Synthesis and characterization of new schiff base ligand derived from 2- aminopyridine and benzil and its complexes with some metal ions and Evaluation of their antibacterial activity

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Abstract

this work includes the preparation and characterization of bidentate ligand (L).The ligand was obtained from the reaction of benzil with 2- amino pyridine .

The synthesized ligand(L) was characterized by using physical and spectroscopicmethods(FT-IR , UV-Vis, ^{1}H,^{13} C-NMR, Mass , CHNS ,andmelting point) The ligand complexes were synthesized from ligand(L) with metal ion (Mn(II),Co(II),Ni(II),Cu(II),Zn(II),Cd Cd(II)and Hg(II)). All complexes were characterized byusing physical and spectroscopicmethods(FT-IR , UV-Vis, ^{1}H,^{13} C-NMR, TGA , Mass and CHNS), setting the chlorine content and designating the percentage ofmetal in addition to measuring the molar conductivity and magnetic sensitivity. These measurements showed the tetrahedral geometricshape of (Mn,Cu,Zn,Cd and Hg) ions and octahedral geometricshape of metal-ion complexes (Co and Ni). Then a test for antibacterial activity of ligands and complexes prepared against two types of bacteria (*Escherichia Coli*)and (*staphylococcus aureus*) the results showed that the prepared preparedwere effective against this bacteria.

Key words: Characterization, Schiff base , Benzil ,2- amino pyridine antibacterial activity .

Introduction:

Schiff basesare compounds containingthe Azomemethine group (CH=N) [(1)]. These compounds are prepared by condensation reaction of (NH_2) PrimaryAmines with (CHO) aldehydes or (CO) ketones[(2-5)] ,due to the importance of Schiff bases derivatives in biology field such as antifungal, antibacterial, anticancer and antioxidant[(6,7)], Complexes of Schiff bases containing metal ions have been studied in several research domains such as structural chemistry [(8)]. Metal complexes prepared from metal ion with Schiff bases

represent an important group of compounds due to their industrial flexibility, selectivity and sensitivity towards the central metal atom and their structural similarityto natural biological substances [9,10]Their applications were also studiedin clinical , analytical and pharmacological domains[١١]. this research reveals , through works of literature , that no work has been undertaken to prepare complexes out of transitional elements with ligands of Schiff base formed by the condensation of 2 – amino pyridine with benzil.The synthesized compound and its behaviour towards metal ions that resulted from ligands liaison with metal ion was studied .

Experimental part :

Chemicals

The following chemical substances were used throughout the research :-2- amino pyridine ,benzil, DMSO, pure ethanol, methanol, $MnCl_2.4H_2O$, $CoCl_2.6H_2O$, $NiCl_2.6H_2O$, $CuCl_2$, $ZnCl_2$, $2H_2O$, $CdCl_2.H_2O$ and $HgCl_2$They were obtained from the companies : Fluka, Aldrich, B.D.H.

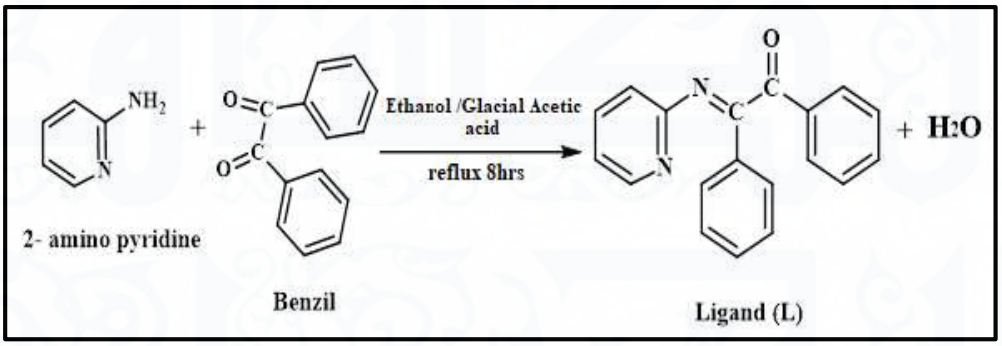
Instrumentation :

The IR spectra for prepared compounds were recorded as KBr discs using a shimadzu 8400S FTIR spectrophotometer in range (4000 – 400) cm^{-1} .Electronic spectra were recorded in the range (200-1100) nm for 10^{-3}M solution in DMSO Solvent at 25˚C, by using UV-160 Shimadzu Spectrophotometeratand quartz cell of 1 cm course .Molar Conductivity was measured at 25˚C for 10^{-3} M solution solved in DMSO by using PhilipsPW.Digital.Elemental analyses(C.H.N.S) were performed using AcrloErba 1106 elemental analyzer. Magnetic susceptibility measurements

were obtained by using a magnetic susceptibility apparatus model MSB-MKI where Faraday Method was adopted to measure the magnetic sensitivity . Metal contents of the complexes were determined by atomic absorption technique by using Shimadzu (AA680G).^{1}H and ^{13}CNMR spectrum of prepared ligand (L) and complexes were recorded on ultra shield500 MHZ, Bruker, Switzerland , using DMSO – d^6 as a solvent .Mass spectra were obtained by LC-Mass 100P Shimadzu .The chloride content for complexes were determined by using moor potentiometric titration method on (686 – swiss),Melting point was recorded by using Stuart-melting point apparatus

Preparation of schiffbase :

2-amino pyridine (0.188 g, 1mmol) dissolved in absolute ethanol (25 ml) was gradually added with a constant stirring to a solution of benzil(0.42g, 1mmol) dissolved in (30 ml) ethanol with drops from glacial acetic acid(12) And the mixture was evaporated for (8hrs), at 56˚C then cooled at room temperature . A yellowsolid substancewas collected by filterition, washed with ethanol and recrystalizedby methanol to give yellowish crystals (scheme-1). The yield percentage was 8٥ % and melting point (103˚- 105˚C) .



Scheme 1: Structure of Schiff base L= [$C_{19}H_{14}N_2O$]

Synthesis of Mn(II),Co(II),Ni(II),Cu(II),Zn(II),Cd(II) and Hg(II) complexes

All metal complexes were prepared in 1:1 molar ratio (metal : ligand). Where (1 mmol) of metal salt dissolved in (15 ml) of ethanol ($MnCl_2.4H_2O$, $CoCl_2.6H_2O$, $NiCl_2.6H_2O$, $CuCl_2.2H_2O$, $ZnCl_2$, $CdCl_2.H_2O$and $HgCl_2$)in a round flask .Schiff base ligand (0.286 ,1mmol) dissolved in (10 ml) ethanol was added and heated mildly . In order to complete the dissolving process the mixture was evaporated for 6 hours at (50 - 60°C) . A solid yellowish – green substance resulted ; it was washed several times by hot ethanol , then dried by air . The physical properties for the complexes are given in table (1-1).

Antimicrobial :

Antimicrobial activities were testedfor the prepared complexes against two types of bacteria one is theGram-negative(Gr^{-ve})which is*Escherichia coli* ,the other is the Gram-positive (Gr^{+ve}) which is*Staphylococcus aureus*.

Results and Discussion :

Bidentate complexes were obtained upon reaction between metal ions and Schiff base with molar ratio (1:1) (M:L). The synthesized Schiff base ligand and its complexes are very stable at room temperature in the solid state. The ligand and its metals complexes are generally soluble in DMF , DMSO ,Methanol and Ethanol . the complexes were diagnosed by the accurate elemental analysis technique (C.H.N) ; chlorine content and metal ratio measurements were taken by atomic absorption technique . with atomic absorption technology .Results were reported in Table (1-1)shows

some physical properties .,The resulting values were practically compared with the calculated values theoretically and a significant convergence was observed, confirming the validity of the proposed chemical formulas for the complexes. The table (1-1) shows alsosome Physical properties .

Table (1-1):Resultsof the accurate elemental analysis for elements and some physical properties of the Ligand and its complexes

Comp. No.	M.Wt g/mole	Color	M.P °C or dec	Found % , (calc. %)				
				C	H	N	Metal	Cl
L	286.33	Yellow	103-105	79.70 (79.91)	4.93 (4.76)	9.78 (9.64)	---	---
$[Mn(L)\ Cl_2]$	412	Brass	99	55.37 (55.31)	3.42 (3.36)	6.80 (6.73)	13.33 (13.24)	17.20 (17.19)
$[Co(L)(H_2O)_2Cl_2]$	452	Air Force blue	135	47.05 (50.33)	4.01 (5.13)	6.20 (6.28)	13.03 (12.98)	15.68 (15.57)
$[Ni(L)(H_2O)_2Cl_2]$	452	Virid	114	50.49 (50.28)	4.01 (4.16)	6.20 (6.32)	12.99 (12.85)	15.69 (15.74)
$[Cu(L)_2Cl_2]$	421	Apple green	140–145	54.23 (54.31)	3. 35 (3.22)	6.66 (6.54)	15.10 (15.07)	16.85 (16.69)

$[Zn(L)_2Cl_2]$	423	Yellow white	97	54.00 (53.86)	3.34 (3.27)	6.63 (6.57)	15.47 (15.42)	16.78 (16.69)
$[Cd(L)_2Cl_2]$	470	Lemon chiffon	97 – 102	48.59 (48.36)	3.00 (2.88)	5.96 (6.09)	23.49 (23.76)	15.10 (14.95)
$[Hg(L)_2Cl_2]$	558	Yellow white	194– 200	54.07 (54.02)	3.34 (3.29)	6.64 (6.71)	23.76 (23.68)	8.40 (8.35)

The magnetic sensitivity measurements of the prepared complexes were performed at absolute temperature (298) and the effective magnetic momentum values were calculated.Molecular conductivity of complex solutions was measured at a concentration of (10^{-3} × 1) in DMSO solvent and laboratory temperature ,and the results were reported in Table.These results gave support to "proposed molecular formulas" and it was ascertained that the chloride ion was not out of the consistency ball by the silver nitrate solutiondissolved in the distilled water,It was observed that the complex solution dissolved in the absolute ethanol was not turbid and remained limpid and that no precipitate was present when silver nitrate was added indicating that chloride ion was not present outside the ball of consistencyas an ion accompanying.Table (1-2) illustrates that .

Table (1-2): magnetic sensitivity, conductivity data and the proposed structure of the complexes

Complexes	M.C $\mu s.cm^{-1}$	μ_{eff} (B.M)	Suggested structure
$[Mn(L)\ Cl_2]$	14.87	٣٨.٤	td
$[Co(L)(H_2O)_2Cl_2]$	14.55	4.79	O.h
$[Ni(L)(H_2O)_2Cl_2]$	15.5	3.12	O.h
$[Cu(L)Cl_2]$	14.15	1.04	td
$[Zn(L)Cl_2]$	14.79	----	td
$[Cd(L)Cl_2]$	17.48	----	td
$[Hg(L)Cl_2]$	6.01	----	td

IR spectra

The coordination mode and sites of link in the complexes were investigated by comparing the infrared spectra of the free ligand with its metal complexes Table (1- 3) .The peak at 1664cm^{-1} in the spectrum (fig.1)belongs to υ C = O of benzilbased Schiff base ligand and , Shifted towards upper values at range (1655-1680)cm-1indicating the coordination of oxygen atom of these carbonyl group[12,13].The spectrum of free ligand shows a band of absorption at 1585cm-1 characteristics of the υ C=N(azomethine) stretching mode indicating the formation of Schiff base product. Thesevalues shifted towards ranging frequencies in the spectra of its complexes (1574 -1606)cm^{-1}, compared with the above Schiff base indicating the involvement of the azomethine

nitrogen atom in the coordination with metal ions[14,15] . The IR spectra of Co(II) (fig.2) and Ni(II) complexes showed a absorption bandsat (3176-3425)cm^{-1} respectively , which pertain to the stretching frequency υ (O–H) and indicate the existence of crystalized , coordinated water in the complex[16,17] . The IR spectra of the prepared complexes also showed new absorption bandspertaint, M-N at the frequencies (459-515)cm^{-1} that support the consistency occuringbetween metallic ion and nitrogen atom in 2-amino pyridine, The other bands have shown at frequencies 422-437 pertain to υ (M-O), which support the consistency between the metal ion and the carbonyl atom O in the ligand[13,18] .

Table (1- 3): Main absorption bands locations in IR spectra for the prepared complexes

complexes	ν (O – H)	ν (C = O)	δ (C = O)	ν (C = N) ν (C – N)	ν (M - N)	ν (M - O)	δ (C = C) arom	ν (C - H) arom	ν (C - H) aleph
L	—	1664 vs	638 m	1585 s 1311 s	—	—	1488 vs	3055 m	—
[Mn (L) Cl_2]	—	1655 sh	640 s	1596 s 1321 m	465 w	422 w	1448 s	3066 w	2971 w
[Co (L)$(H_2O)_2Cl_2$]	3475 3176 b	1656 sh	640 s	1606 s 1319 m	467 w	424 w	1448 s	3062 w	2965 w
[Ni(L) $(H_2O)_2Cl_2$]	3425 3319 b	1622 w	640 s	1595 s 1321 m	465 w	428 w	1448 s	3066 w	2979 w
[Cu (L) Cl_2]	—	1724 s	622 w	1597 s 1324 m	515 w	437 w	1462 w	3034 w	2977 w
[Zn (L) Cl_2]	—	1680 s	677 s	1578 w 1347 m	461 w	426 w	1441 s	3070 w	2968 w
[Cd (L) Cl_2]	—	1652 w	648 s	1591 s 1321 m	465 w	428 w	1448 s	3064 w	2974 w
[Hg (L) Cl_2]	—	1670 s	644 s	1574 w 1327 m	459 w	431 w	1441 s	3062 w	2970 w

Strong= S , weak= w , middle = m , broad = b , shoulder = sh

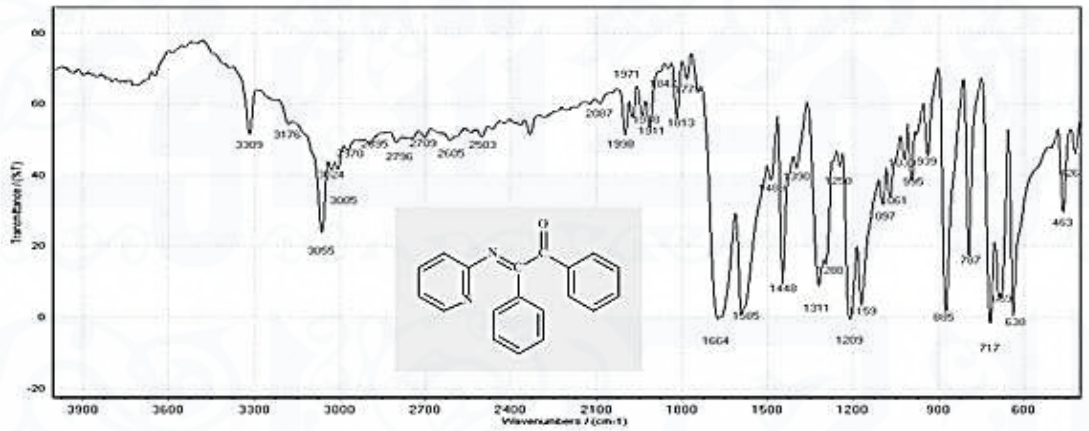


Fig.(1): Infrared spectrum of ligand (L)

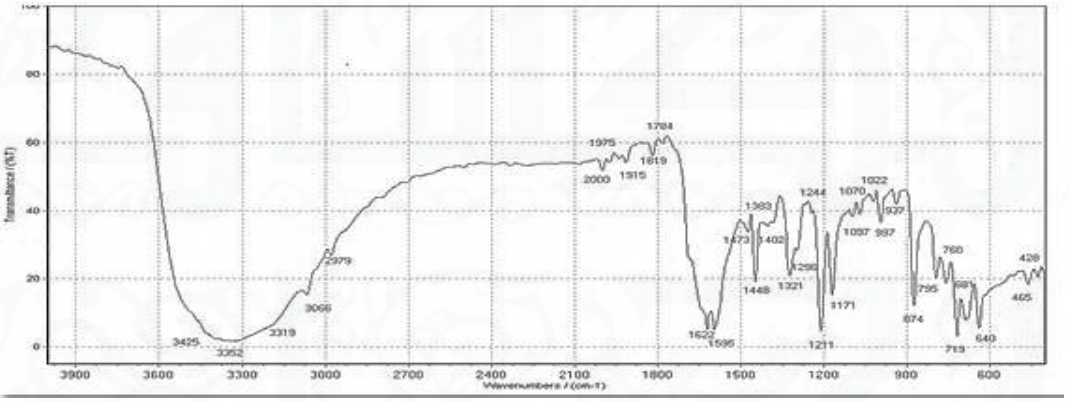


Fig.(2): Infrared spectrum of complex $[Ni(L)(H_2O)_2Cl_2]$

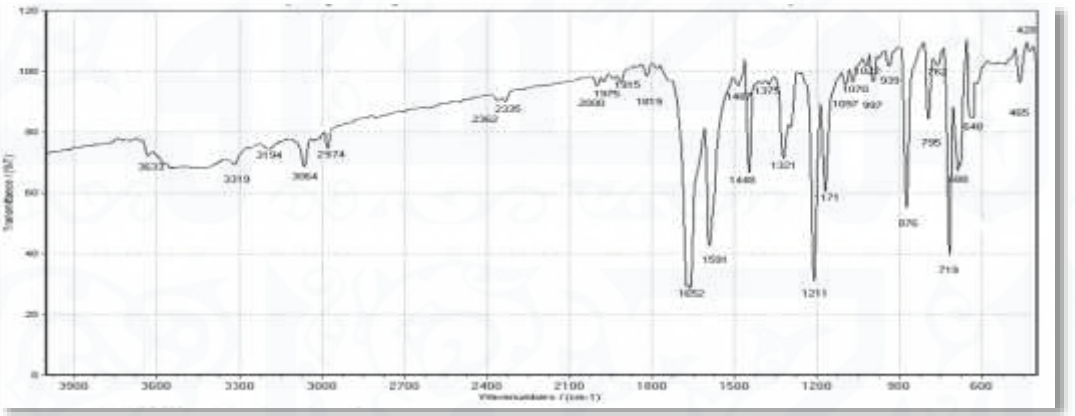


Fig.(3): Infrared spectrum of complex $[Cd(L)Cl_2]$

Electronic spectra of ligands and complexes:[19-22]

The visual IR spectrum for the prepared ligand showed two high tension absorption peaks arranged as in table (4-1) respectively . They appeared by turns at (283) nm,(218) nm resulting from the electronic transition π → π* in the ligand spectrum .

The visual IR spectrumfor the preparedcomplexes also showed different absorption peak , where they were displaced to higher frequencies in some of them and to lower frequencies in some others compared with the ligand spectrum . In Mn(II) complex, the spectrum showed four absorption peaks : the high- tension first one at (284) nm pertaining to the electronic transition (π → π*) of the ligand range , the second , third and fourth at (378)nm, (780)nmand (924) nm attributed to the electronic transition (d-d) of type $^{6}A_1g \rightarrow {}^{4}T_1g_{(D)}$, $^{6}A_1g \rightarrow {}^{4}T_1g_{(G)}$ and $^{4}A_1g \rightarrow {}^{4}Eg_{(D)}$,which indicate the tetrahedral geometric shape of the complex . The electronic spectrum for the complex Co(II) showed three new absorption peaks . The first one at (278) nm pertaining to (π → π*), the second and third peaks at (732)nm and (964) nm pertaining to the electronic transitions (d-d)of type : $^{4}T_1g \rightarrow {}^{4}A_2g_{(F)}$, $^{4}T_1g_{(F)} \rightarrow {}^{4}T_2g_{(F)}$which indicate . the octahedron geometric shape (figure 5). The electronic spectrum of Ni(II) complex displayed four new absorption peaks. The first peak at (279) nm attributed to the (π → π*), and the second , third and four peaks at (338)nm , (768)nm and (928)nm due to (d-d) electronic transitions type $^{3}A_2g_{(F)} \rightarrow {}^{3}T_1g_{(b)}$, $^{3}A_2g_{(F)} \rightarrow {}^{3}T_1g_{(F)}$, $^{3}A_2g_{(F)} \rightarrow {}^{3}T_2g_{(F)}$,which are a good evidence for octahedral geometry[13]. The electronic spectrum of Cu(II) displayed two new absorptionpeak. The first peak at (264)nm attributed to the (π → π*) , and the second peak at (816)nm due to (d-d) electronic transitions type $^{2}T_2g \rightarrow {}^{2}Eg$, which is a good evidence for distorted tetrahedral geometry.The

electronic spectrum of Zn (II) complex displayed one new absorption peak. at (282)nm attributed to the transition (π → π*) which is a good evidence for tetrahedral geometry. The electronic spectrum of Cd(II) complex displayed one new absorption peak. at (283)nm attributed to the transition (π → π*) which is a good evidence for tetrahedral geometry. and The electronic spectrum of Hg (II) complex displayed one new absorption peak at(275)nm attributed to the (π → π*) which is a good evidence for tetrahedral geometry(fig.6)[22].Table (1-4) shows the results of the spectrum .

Table1- 4: Electronic Spectral Data of the Metal Complexes with Ligand

Compounds	λ(nm)	υ (cm^{-1})	ε_{max} L.mol^{-1}.cm^{-1}	Transition	Suggested Formula
L =$C_{19}H_{14}N_2O$	283	35336	2486	π→π*	----
	218	45872	1852	π→π*	
	284	35212	671	π→π*	
[[Mn(L)Cl_2]	378	26456	143	$^6A_1g \rightarrow {}^4T_2g_{(D)}$	
	780	12821	162	$^6A_1g \rightarrow {}^4T_1g_{(G)}$	Tetrahedral
	924	10823	186	$^4A_1g \rightarrow {}^4Eg_{(D)}$	
	278	35971	1284	π→π*	
[Co(L)($H_2O)_2Cl_2$]	732	13662	12	$^4T_1g(F) \rightarrow {}^4A_2g$ (F)	Octahedral
	964	10374	18	$^4T_1g(F) \rightarrow {}^4T_2g$ (F)	
	279	35843	1682	π→π*	
	338	29586	79	$^3A_2g(F) \rightarrow {}^3T_1g$ (b)	

$[Ni(L)(H_2O)_2Cl_2]$	768	13021	16	$^3A_2g(F)\rightarrow{}^3T_1g\ (F)$	Octahedral
	928	10776	18	$^3A_2g(F)\rightarrow{}^3T_2g\ (F)$	
$[Cu(L)Cl_2]$	264	37879	2284	$\pi\rightarrow\pi^*$	
	816	12255	16	$^2T_2g\rightarrow{}^2Eg$	Tetrahedral
$[Zn(L)Cl_2]$	282	35461	614	$\pi\rightarrow\pi^*$	Tetrahedral
$[Cd(L)Cl_2]$	283	35336	746	$\pi\rightarrow\pi^*$	Tetrahedral
$[Hg(L)Cl_2]$	275	36364	2756	$\pi\rightarrow\pi^*$	Tetrahedral

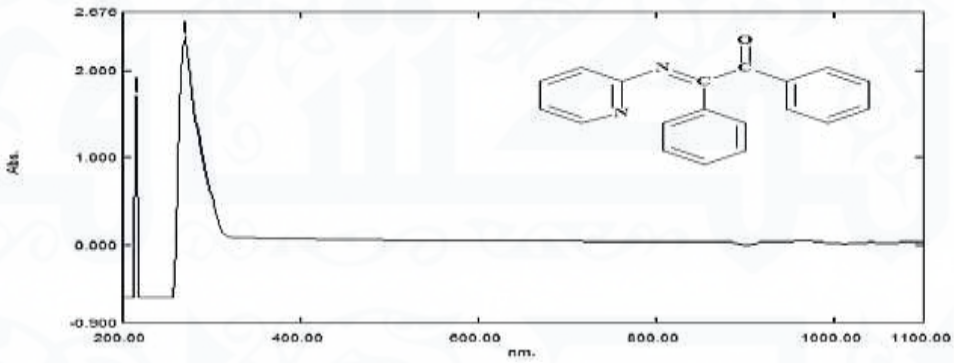


Fig.(4): U.V spectrum of ligand (L)

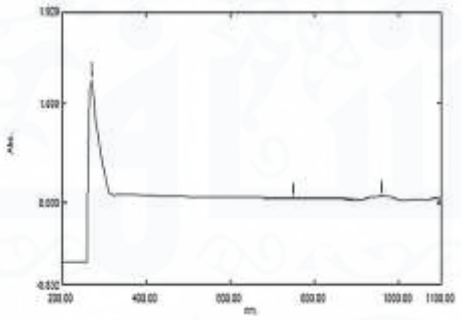


Fig.(5): Electronic spectrum for $[Co(L)(H_2O)_2Cl_2]$

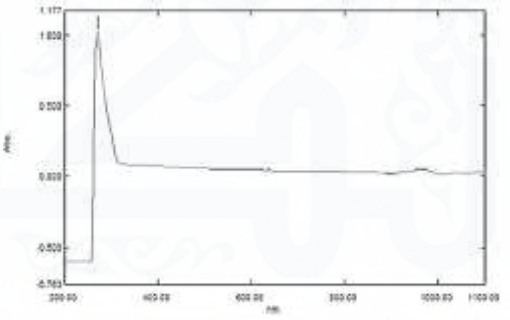


Fig. (6): Electronic spectrum for $[Hg(L)Cl_2]$

^{1}H, $^{13}CNMR$ spectra:

The ^{1}H,$^{13}CNMR$ spectra of the Schiff base ligand and its$^{1}HNMR$ zinc complex were recorded at lab temperature in DMSO – d^{6} .The aim of this work was to compare the chemical shifts of different protons for Schiff base ligand with that recorded for zinc complex .The predicted 1HNMR spectrum of the free ligand (Fig.8,Fig.9) showed signals at : multiplate signals for Ar –H at range (7.51–7.71) ppm ,DMSO – d^{6} at range (2.50–2.51) ppm.The spectrum $^{13}CNMR$ showed unique bands which pertain to carbon atoms,by determining the values directly on each carbon atom as shown in (Fig.7) .However the $^{1}HNMR$ spectrum of the zinc complex (Fig.10) showed signals of coordinated ligand, where we observe that displacement occured at the site of peaks in the spectrum compared with its location in the ligand spectrum , as the , where we observe that displacement occurred at the site of peaks in the spectrum compared with its location in the ligand spectrum , as the ligand molecular becomes less able to bend as a result of congruity ; moreover , the number of protons accord with those of the proposed formula of the complex , and that $^{1}HNMR$ spectrum affirms the complex stability in the solvent DMSO – d^{6}.[23, 24]

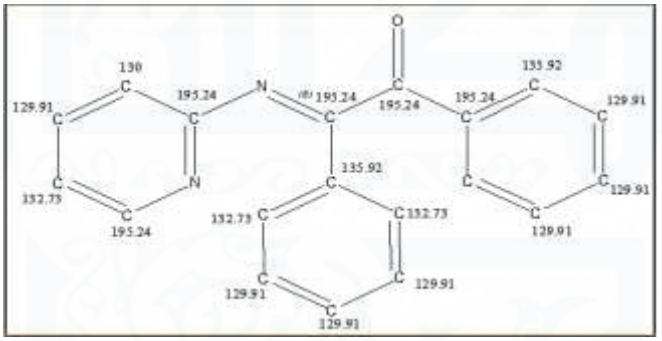


Fig. (7): Values of $^{13}CNMR$ Signals on carbon atoms

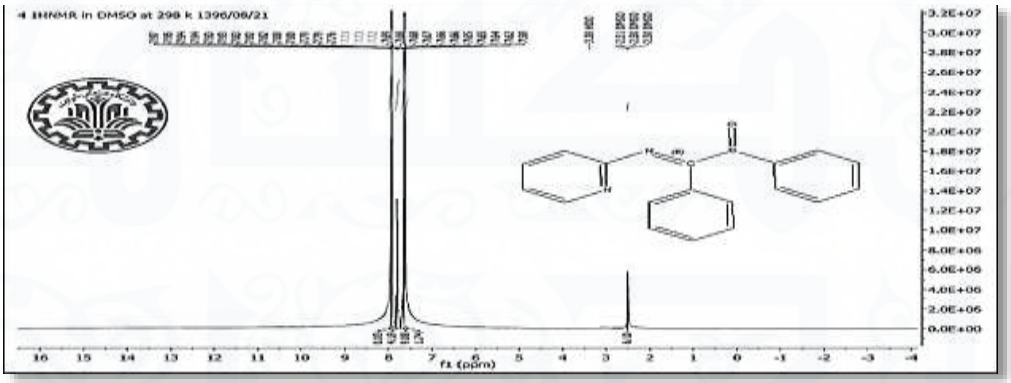


Fig.(8): 1H-NMR spectrum of ligand (L)

Fig.(9): ^{13}C-NMR spectrum of ligand (L)

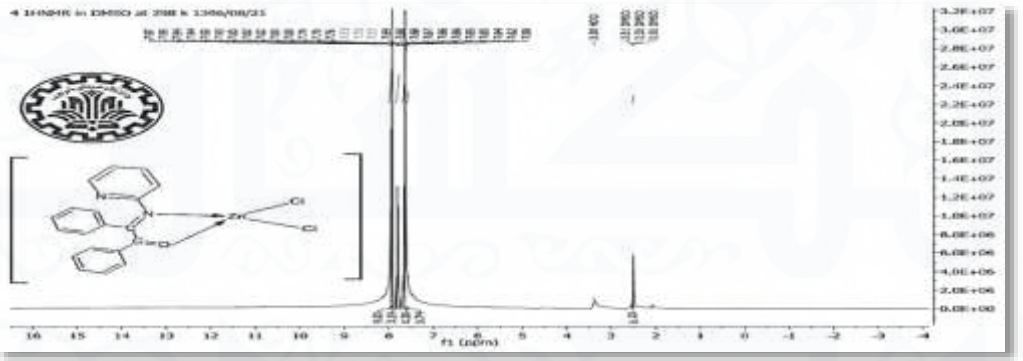


Fig.(10): 1H-NMR spectrum of [Zn(L)Cl$_2$]

Thermogravimetric decomposition study:

Certain complexeswere determinedby the (TGA)curve . This technology measures mass change in term of temperature in subjecting this substance to the control of a heating program at a given time . The resulted curve is called "thermogravimetric curve " [25].

The results of (TGA) for the complexes shown in table (1-5).display results that show conformity with the suggested formula of complexes which support the results of elements analysis .

Table (1-5): Thermal analysis data of some metal complexes

Complexes	Step	Ti ˚C	T_f ˚C	T_{DTG} max	Weight mass loss (calc)	Found %	Reaction	Total mass ٪loss
$[Co(L)(H_2O)_2Cl_2]$	1	78.4	193	138	7.964	9.8495	$-2H_2O$	(83.185)
	2	193	319	296	43.805	44.6922	$-C_9H_6NCl_2$	84.0201
	3	319	535	443	31.416	29.4784	$-C_{10}H_8N$	
							CoO	
المتبقي عمليا =% 15.9799 والذي يمثلCoO المتبقي من المعقد ونظرياً المتبقي 16.815%								
$[Cu(L)Cl_2]$	1	39	389	204	38.425	39.2393	$-C_7H_7Cl_2$	(81.145)
	2	396	588	478	42.720	43.7517	$-C_{12}H_7N_2$	82.991
							CuO	
المتبقي عمليا =% 17.009 والذي يمثلCuO المتبقي من المعقد ونظرياً المتبقي % 18.855								

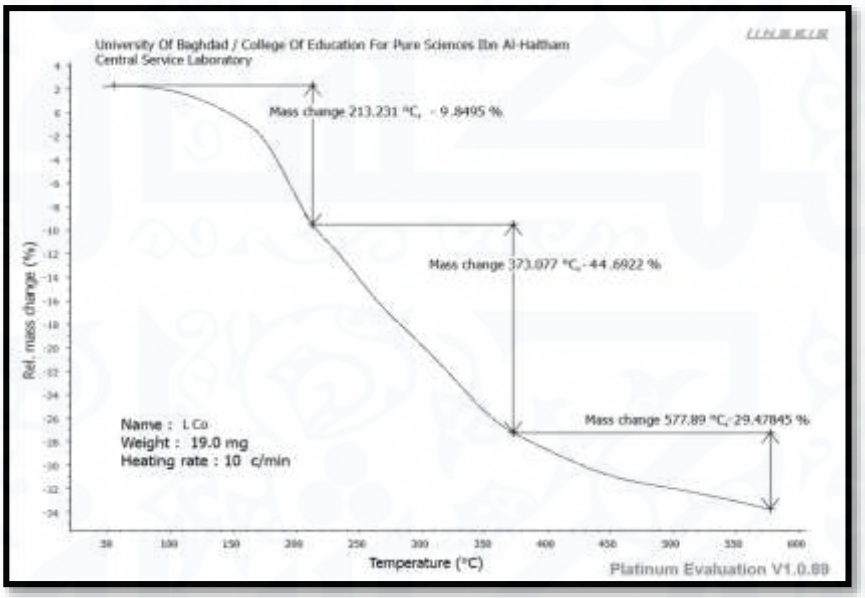


Fig. 11: TGA and DTA Curve of the complex[Co(L)(H_2O)$_2$$Cl_2$]

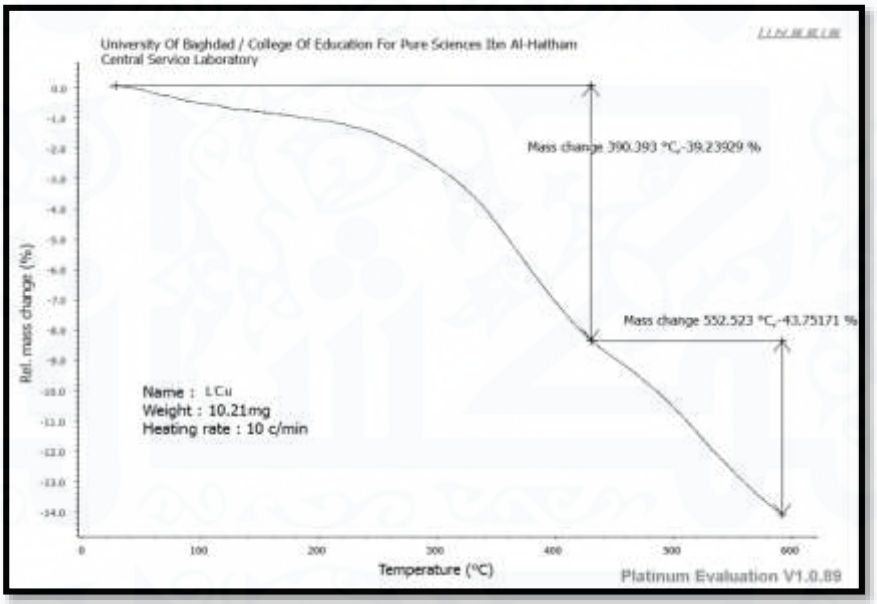


Fig. 12: TGA and DTA Curve of the complex [Cu(L)Cl_2]

Mass spectra for ligand and some prepared complexes:

The LC-Mass spectra used to support and determine the molecular weights of ligandand complexes[26].The ligand measurement was done and complexMn(II) (figure 13 and figure 14) ,The results showed their molecular weights as in the table (1-6) .

L =$C_{19}H_{14}N_2O$		[Mn(L)Cl_2]	
Assignment	**Peak m/z**	**Assignment**	**Peak m/z**
M= $^{+}(C_{19}H_{14}N_2O$	285.7	M=$^{+}(C_{19}H_{14}N_2OMnCl_2$	410.9
M- H O = M_1^+	268.8	M- C = M_1^+	398.9
M_1- C_7H_4N = M_2^+	166.9	M_1- $C_9H_3OCl_2Mn$ =M_2^+	152.9
M_2 N = M_3^+	152.9	M_2 – H_2 =M_3^+	150.9
M_3 H_2 = M_4^+	150.9	M_3 – N = M_4^+	136.9
M_4 – CH_2= M_5^+	136.9	M_4 – NH_2 = M_5^+	120.9
M_5 C_3H_4= M_6^+	96.9	M_5 – C_2 = M_6^+	96.9
M_6 C_3 = M_7^+	60.9	M_6 – C_3 = M^+_7	61.9

Table (1-6): The Fragmentation Pattern data for Ligand and Complexe

Fig. (13): Mass spectrum of (L)

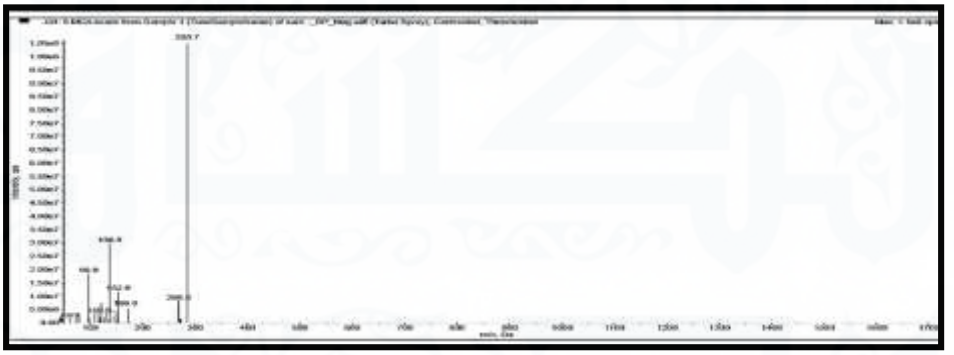


Fig.(14): Mass spectrum of [Mn(L)Cl_2]

Proposed geometric shape for the complexes :

Based on the study data of ligand spectrum and the complexes that prepared by the techniquesof accurate analysis of elements (C.H.N) , IR , electronic spectrum , 1HNMR , LC - Masson and determining of melting point , and results are also based on the complexes study on the measurement of the metal ratio by atomic absorption , chlorine content , molar conductivity , magnetic moment measurement and study by techniques on elemental microanalysis (C.H.N) , measurement of the ratio of the metal by atomic absorption , chloride containing ,molar conductivity, magnetic moment measurement and TGA ;It

was found that the prepared ligand behaves as bi – dentate as it accords with all the metal ions by the atom of N of azomethine group υ(C=N)and the atom of O of carbonyl groupυ (C = O)for benzil ligand with all the metal ions Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) . measurements of IR spectrum , electronic spectrum , ^{1}HNMR , molar conductivity , TGA , elements analysis technique (C.H.N.) and chlorine content , proved that the two complexes Co (II), Ni (II) contain two consistent water molecules each , as well as a consistent chlorine molecule in the complex which proves the octahedralgeometric shape , which confirm that the proposed for formulas in figure (15) are correct .

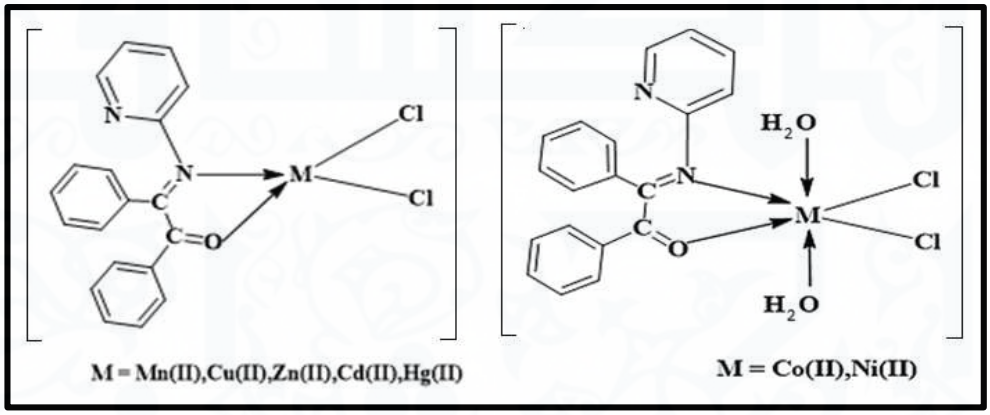


Fig.(15): Synthetic route of complexes

Antibacterial activity:

Ligand (L) and prepared complexes effect were studied against two types of bacteria : *Escherichia Coli*of gram-negative(Gr^{-ve}) and *Staphylococcus*of gram positive(Gr^{+ve}) . Dimethylsulphoxide (DMSO)was used as a solvent , and a control sample of the solvent was done which gave effectiveness of zero . A study of the prepared complexes effect on bacteria growth in the same conditions to avoid the solvent overlaps .

Escherichia Coli:

Theresultsshowed ,as in table(1-7) , that ligandSt1*(L) owned high inhibitioneffect against bacteria. Resultsalso explained that the complex[$Hg(L)Cl_2$] owned high inhibition effectagainst bacteriaat concentrations(a,b,c)by comparisionwith(St1*). And complexes [$Co(L)(H_2O)_2Cl_2$] , [$Ni(L)(H_2O)_2Cl_2$] , [$Cu(L)Cl_2$]where they showed high inhibitioneffect at the two concentrations (a,b) by comparison with (St1*); as for concentration (c) . it had mildinhibitioneffect , but it was considered the highest effect when compared with (St1*) . Complex [$Mn(L)Cl_2$]showed , through the results , high inhibition effect atconcentration (a) . Concentrations (c,b) showed mild inhibition effect , but it was the highest effect in comparison with (St1 *) . Complex [$Cd(L)Cl_2$] gave mediuminhibition effectatconcentrations(a, b, c)and it was the highest effect at comparison with (St1 *).Observingthe results , it appears that complex [$Hg(L)Cl_2$] has the highest inhibition effect for bacteria ; while the two complexes [$Zn(L)Cl_2$]and[$Cd(L)Cl_2$] have , through the given results , the least inhibition effect as in table (1-7).

Staphylococcus aureus:

Results showed ,as shown in the table(1-7)that ligand (St1)(L)has medium effect against this type of bacteria.Results showed that complex [$Hg(L)Cl_2$] has the highest inhibition effectiveness against bacteria at the two concentration (a,b) ; and concentrations (c) has high inhibition effect but less than (a,b) concentrations of complex (St1) . Complex [$Cd(L)Cl_2$] gave high

Inhibition effectat concentration (a,b) , and concentration (c) gave medium inhibition effect but higher one in comparisonwith (St1). The complexes [$Ni(L)Cl_2(H_2O)_2$] ,[$Co(L)(H_2O)_2Cl_2$]showed , through the results , medium

inhibition effect at concentration (a,b) , and concentration (c) gave medium inhibition effect but less than the two concentrations (a, b) which is the highest inhibition compared with (St1). Complex $[Zn(L)Cl_2]$ gave medium inhibitioneffect atthe two concentrations (a,b), and concentration (c) also gave medium inhibition effect and less than the concentrations(a,b) , but the highest inhibitionamong the three concentrations , but the highest inhibition when the complex concentrations are compared with (St1) . Complex $[Cu(L)Cl_2]$gave medium inhibitioneffectat concentrations (a,b,c) , and concentration (a) is regarded the highest inhibition compared with(St1). The complex $[Mn(L)Cl_2]$ had inhibition effectat (a)concentrationidentical to the activeness of ligand (St1)incomparison ; while the two concentrations (b,c) gave inhibitioneffect equals zero.

Tabie (1-7) Valuable effect inhibitionof the ligand and prepared complexes against bacteria*Escherichia Coli* ,*staphylococcus aureus*

NO	Complexes	*Escherichia Coli*				*Staphylococcus aureus*			
		St.1*	a	b	c	St.1	a	b	c
1	$[Zn(L)Cl_2]$	10.5	14	12	10.8	11	16	14.5	12
2	$[Ni(L)(H_2O)_2Cl_2]$	11	25	20	18	11	19	17	15
3	$[Co(L)(H_2O)_2Cl_2]$	11	25	22	18	11	18	16.5	15
4	$[Cu(L)Cl_2]$	11	24	20	17	10	15	13	11.5
5	$[Cd(L)Cl_2]$	10.5	18	16	15	11	22	19	16
6	$[Hg(L)Cl_2]$	11	26	22	20	14	30	27	22
7	$[Mn(L)Cl_2]$	11	20	16	12	11	15	---	---

a= 10mg/ml , b= 7.5mg/ml , c=5mg/ml
St.1* ,St.1= Ligand (L)

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