AH, Hasan A, Azi MR; Synthesis of some metal complexes of azo type ligand and evaluation of their antibacterial activity. Journal of College of Education al- mustansirya university, 2010; 1(6): 392-406.
4. Tajmir-Riahi HA; Coordination chemistry of vitamin C. part II. Interaction of Lascorbic acid with ZnII, CdII, HgII and MnII ions in the solid state and in aqueous solution.Journal of Inorganic Biochemistry, 1991; 42(1): 47-55.
5. Saravanakumar D, Sengottuvelan N, Priyadarshni G, Kandaswamy M, Okawa H; Synthesis of unsymmetrical end-off phenoxo and oximinatodibridged Copper(II) and nickel(II) complexes: spectral, electrochemical and magneticproperties. Polyhedron, 2004; 23(4): 665-672.
6. Sakakibara Y, Okutsu S, Enokida T, Tani T; Red organic electroluminescence devices with a reduced porphyrin compound, etraphenylchlorin. Applied Physics Letters, 1999; 74(18): 2587.
7. Djebbar S, Benali B, Deloume J; Synthesis, characterization, electrochemical behaviour and catalytic activity of manganese(II) complexes with linear and tripodaltetradentate ligands derived from Schiff bases. Trans.Met., 1998; 23(4): 443-447.
8. Vollhardt P, Schore N; Organic Chemistry,Structure and Function. 6thEdition, W. H. Freeman, 2010.
9. Mishchenco AV, Lukov VV, Popov LD; Synthesis and physicochemical study of complexation of glyoxylic acid arolhydrazone, with Cu (II) in solution and solid phale. Joural of coordination chemistry, 2011; 64(11):1963- 1976.
10. Cemal S, Zeliha H, Hakan D; Synthesis, characterizations and structure of NO doner Schiff base ligands and nickel (II) and copper(II) complexes. Journal of Molecular structure, 2011; 977(s 1–3): 53- 59.
11. Abdulghani AJ, Abbas NM; Synthesis, characterization and biological Activity study of New Schiff and mannich bases and some metal complexes derived from isatin and dithiooxamide. Hindawi publishing corporation bioinorganic chemistry and applications, 2011; 45: 1-15.
12. Arif M, Qurashi MM, Shad MA; Metal- based antibacterial agents; synthesis, characterization, and in vitro biological evaluation of cefixime-derived Schiff bases and their complexes with Zn(II), Cu(II), Ni(II) and Co(II). Journal of coordination chemistry, 2001; 64(11):1914-1930.
13. Lever AB; Inorganic electronic spectroscopy. 2nd edn. Elesvier, New York, 1984.
14. Dominik C, Branko K; Schiff base derived from 2-hydroxyl-1-Naphthaldehydeand liquid-assisted mechanochemical synthesis of its isostructuralCu(II) and Co(II) complexes. Crystengcomm, 2011; 13: 4351-4357.
15. Geary WJ; The use of conductivity measurements in organic solvents for the characterisation of

coordination compounds. Coord. Rev., 1971; 7: 81-122.

16. Maurya RC, Rajput S; Vanadium Complexes of Bioinorganic Relevance: Synthesis, Magnetic, and Spectral Studies of Some M ixed-Ligand Oxovanadium (IV) Complexes Having an N, O-Donor Environm. Synthesis and Reactivity in Inorganic and Metal-organic Chemistry, 2003; 33: 1877-1894.
17. Fleming I, William DH; Spectroscopic methods in organic chemistry. Ed. McGraw Hill publishing company ltd, London, 1966.
18. Socrates G; Infrared Characterstic Group Frequencies. Wiley, NewYork, 1980.
19. El-Sonbati AZ, El-bindary AA Al-Sarawy A.A; Stereochemistry of new nitrogen containing heterocyclic aldehyde. IX. Spectroscopic studies on novel mixed ligand complexes of Rh (III). SpectrochimActa Part A, 2002; 58: 2771-2778.
20. Sutton D; Electronic spectra of Transition Metal complexes. McGRAW-HILL, London, 1968.
21. Sreedaran S, Bharathi KS, Rahiman AK, Rajesh K, Nirmala G, Jagadish L, Kaviyarasan V; Narayanan V; Synthesis, electrochemical, catalytic and antimicrobial activities of novel unsymmetrical macrocyclicdicompartmental binuclear nickel(II) complexes. Polyhedron, 2008; 27: 1867.
22. Orgel L; An Introduction to transition metal Chemistry. 2nded,Wiley, New York, 1966.
23. Shank RC, Duguid JP, Marmion BP, Swain RA; Medical Microbiology the Practical of Medical Microbiology. 12th 2ed. Longan Group Lted London, 1975.
24. Geeta B, Ravinder V; Synthesis, characterization and biological evaluation of mononuclear Co(II), Ni(II) and Pd(II) complexes, with New N_2O_2 schiff base ligand",chem., pharm. Bull., 2011; 95 (2):166-171.
25. Sh. Rakesh K, Munirathnam N, Ashoka GS; Asymmetric allylicalkylation by palladium-bisphosphinites. Tetrahedron; Asymmetry, 2008; 19:555–663.
26. Sh. Jasim S; Synthesis, Characterization of new Schiff base and some metal complexes derived from Glyoxylic acid and O-phenylenediamine. Ibn-AL-Haitham, Journal for Pure and Appllied Science, 2012; 25:64-275.
27. Silverstein MR, Bassler GC, Morrill TC; Spectrometric Identification of Organic Compounds. 4th ed., John Wiley and Sons, New York, 1981.
28. Sajjad M, Shokoh B, Sh. Asad; Heterotrinuclear Manganese (II) and Vanadium (IV) Schiff base complexes, as epoxidation catalysts. Transition met chem., 2011; 36: 425-431.
29. Tajmir R; Coordination chemistry of Vitamin C part I. Interaction of L-Ascorbic Acid with Alkaline Earth Metal Ions in the Crystalline Solid and Aqueous Solution", J. Inorg. Biochem, 1990; 40: 181-188.
30. Tajmir R; Coordination chemistry of Vitamin C. part (II). Interaction of L- Ascorbic Acid with Zn(II), Cd(II), Hg(II), and Mn(II) Ions in the solid state and in Aqueous solution. Int. J. Inorg. Biochem, 1991; 42: 47-55.
31. You ZL, Zhu HL; Syntheses, crystal structures, and anti-bacterialactivities of four schiff base complexes of copper and zinc. Zeitschrift fur Anorganische und AllgemeineChemie, 2004; 630(15): 2754–2760.
32. Golcu A, Tumer M, Demirelli H, Wheatley RA; Cd(II) and Cu(II) complexes of polydentate Schiff base ligands. Journal of Inorganic Chemistry synthesis, characterization, properties and biological activity. InorganicaChimicaActa., 2005; 358 (6): 1785–1797.
33. Choudhury CR, Dey SK, Mondal N, Mitra S, Mahalli SO, Malik KM; Synthesis and structural characterization of $[Ni(Me_2NCH_2CH_2CH_2N{=}CHC_6H_4O)_2]$. Journal of Chemical Crystallography, 2001; 31(1): 57–62.
34. Chandra S, Sangeetika X; EPR, magnetic and spectral studies of copper (II) and nickel(II) complexesofschiff base macrocyclicligand derived from thiosemicar- bazide and glyoxal. SpectrochimicaActa., 2012; A, 60.
35. Martinez MP, Llavori RB, Cabo MJA, Pedersen TB; Integrating Data Warehouses with Web Data: A Survey. IEEE Trans. Knowledge and Data Eng. preprint, doi:10.1109/TKDE.2007.190746, 21 Dec. 2007.