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RESEARCH ARTICLE

Structural, Spectral and Thermal Studies of Novel Tridentate Schiff Base Ligand Type (NOO) as Donor Atoms Derived from Nalidixic Acid and 4-Aminoantipyrine and Metal Complexes and Evaluation of their Biological Activity

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Abstract

In this study, a novel Schiff base (E)-4-(1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-ylimino)-1-ethyl-7-methyl-1,4-dihydro-1,8-naphthyridine-3-carboxylic acid [HL] was synthesized from nalidixic acid 4-Aminoantipyrine and its metal complexes for metal ions M=VO, Mn, Co, Ni, Cu, Zn, Pd and Pt in ethanol and acetic acid with mole ratio (M:L) (1:2). All complexes have general composition [VO (L) (SO_4)] H_2O, [$Mn(L)_2$], [$Co(L)_2$] H_2O, [$Ni(L)_2$] H_2O, [$Cu(L)_2$] H_2O, [$Zn(L)_2$].H_2O, [$Pd(KL)_2$] and [$Pt(KL)Cl_2$] Cl_2 where $L^- = C^{23}H_{22}N_5O_3$. The ligand and all complexes were characterized by modern spectroscopic (FT-IR, UV Vis, ^{1}HNMR, Mass spectroscopy, atomic absorption), along with elemental microanalysis, magnetic susceptibility measurements, thermal analyses, chloride content and molar conductance. In addition to evaluated their biological activity against one type of bacterial and one type fungus. Based on date for all techniques we suggested that all the prepared complexes have octahedral geometry accept [[VO (L) (SO_4)] H_2O] square pyramidel geometry and [Pd (KL) $_2$] Square planer geometry. The value of antibacterial activity of this prepared complexes showed higher inhibition activity compared to the free ligand and starting material.

Keywords: *Nalidixic Acid, 4-Aminoantipyrine, Metal complexes, Biological activity.*

Introduction

Schiff's base is a nitrogen analogue of an aldehyde or ketone in which C=O group is substituted by a C=N–R group. It is also known as an azomethine. The first Schiff's base was prepared by Schiff by condensation of an aldehyde with a primary amine in 1864 [1].Schiff bases are usually bi and tri-dentate ligands capable of forming very stable complexes with transition metals. Many diverse Schiff bases structures have been synthesized. These Schiff bases find versatile uses in chemistry [2]. Schiff bases appear to be important intermediates in a number of enzymatic reactions involving interaction of an amino group of the enzyme with a carbonyl group of the substrate. Many Schiff bases possess antibacterial [3], antifungal [4], antiviral [5], anticancer [6], ant tubercular [7], anticonvulsant [8], anti-inflammatory [9], antitumor [10], anti-HIV [11] and anthelmintic [12] cardiovascular. Nalidixic acid has been used in the treatment of several diseases as a powerful antibiotic drug for decontamination of the gut infections [13-20]. Nalidixic acid is effective primarily against gram-negative bacteria, with minor anti-gram-positive activity. In lower concentrations, it acts in a bacteriostatic manner; that is, it inhibits growth and reproduction. In higher concentrations, it is bactericidal, meaning that it kills bacteria instead of merely inhibiting their growth [21]. It has historically been used for treating urinary tract infections, caused, for example, by Escherichia coli, Proteus, Shigella, Enterobacter, and Klebsiella. It is no longer clinically used for this indication in the USA as less toxic and more effective

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agents are available [22]. The Chemical name is 4-Aminoantipyrine, synonyms are 4-AAP; Solnapyrin-A.; Solvapyrin-A.; Minoazophene; Aminoazophene and Aminoantipyrin; Formula is $C_{11}H_{13}N_3O$, and molecular weight = 203.24. G/mol. 4-AAP has large scale of applications in biological, clinical, analgesics, antifungal, antibacterial, anticancereous and pharmacological areas [23-26]. Schiff bases of 4-AAP and its complexes have a variety of applications in clinical, biological, analytical and pharmacological areas [27]. Properties of 4-AAP to coordinate with metal is varied by condensing it with aldehydes, ketones, thiosemicarbazides and carbazides etc., Metal complexes of 4-AAP and biological behavior involving the amino group of 4-AAP has been studied exhaustively, when compared to the work carried out on the chemistry of transition metal complexes and biological behavior involving the amino group of 4-AAP [28, 29].

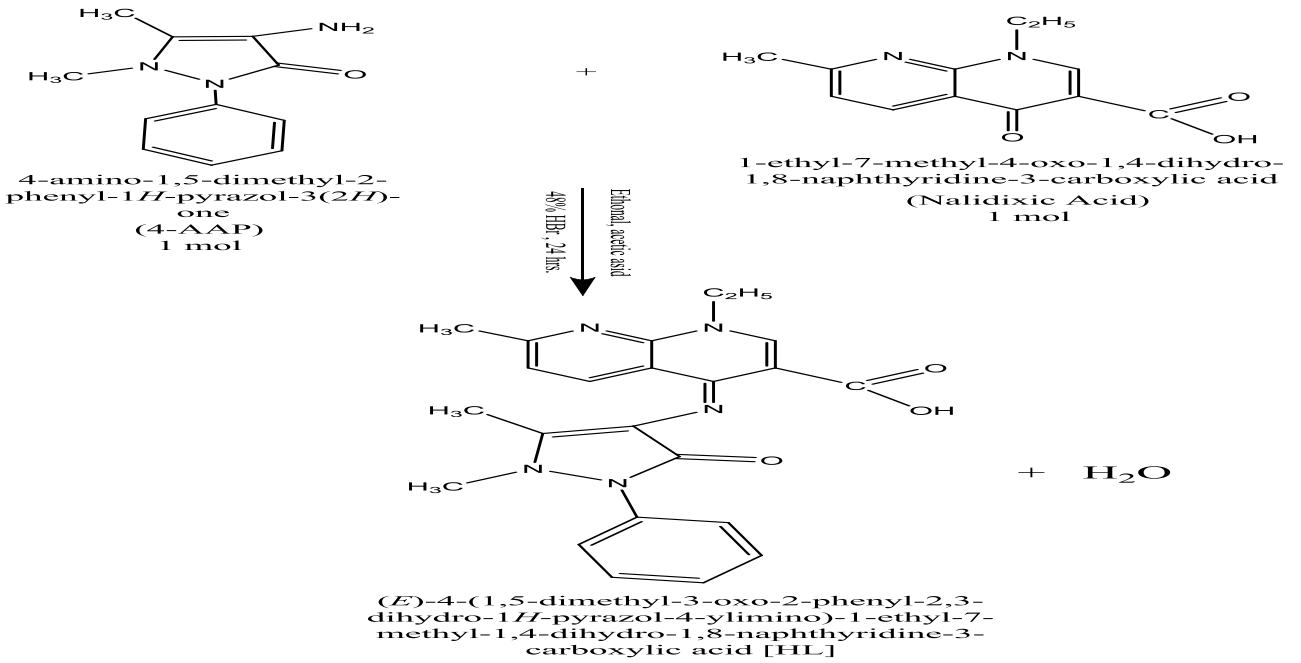
Experimental

Martial's and Methods of Characterization

Nalidixic Acid, 4-Aminoantipyrine, vanadyl (II) sulfate mono hydrate, manganis (II) chloride tetrahydrate, cobalt (II) chloride hexahydrate, nickel (II) chloride hexahydrate, cupper (II) chloride dehydrate, Palladium chloride, zinc (II) chloride and Hydrogen hexachloroplatinum (IV), DMSO acetic acid and ethanol were provide from Aldrich company. Melting points for prepared complexes were measured by electro thermal (Stuart melting point apparatus). Infrared spectra were performed using a Shimadzu (FT–IR)-8400S, The electronic spectra of the compounds were recorded by using double-beam (U.V-Vis) spectrophotometer type U.V 160A (Shimadzu), Elemental micro analysis recorder by using Euro Vector, model EA 3000 single V.3.Osinglein.The Chloride contents were determined using (686-Titro processor-665. Dosimat Matron Swiss), Electrical conductivity measurements of the complexes were recorder at (25ºC) for (10^{-3} mole. L^{-1}) solution of the samples in DMSO by using (conductivity meter, model 4070), Magnetic measurements of the metal complexes were performed on a Magnetic Susceptibility Balance Mode (MSB _MKI), 1HNMR, acquired using a Brucker-400 MHz and 200 MHz for thermogravimetric analysis (TGA) was carried out using STA PT-1000 Linseis company /Germany.

Synthesis of ligand [HL]

A Solution of 4- amino antipyrine (0.203g, 1mmol) in (10ml) ethanol was added to a solution of nalidixic acid (0.232 g, 1 mmol) in (5 ml) ethonal and (5ml) acetic acid then heated to complete dissolving with (3) drops of HBr (48%). The mixture was refluxed for overnight with stirring. The yellow crystal precipitate was formed during refluxing, which was cooled at room temperature then filtered and washed with ethanol and acetic acid then recrystallized by methanol to get a pure sample, yield 80% m.p. (198-200)°C and M.wt = 417 g/mol ($C_{23}H_{23}N_5O_3$). As displayed in Scheme (1).



Scheme 1: synthesis route of the ligand [HL]

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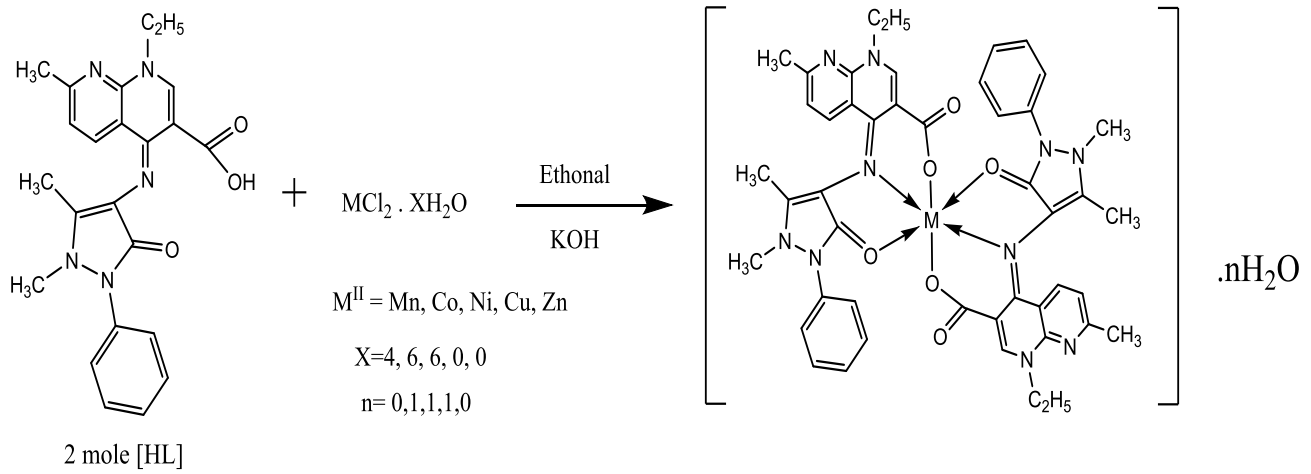
Synthesis of Ligand [HL] Complexes

Synthesis of [Cu (L) $_2$] H_2O]

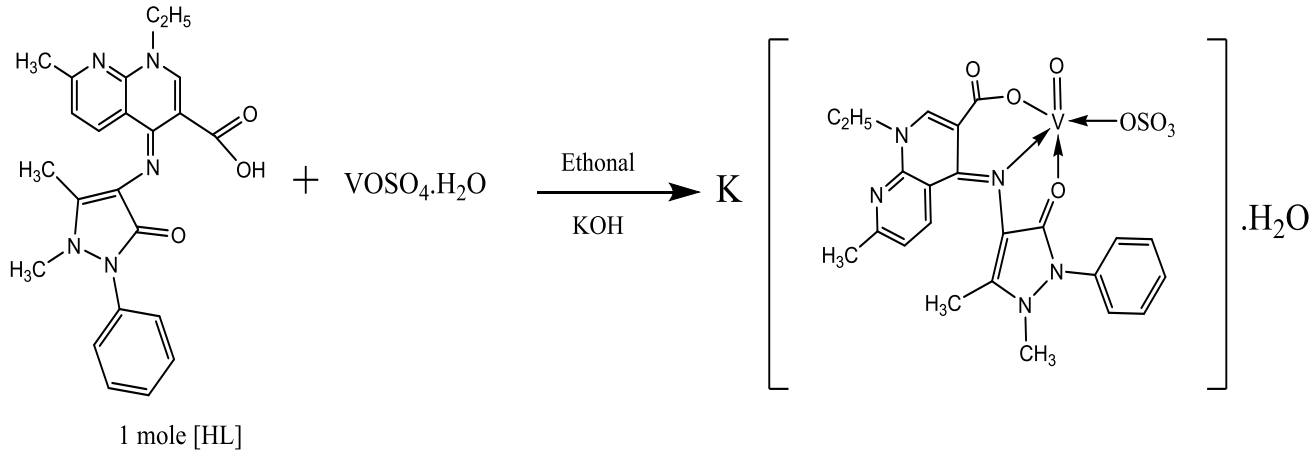
A solution of KOH (0.056 g, 1 mmol) in (5 ml) ethanol was added to a solution of Schiff bases ligand [HL] (0.417 g, 1 mmol) in (10 ml) ethanol in order to form [KL]. A solution of $CuCl_2$ (0.1345 g, 1 mmol) in (10ml) ethanol was added to a solution of [KL] ligand. The reaction mixture was allowed to reflexed for (3hrs). A reddish brown precipitate was formed which was filtered off, washed several times with Absolut ethanol and dried. Yield 78% m.p. (206°-208°) C. See scheme (2)

Syntheses of Complexes [(VO (L) (SO_4)] H_2O, [Mn(L)$_2$], [Co(L)$_2$] H_2O, [Ni(L)$_2$] H_2O, [Zn(L)$_2$].H_2O, [Pd(KL)$_2$], [Pt(KL)Cl_2] Cl_2)

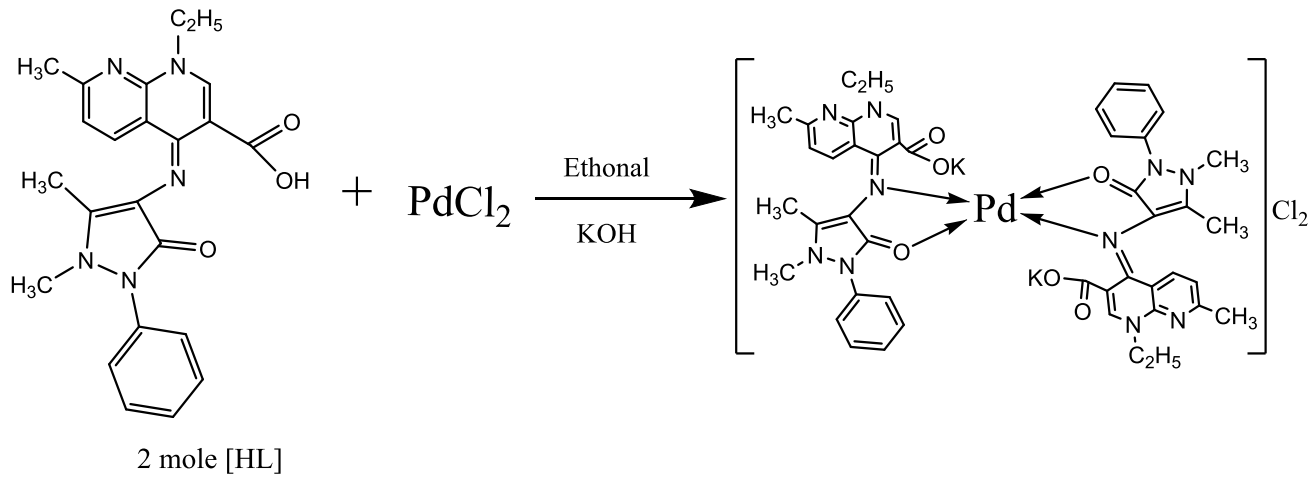
Similar method to that mentioned in [2.4.2.1] in synthesizing of Cu (II) complex was used to synthesized the complexes of [HL] with $VOSO_4.H_2O$ and with $MCl_2.xH_2O$ M (II) = [Mn (x=4), Co (x=6), Ni (x=6), Zn (x=0), Pd (x=0) and H_2PtCl_6]. The physical properties of the complexes and their reactant quantity displayed. See Scheme (2-5).



Scheme 2: Synthesis route of [M (L)$_2$]



Scheme 3: Synthesis route of K [VO (L) SO_4] H_2O



Scheme 4: Synthesis route of [Pd (KL) $_2$] Cl_2

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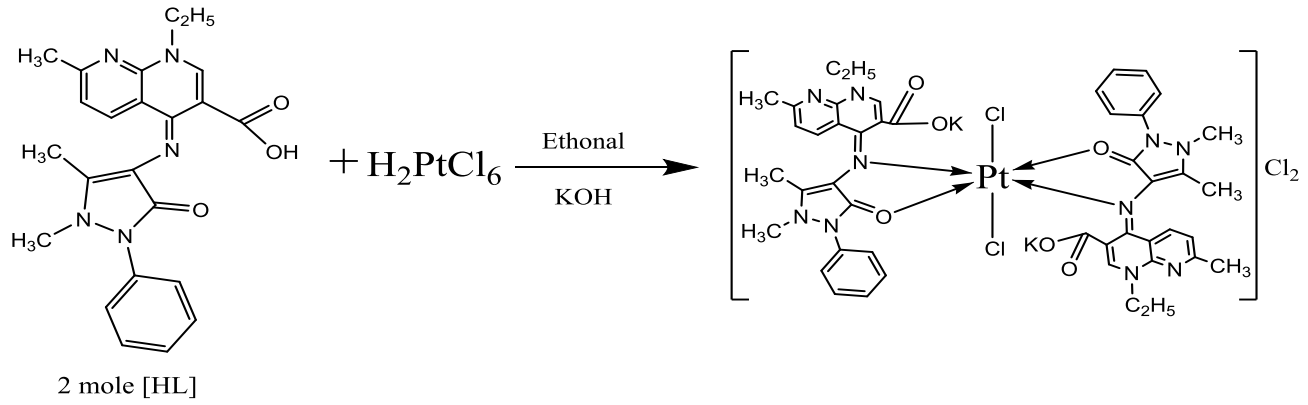

Scheme 5: Synthesis route of [Pt (KL)$_2$ Cl$_2$] Cl$_2$

Results and Discussion

FT-IR Spectrum of Ligand [HL]

The FT-IR Spectrum of ligand [HL] fig. (3.6) showed a band at (3205) cm^{-1} refers to (O-H) stretching frequency of carboxylic group. The two bands at (1712) cm^{-1} and (1375) cm^{-1} can be attributed to (υ asy – COO$^-$) and (υ asy-COO$^-$). The strong band at (1616) cm^{-1} was assigned to (υC=O) for 4-AAP. The new weak band at (1562) cm^{-1} can be attributed to (υC=N) of azomethine group [30]. Appearance of this band (azomethine) and disappearance of (υ asy) and (υ sy.) of NH_2 for 4-AAP and υC=O (ketonic) of nalidixic acid, in the IR spectrum of ligand [HL] confirms the formation of schiff bases ligand [31]. The observed bands at (1518, 1473) cm^{-1} and (3045) cm^{-1} can be assigned to aromatic (υC= C) and (υC= H) respectively. The characteristic bands were summarized.

The Electronic Spectrum of ligand [HL]

Fig (3).The U.V-Vis spectra data of ligand [HL] were given. The U.V-Vis spectrum of this ligands, Fig. (3-8) exhibits three intense absorption peaks. The first and second at (270) nm (37037) cm^{-1} and (301) nm (33223) cm^{-1} were assigned to π→π* electronic transition [32]. The third peak at (338) nm (29586) cm^{-1} was attributed to n→π * electronic transition [33].

^{1}H-NMR Spectrum of ligand [HL]

The singlet signal observed at (δ=2.70 ppm) in the spectrum of free Schiff base [**HL**], was assigned to the methyl group (C-CH_3) , singlet signal showed at (δ=2.08 ppm), was attributed to the (N-CH_3), triplet showed at (δ=1.38-1.42 ppm), was attributed to the group (N-CH_2-CH_3), multiple a ranged between (δ=7.20-7.59 ppm) were assigned to the aromatic protons of the phenyl, singlet signal showed at (δ=14.90 ppm), was attributed to the methyl of O-H carboxylic group (O-H), quart showed at (δ=5.22 ppm), was attributed to the ethyl group (N-CH), The singlet signal appeared at (δ=2.50 ppm) in fig (4). Can be assigned to the solvent (DMSO) [34].

GC-Mass Spectrum of ligand [HL]

Is depicted in Figure (5).The electrospray (+) mass spectrum of [**HL]** is presented. The spectrum exhibits successive fragments related to ligand structure [35]. The molecular ion peak for the ligand is observed at m/z = 417 which corresponds to M^+ (50%) for [$C_{23}H_{23}N_5O_3$]; requires = 417, other fragments and their relative abundance and fragmentation pattern are shown in Table (1).

The suggested mass fragmentation of (L) is shown in scheme (6).

Table 1: The fragmentation pattern of ligand [HL]

Ligand	Assignment	Peak m/z	Relative abundance%
[HL]	M = ($C_{23}H_{23}N_5O_3$)	417	50
	M – C_3^+= M_1	382	15
	M_1 – CH_2^+ =M_2	368	14
	M_2 – OH_4^+ = M_3	348	11
	M_3 – $C_4H_2N_2^+$ =M_4	270	25
	M_4 –$C_2H_3NO^+$= M_5	213	12
	M_5 – $C_2H_2^+$ = M_6	187	13
	M_6 – CHN^+ = M_7	160	32
	M_7 – HNO^+ = M_8	129	60
	M_8 – C_6^+ = M_9	57	100
	M_9 – CH_2^+= M_{10}	43	85

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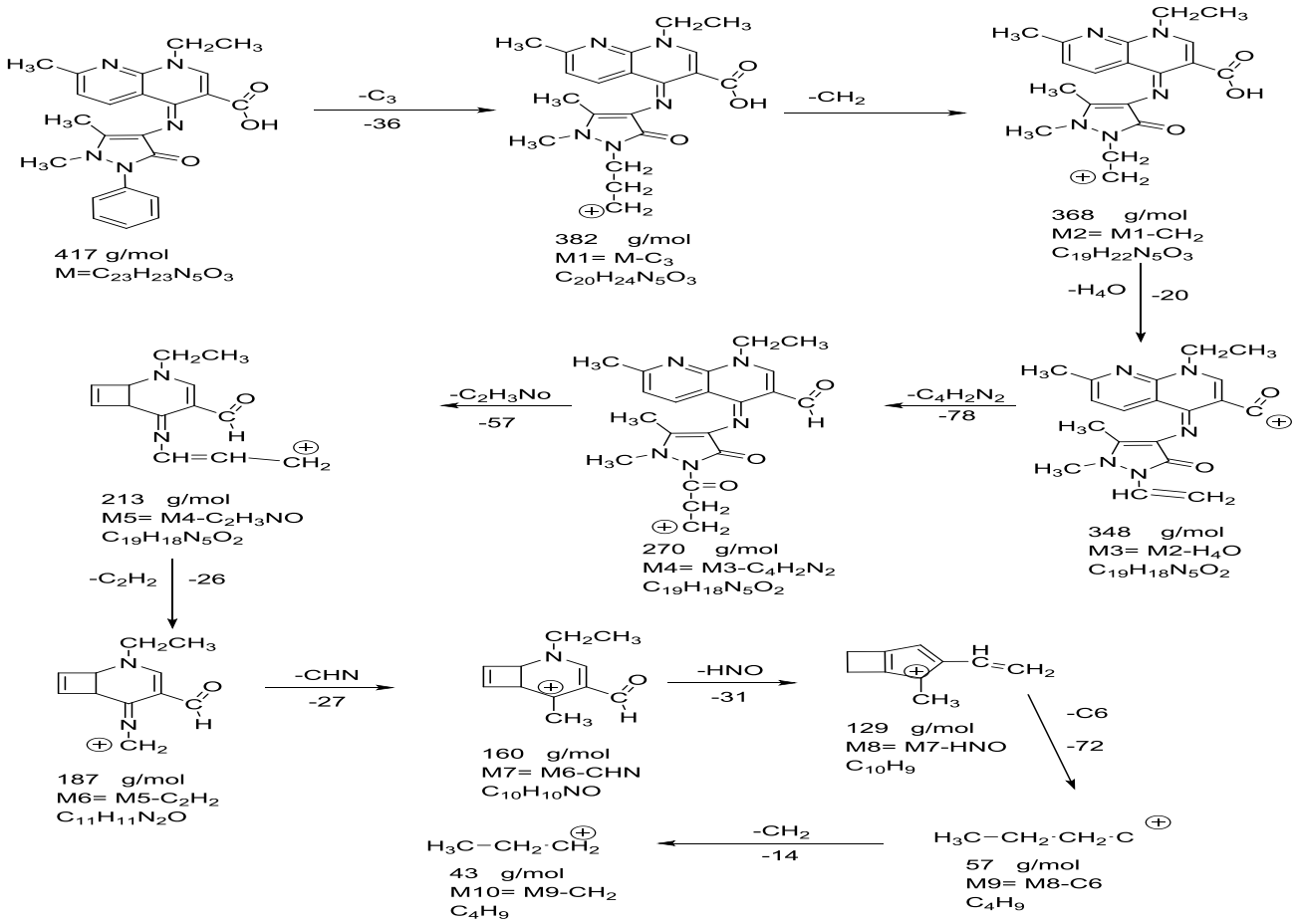

Scheme 6: Suggested mass fragmentation of ligand [HL]

Characterization of Complexes

Characterization of Complexes K [VO (L) (SO_4)]. H_2O

Dark gray, Yield: 71%. m.p. 175 ºC. IR 3381 υOH (H_2O), 1712-1375 υ asy. COO-υsyCOO, 1612 υ C=$O_{4\text{-AAP}}$, 1560 υC=N_{iminic}, 573 M-N, 548 M-O, 970-, 1115,616 SO_4. UV/visible (DMSO, mm):270 (Intra - ligand), 319 (Intra-ligand), 408 ($^2B_2g \rightarrow {}^2A_1g$), 605 ($^2B_2g \rightarrow {}^2B_1g$), 808 ($^2B_2g \rightarrow {}^2Eg$). (C.H.N) (found %), cala. %:(42. 85)43.39C, (3.15)3.77H, (11.26)11.00N, (7.63)8.01Metal. μ_{eff} (B.M):1.64

[Mn (L) $_2$]

Orange, Yield: 75%. m.p. 187ºC. IR 1705-1390 υ asy. COO-υsyCOO, 1624 **υ C=$O_{4\text{-AAP}}$**, 1576 υC=N_{iminic}, 550 M-N, 447 M-O. UV/visible (DMSO, mm):277 (Intra – ligand), 346 (MLCT), 386 $^6A_1g \rightarrow {}^4A_1g$, Eg (G)), 402 ($^4A_1g \rightarrow {}^4T_2g$ (G)), 477 ($^4A_1g \rightarrow {}^4T_1g$ (G)). (C.H.N) (found %), cala. %:(61.84)62.23C, (4.83)4.96H, (15.01)15.78N, (5.53)6.20 Metal. μ_{eff} (B.M):5.37

[Co (L) $_2$]. H_2O

Brown, Yield**:** 61%**. m.p.** 220 **ºC.** IR 3360 υOH (H_2O), 1705-1390 υ asy. COO-υsyCOO, 1620 **υ C=$O_{4\text{-AAP}}$**, 1572 υC=N_{iminic}, 498 M-N, 445 M-O in Fig (6). UV/visible (DMSO, mm): 270 (Intra – ligand), 332(Intra – ligand), 345 (Intra - ligand), 423($(\upsilon_3)^4Tig(F) \rightarrow {}^4T_2g(P)$), 683 ($(\upsilon_2)^4Tig(F) \rightarrow {}^4A_2g(F)$), 803 ($(\upsilon_1)^4Tig(F) \rightarrow {}^4T_2g$ (F)). Fig. (7) (C.H.N) (found %), cala.% :(59.83) 60.72C, (4.67)5.06H, (15.40)16.02N, (6.11)6.49Metal. μ_{eff} (B.M):4.33

[Ni (L) $_2$]. H_2O

Orange, Yield: 71%. m.p. 122-125 ºC. in fig. (6) IR 3275 υOH (H_2O), 1705-1398 υ asy. COO-υsyCOO, 1620 **υ C=$O_{4\text{-AAP}}$**, 1572 υC=N_{iminic}, 579 M-N, 440 M-O. in fig (7) UV/visible (DMSO, mm):268 (Intra – ligand), 345 (Intra – ligand), 406 ((υ_3) $^3A_2g(F) \rightarrow {}^3T_1g$ (P)), 726 ((υ_2) ^3A_2g (F)$\rightarrow {}^3T_1g$ (F)), 978 ((υ_1) $^3A_2g(F) \rightarrow {}^3T_2g$ (F)). (C.H.N) (found %), cala. %: (60.16) 60.74C, (4.53) 5.06H, (14.68)15.40N, (6.31)6.45 Metal. μ_{eff} (B.M):2.68

[Cu (L) $_2$].H_2O

Yellow, **Yield:** 70**%. m.p.** 206-208 **ºC.** IR 3390 υOH (H_2O), 1704-1387 υ asy. COO-υsyCOO, 1620 **υ C=$O_{4\text{-AAP}}$**, 1558 υC=N_{iminic}, 515 M-N, 472 M-O. UV/visible (DMSO, mm):270 (Intra – ligand), 346 (Intra – ligand), 368 (MLCT), 727 ($^2Eg \rightarrow {}^2T_2g$). (C.H.N) (found %), cala. % :(59.88) 60.42C, (4.63)5.03H, (14.72)15.32N, (6.27)6.95Metal. μ_{eff} (B.M):1.74

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[Zn (L) $_2$]

Dark brown, **Yield:** 76%**. m.p.** 195 **ºC.**

IR 1704-1383 υ asy. COO-υsyCOO, 1624 **υ C=O$_{4\text{-AAP}}$**, 1574 υC=N$_{iminic}$, 575 M-N, 442 M-O. UV/visible (DMSO, mm):366 (Intra-ligand), 335 (Intra – ligand). (C.H.N) (found %), cala. % :(60.84)61.53C, (4.56) 4.90H, (15.92) 15.60N, (6.87)7.28 Metal.

[Pd (KL) $_2$] Cl$_2$

Brown, **Yield:** 72%**. m.p.** 240**ºC** IR 1714-1367 υ asy. COO-υsyCOO, 1628 **υ C=O$_{4\text{-AAP}}$**, 1560 υC=N$_{iminic}$, 552 M-N, 445 M-O. UV/visible (DMSO, mm):375 (Intra – ligand), 331 (Intra – ligand), 351 (MLCT), 468 (^{1}A$_1$g→^{1}B$_1$g), 572 (^{1}A$_1$g→^{1}A$_2$g). (C.H.N) (found %), cala. %: (49.18) 50.76C, (3.67) 4.04H, (11.58)12.87N, (8.95)9.78Metal, (6.01) 6.52 Cl.

Thermal Analyses for [Zn(L)$_2$]

Figure (8) TGA peak observed at 376 ºC indicated the loss of ($C_{23}H_{25}N_5O_3$) fragment, (det. = 48.288 mg, calc. =46.920 mg).

The two step occurred at 519 ºC revealed the loss of (-$C_{12}H_{12}N_2O$) portion, (det. = 20.789 mg, calc. = 22.949 mg) Wight experimental loss(69.071)% , final (30.929)% , Wight theoretical loss (69.414)% and final(30.586)% with ($C_{11}H_7N_3O_2Zn$).

[Pt (KL) Cl$_2$] Cl$_2$

Dark gray, **Yield:** 71%**. m.p.** 230 **ºC.**IR IR 1712-1377 υ asy. COO-υsyCOO, 1620 **υ C=O$_{4\text{-AAP}}$**, 1571 υC=N$_{iminic}$, 570 M-N, 489 M-O. UV/visible (DMSO, mm):266 (Intra – ligand), 323(Intra – ligand), 385(MLCT), 506 (^{1}A$_1$g→^{1}T$_2$g), 848 (^{1}A$_1$g→^{1}T$_1$g). (C.H.N) (found %), cala. % :(43.57) 44.26C, (3.01)3.52H, (10.78) 11.22N, (15.22)15.63 Metal, (10.94) 11.83 Cl

Results and Discussion of Complexes Chemistry

A novel Schiff base and eight complexes were synthesized by direct reaction between ligand [HL] and metalions, this complex were synthesis to confirm the suggested structures of complexes.

FT-IR Spectra of ligand [HL] Complexes

The FT-IR spectral data were summarized in table (3-14). The band at (1562) cm^{-1} in the spectrum of free ligand [HL], which referred to υC=N of imine group was shifted to lower or higher frequency and appeared at range (1558-1576) cm^{-1} in spectra of all complexes. This shift in υC=N of imine group confirming the coordination of ligand [HL] through N atom of this group with metal ions [36]. On the other hand, the two bands related to carboxyl a to moiety at (1712) cm^{-1} and (1375) cm^{-1}, which were assigned to υasy. COO$^-$ and υsy. COO$^-$ modes respectively, in the IR spectrum of free ligand [HL], were shifted to lower or higher frequency at range (1635-1707) cm^{-1} and (1363-1398) cm^{-1} in the spectra of all complexes (except Pd(II) and Pt(IV) two complexes) Δυ values refer to the COO- group behaves as monodentate. This shift suggested the coordination between COO$^-$ group with metal ion (VO (II), Mn(II), Co(II), Ni(II), Cu(II) and Zn (II) via oxygen atom.

The band at (1616) cm^{-1} which refers to υC=O for 4-AAP ring in spectrum of free ligand [HL], was shifted to lower or higher frequency at range (1612-1628) cm^{-1} in the spectra of all complexes, showing that the coordination was happened via oxygen atom of this group (C=O) with metal ions. In complexes the band of υasy. COO$^-$ which was shifted to lower or higher frequency, as previously passed, was appeared as shoulder and overlap with band of υC=O of 4-AAP ring.

The new bands in IR spectrum of VO (II) (9) complex at frequencies (901) cm^{-1} and (1115, 970, 616) cm^{-1} were attributed to (υV=O) group and (υSO$_4$, δSO$_4$) monodentate ligand of SO_4^{-2}. The FR spectra of VO(II), Co(II), Ni(II) and Cu(II) complexes exhibited abroad band at (3381, 3360, 3275 and 3390), was assigned to hydrated H_2O [37]. At the lower frequency region, the IR spectra of all complexes showed new bands which are not present in spectrum of free ligand, these band, were noted at range (498-579) cm^{-1} and (440-548) cm^{-1}, were attributed to υM-N and υM-O respectively.

The band which due to υC=N (ring) could be overlap with the band of υC=O (4-AAP) at range (1612-1628) cm^{-1} From these observation, we conclude that the ligand [HL]behaves as tridentate with [VO(II), Co (II), Ni (II), Cu(II) and Zn(II)]complexes via N atom of iminic group (C=N) and two oxygen atoms of carboxylic group (-COO$^-$) and (C=O) group of 4-AAP ring [38], while it behaves bidentate with [Pd(II) and (Pt(IV)] complexes via N atom of iminic group(C=N) and oxygen

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atom of (C=O) group of 4-AAP ring.

The Electronic Spectra

The electronic spectrum of Zn (II), complex showed that no (d_d) transition because it contains a full d sub shell [39]. (UV_Vis) electronic transitions for all complexes have good agreement for octahedral geometry accept [[VO (L) (SO_4)] H_2O] square pyramidel geometry and [Pd (KL) $_2$] Square planer geometry, around the metal ion. The TGA Data of **[Zn (L) $_2$]** has agreement with their molecular formula [40].

Elemental Analysis

Elemental microanalysis results also have a good agreement with the calculated values. At last the molar conductance showed that all complexes non- electrolytic behavior show Table (2).

Magnetic Moment (μ_{eff})

The (μ_{eff}) values for Mn(II) Co(II), Ni(II) and Cu(II) refer to high-spin octahedral geometry, while for VO(II) complexes refers to square pyramidel. But μ_{eff} = 0.00 for Pd(II) -4d^8 square planer and Pt (IV) -5d^6(octahedral) because this two ions diamagnetic in nature.

Table 2: The molar conductivity the complexes

Compounds	Λ_m S.cm².mole^{-1}
K[VO (L) (SO_4)] H_2O	33.61
[$Mn(L)_2$]	8.95
[$Co(L)_2$] H_2O	13.7
[$Ni(L)_2$] H_2O	14.26
[$Cu(L)_2$] H_2O	8.58
[$Zn(L)_2$]	11.48
[$Pd(KL)_2$] Cl_2	71.63
[$Pt(KL)Cl_2$] Cl_2	72.54

Biological Activity

In Fig (9).The biological activity of prepared ligand and its complexes were evaluated in vitro, E. coli and C. albicans aeruginosa which described in Table.(3) The ligand and all complexes give higher inhibition activity against one type of bacterial (Escherichia coli) and one type of fungus (Candida albicans) was compared with the control DMSO and the starting materials.

Table 3: Bacterial activity of the starting material, ligands and its complexes

No.	Compound	*Esherichia Coli*	*Bacillus subtilis*
	HL	13	20
9	**K[VO (L) (SO_4)] H_2O**	14	22
10	**[$Mn(L)_2$]**	12	17
11	**[$CO(L)_2$] H_2O**	14	25
12	**[$Ni(L)_2$] H_2O**	13	23
13	**[$Cu(L)_2$] H_2O**	11	23
14	**[$Zn(L)_2$].H_2O**	13	26
15	**[$Pd(KL)_2$] Cl_2**	11	18
16	**[$Pt(KL)Cl_2$] Cl_2**	12	22

Conclusion

The Schiff base [HL] behave as tridentate ligand through two oxygen atoms of Carboxylic group and carbonyl group of 4-AAP and N atom of iminic group with the central metal ions: VO(II) (Mn(II), Co(II), Ni(II), Cu(II), Zn(II) accept (Pd(II) and Pt(IV) bidentate via oxygen atom of C=O of 4-AAP ring and N atom of iminic group forming complexes with geometrical structure as in Fig.(1):

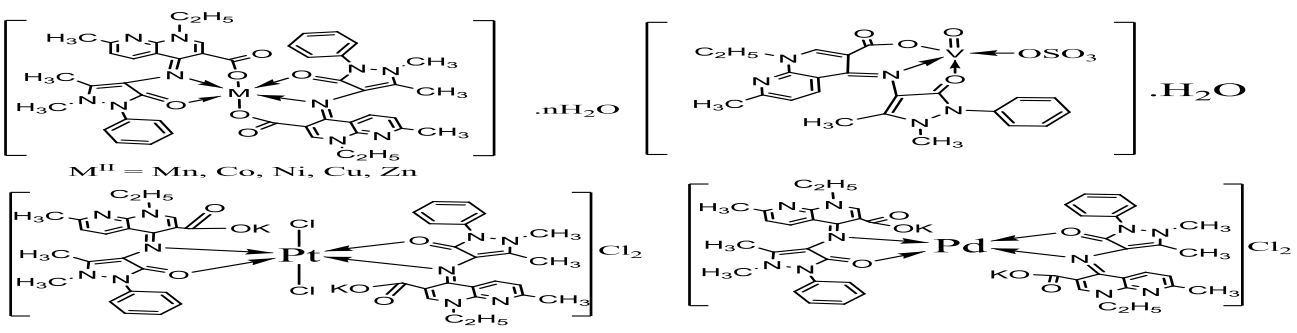

Fig 1: Suggested structure of complexes

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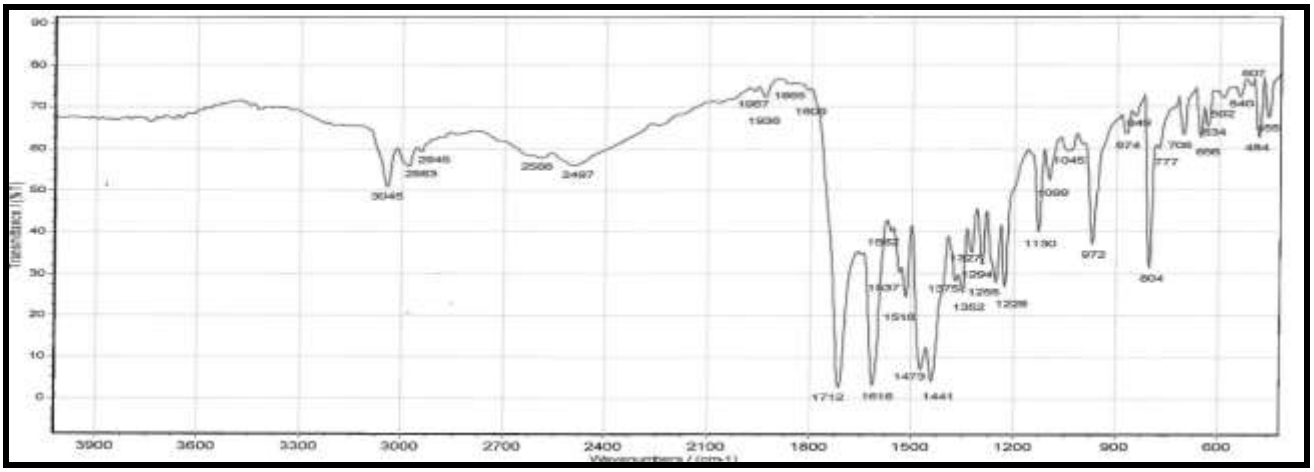

Fig.2: Infrared spectrum of Schiff base ligand (HL)

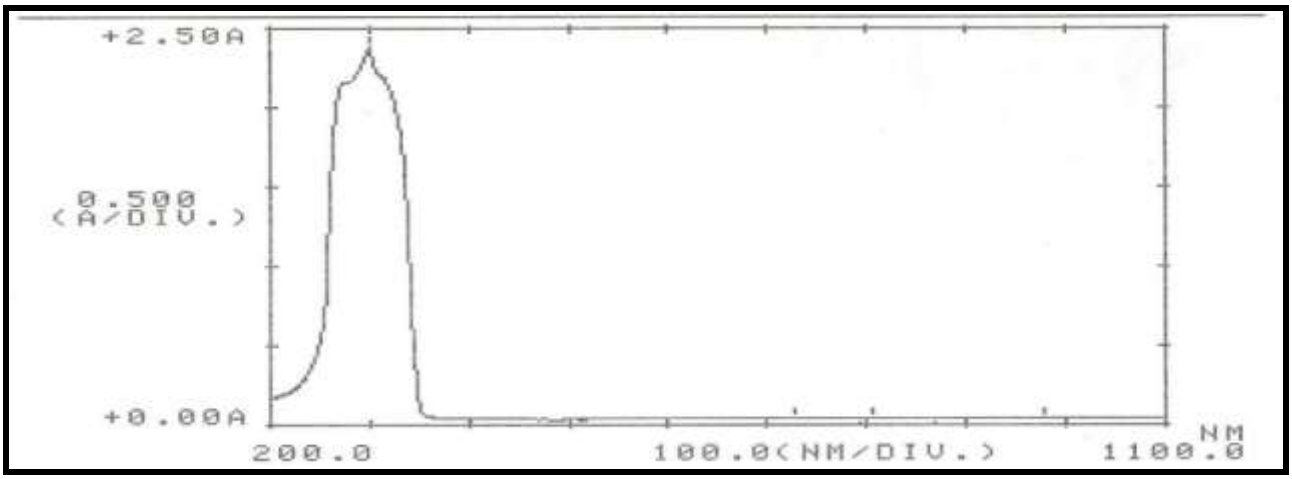

Fig.3: Electronic spectrum of ligand [HL]

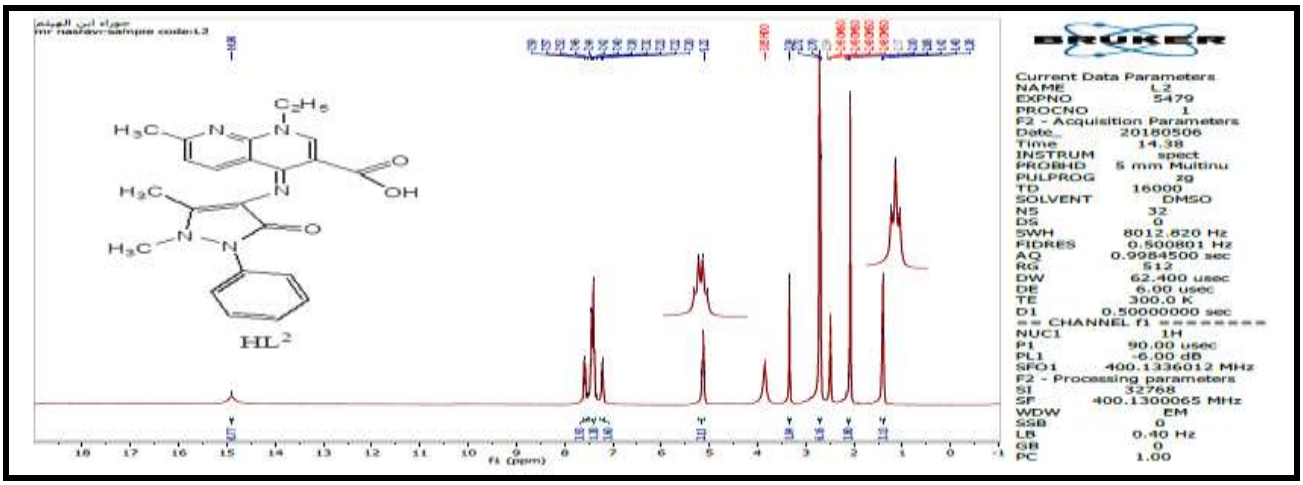

Fig.4: ^{1}H-NMR spectrum of ligand [HL]

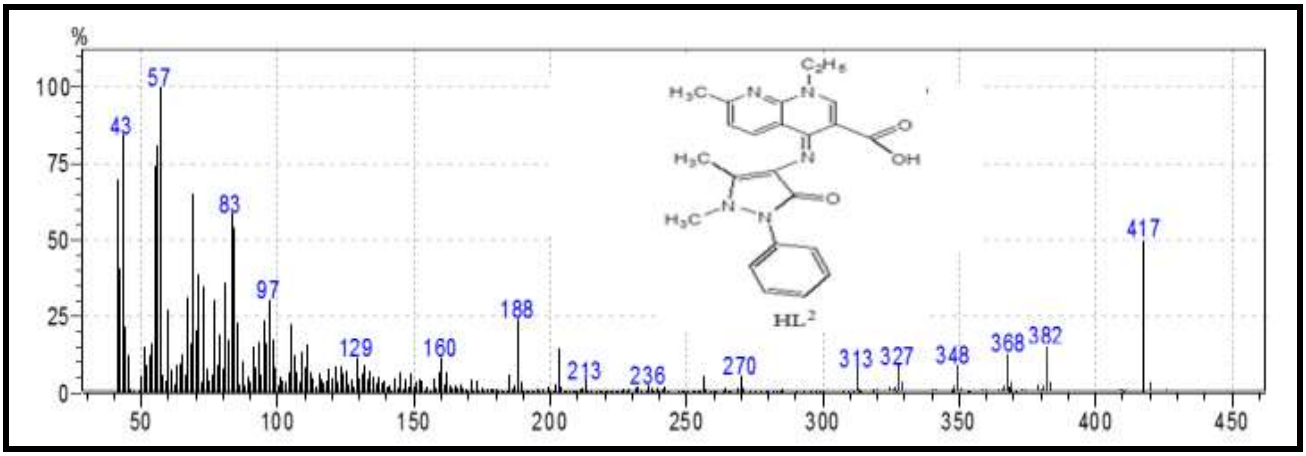

Fig.5: GC-Mass spectrum of ligand [HL]

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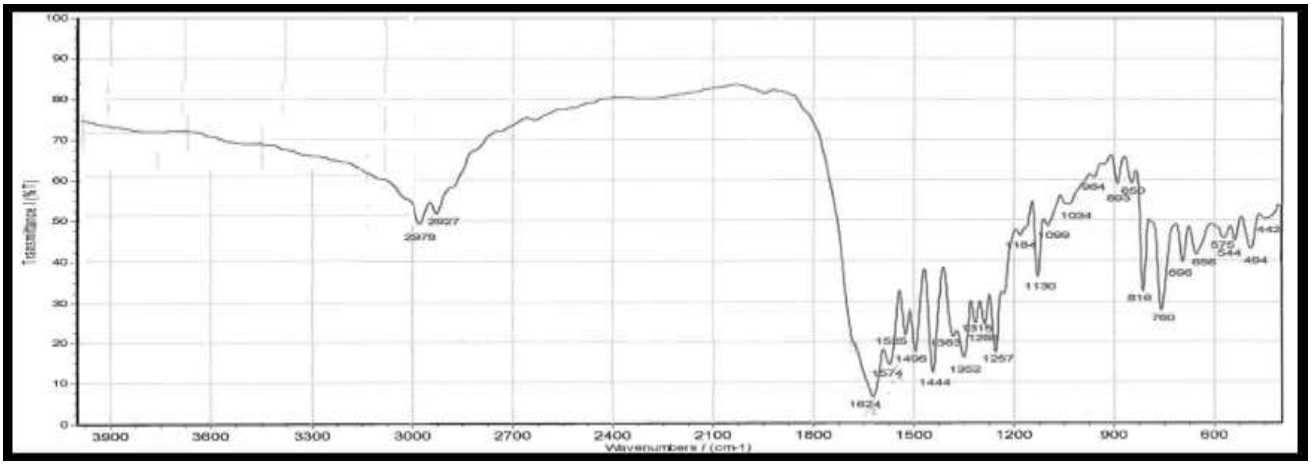

Fig.6: Infrared spectrum of ligand complex [Zn (L) $_2$]

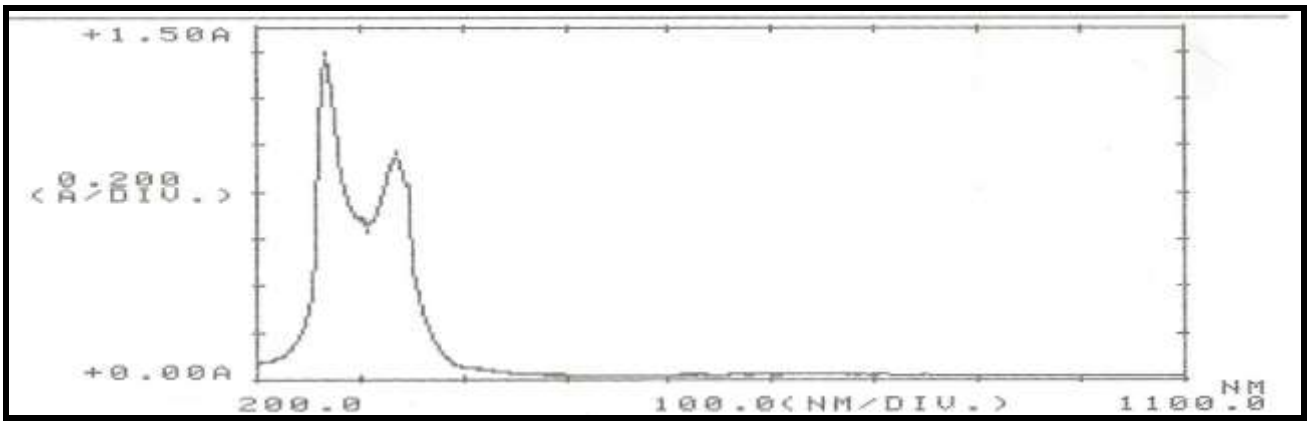

Fig. 7: Electronic spectrum of mono – ligand complex [Zn (L)$_2$]

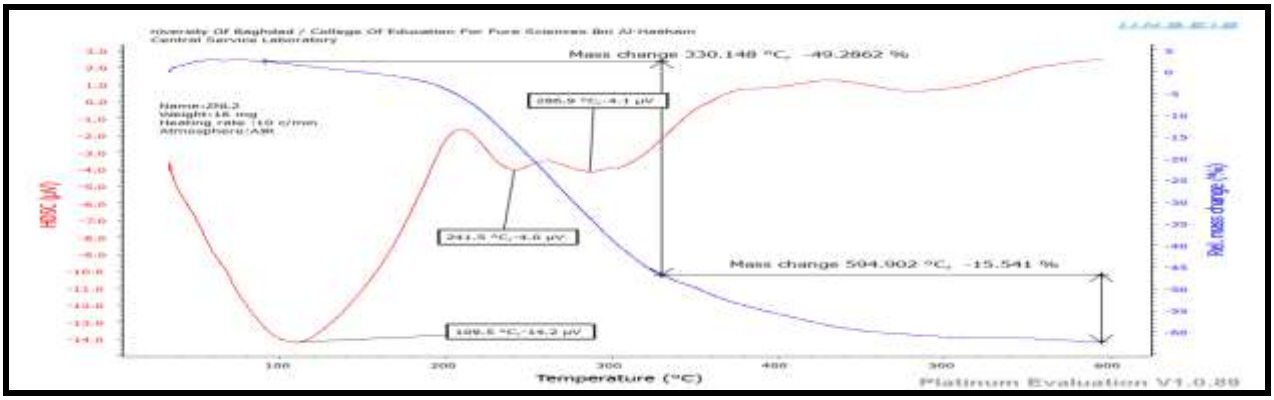

Fig.8: (TGA and DSC) thermo gram of [Zn (L) $_2$] in an argon atmosphere

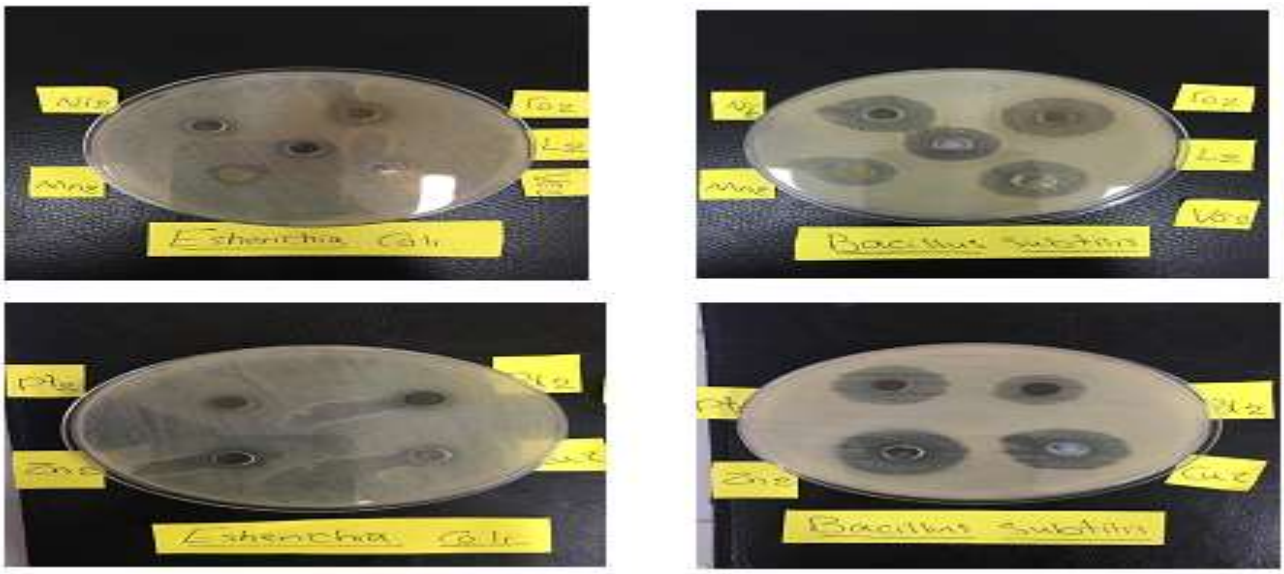

Fig.9: Inhibition diameter for ligands and complexes E coli=Escherchia coli baci=bacillus

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