SYNTHESIS, Spectroscopic Characterization and Evaluation (Antibacterial & (GOT, G pT) Enzyme)Activity of Mixed Ligand Complexes of M(II) with Amino Acid (L-Asparagine) and Schiff...

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SYNTHESIS, Spectroscopic Characterization and Evaluation (Antibacterial & (GOT, G pT) Enzyme)Activity of Mixed Ligand Complexes of M(II) with Amino Acid (L-Asparagine) and Schiff Bases Derived from (Sulfamethoxazo Drug with 2,4Dimethoxybenzaldehyde)

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Abstract
Mixed ligand Mn(II),Co(II), Ni(II),Cu(II) , Zn(II), Cd(II) and Hg(II)complexes with a bidendate Schiff base prepared by condensation of (Sulfamethoxazo Drug With 2,4Dimethoxybenzaldehyde) as a primary ligand and potassium asparaginate as secondary ligand were synthesized and characterized on the basis of molar conductance measurements, magnetic susceptibility values, UV-Vi s ,FT- IR, spectral data wherever possible. Electronic spectra and magnetic susceptibility measurement reveal octahedral geometry for all M(II) complexes. The complexes are found to be non-electrolytic in nature on the basis of low molar conductance. The antibacterial activity of the free ligands HL and there metal complexes were tested against the bacterial (*E.coli, Staphylococcus aureus, Psedomonas* and *Acinetobactera)*
Keywords:: biidendate, Schiff base, Antibacterial.

1. Introduction

Transition metal complexes containing heterocyclic compounds have been of considerable interest in terms of structural chemistry, catalysis and biological functions. The field has undergone spectacular growth due to the synthesis of multidentate ligands from heterocyclic compounds and the complexes of such ligands form with metal ions [1-2]. Metal complexes of the Schiff bases are generally prepared by treating metal salts with Schiff base ligands under suitable experimental conditions. However, for some catalytic application the Schiff base metal complexes are prepared in situ in the reaction system [3].The sulphur containing ligands are well known for their anticarcinogenic, antibacterial,tuberculostatic, antifungal, insecticidal, and acaricidal activities[4-5].
Although the aromatic Schiff bases display obvious bioactivities at experimental level, but usually unsatisfactory in animal studies or clinical level due to a targets.[5-6]. All amino acids exhibit the perfect identification and selection abilities to biological tissue, in view of their special 3D geometric configuration [7]. In general, antibiotics of the amino acid type had greater complex-forming ability than antibiotics of the acid type. They formed highly stable acid complexes with cations of f and d-elements. [8-10].However, for some catalytic application the Schiff base metal complexes are prepared in situ in the reaction system. [3]. The sulphur containing ligands are well known for their anticarcinogenic, antibacterial,tuberculostatic, antifungal, insecticidal, and acaricidal activities [4].
In this paper, we have been undertaken in order to get information on the structure of the Schiff Bases Derived From(Sulfamethoxazo Drug With 2,4Dimethoxybenzaldehyde) (L), metal and Amino Acid (L-Asparagine) complexes $[Mn(L)(Asn)_2]$; using FT-IR, , UV-Visible and molar conductance.

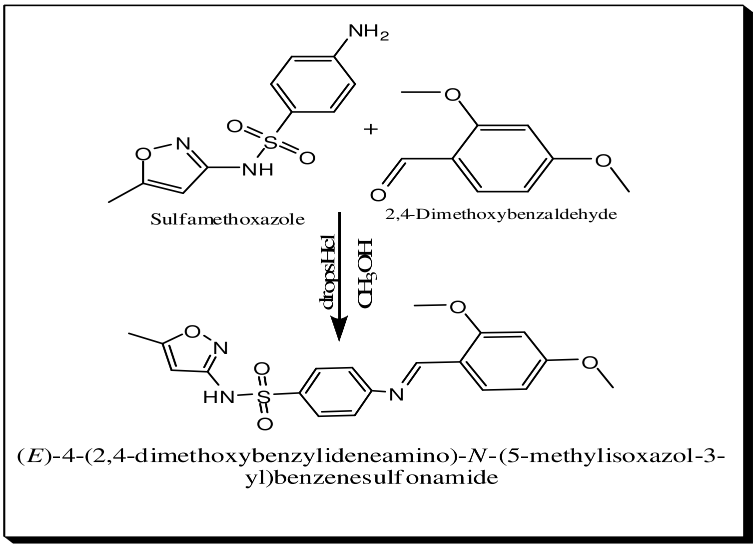
2. Experimental

A-Material

All chemicals used in this work are of analytical reagent grade and used as received from supply.

B- Synthesis of Schiff base ligand (L):

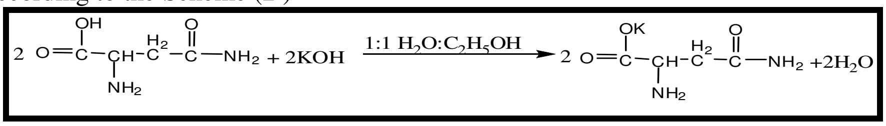
The Schiff-base (L) was prepared as in Scheme (1) by the usual condensation reaction in which (1.77 gm , 7m mole) of Sulfamethoxazole dissolving in (20) ml of methanol was added to solution contain (1.162 gm , 7mmole) of 2,4Dimethoxybenzaldehyde dissolving in 10 ml of methanol with continuous stirring, (tow drops of con. HCl was added) [10], After complete addition the reaction mixture was heated under reflux for about 7 hours. Then the volume of reaction mixture reduced by slow evaporation at room temperature. The isolated compound was purified by recrystallization from n-butanol to get a pure product of (imin),Yield:82%, Mp: 194-196C°, M.W= 401 gm.mole-1 and general formula ($C_{19}H_{19}N_3O_5S$). %
% Experimental : C : 56.02 , H :4.63 , N: 10.84 , S :6.22 ,,
% Calculated : C: 56.86 , H: 4.74 , N: 10.47 , S: 7.98



Scheme 1: Synthesis of Schiff base ligand

C- Potassium asparginate (k+ Asn-):

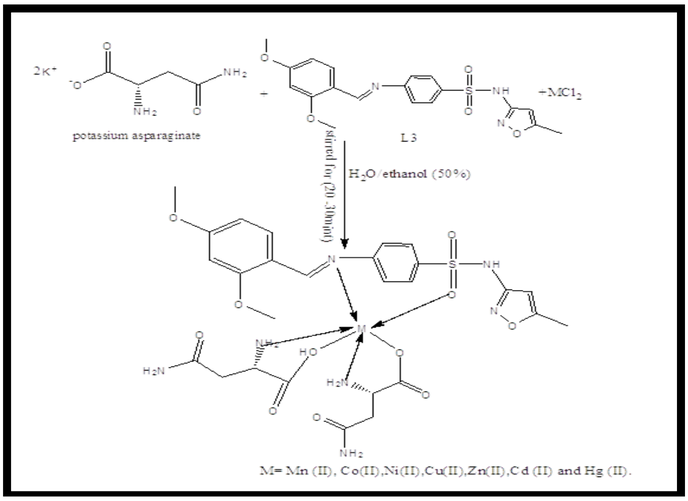
The amino acid L- Asparagine monohydrate[0.3 gm,2 m mol]was dissolved in 10 ml H_2O/ethanol(50%) mixture containing KOH(0.112 g, 2 m mol) in a flask and stirred at room temperature (20 ºC),the solution was deprotonated according to the Scheme (2)



Scheme 2: Schematic representation Preparation of the potassium asparaginate

D-General method for Preparation of the L complexes: $[M(L)(Asn)_2]$

Set of metal(II) chloride solution (1 mmole) was prepared by dissolving (0.197, 0.237, 0.237, 0.17, 0.136, 0.183 and 0.271)gm of ($MnCl_2.4H_2O$, $CoCl_2.6H_2O$,$NiCl_2.6H_2O$, $CuCl_2.2H_2O$,$ZnCl_2$,$CdCl_2$,and $HgCl_2$) respectively in 10 ml of 1:1 ethanol: water .[(0.401gm,1mmole of (L)] was dissolved in (10 ml) of ethanol and the solution of (K^+ Asn^-)that has been prepared in step(2) were added at the same time to each of the metal(II) chloride solution mentioned above by using stoichiometric amount [(1:2:1) [(metal: 2(K^+ Asp^-): (L)] molar ratios, the reaction mixture was stirred for (4-5 hours)at room temperature. After one day a colored crystalline solid was obtained which was filtered and washed with ethanol then triethyl ether .The solids were recrystallized from (H_2O:DMSO) (30:70) volumes' mixture. and dried in vacuum over anhydrous $CaCl_2$. The yields range from 58 to 89 %.



Scheme 4: Schematic representation synthesis of the $[M(Asn)_2(L)]$ Complexes

3. RESULTS AND DISCUSSION

3 -1 . ^{1}HNMR spectrum for Schiff base ligand : (L)

The integral intensities of each signal in the 1HNMR spectrum of ligand was found to agree with the number of different types of protons present.[11] The Chemical shift of CH protons of the azomethine group (-CH=N)of (L) was assigned at δ (8.88) ppm. multiplied signals of the aromatic protons at δ (6.1- 8.21) ppm [12].The chemical shift of methoxy group (-OCH3) was appeared at δ (3.91) ppm . The chemical shifts of methyl group (-CH3) and (- CH=C-) were appeared at δ (2.29 and 2.42) ppm. [11] The singlate signal noticed at δ (9.69) ppm represent to proton of NH group[10].This observation was also supported by the FTIR data of the ligand discussed earlier. [13]. The NMR spectral data of (L)was compared with the spectral data for the similar ligands reported in literatures .[13]

3-2-Mass spectrum of the Schiff base ligand : (L) [14,15]

EI-mass spectrometry further confirmed the integrity of ligand (L) by displaying base peaks at m/z 108. for the anisole [ph-OCH_2.]$^+$ ion. The mass spectrum of (L3), figure (1), and Scheme 3 (A,B& C) respectively.

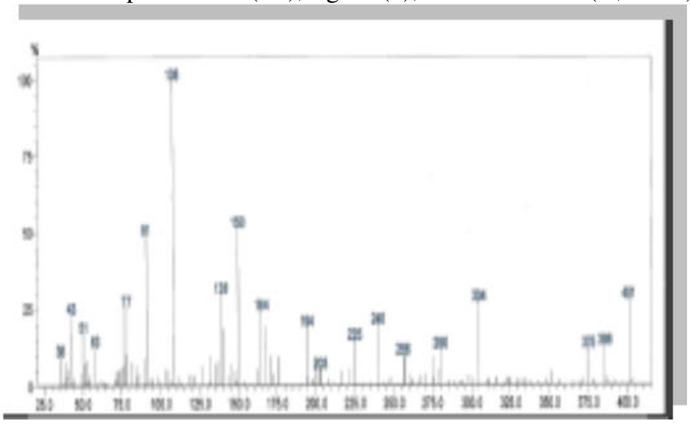
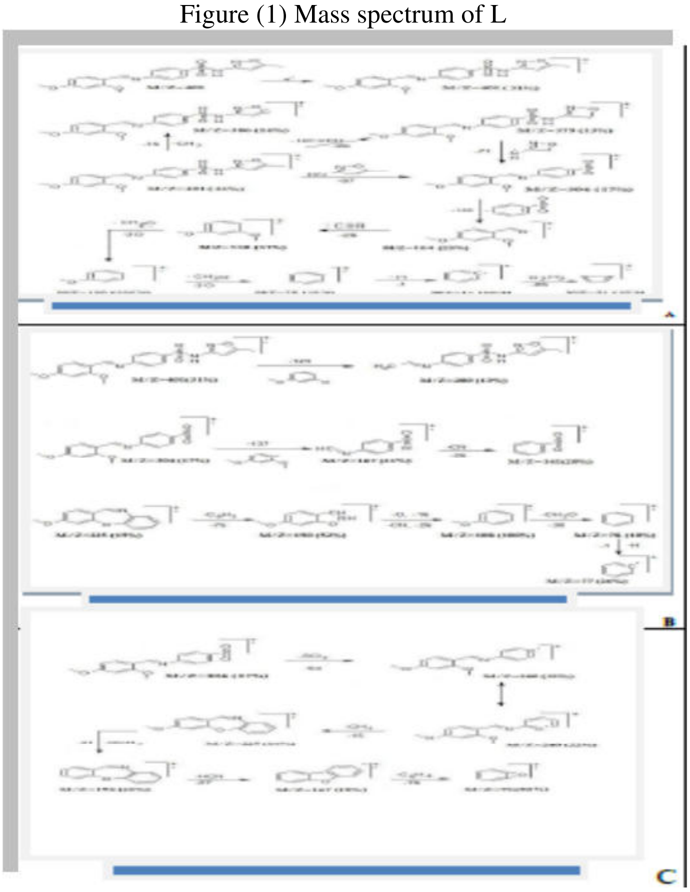


Figure (1) Mass spectrum of L



Scheme 3(A,B&C)Proposed Fragmentation Pathways of L

3-3 Characterization Of Schiff Base Ligand [L-Asn] Complexes

Generally, the complexes were prepared by reacting the respective metal salts with the ligands using 1:1:2 mole ratio, i.e. one mole of metal chloride : one mole of L_3 and two moles of potassium asparginate (AsnK). complexes was studied in various solvents which showed that all complexes are soluble in dimethyl sulfoxide

(DMSO) while they are insoluble in water and common solvents,. The calculated and experimental values of metal percentage in each complex are in fair agreement as shown in table (1).The test for chloride ion with AgNO3 solution was negative (Nil%) indicating that there is no chloride ion outside the coordination sphere of the central metal [16].Molar conductance's (Λm) of 10^{-3} solutions of the complexes in DMSO lie in very low range (3.8-13.5) $\Omega^{-1}cm^2mol^{-1}$ supporting their non-electrolytic behavior [17]./

Table 1: The Physical Properties & Atomic Absorption Results of the Mixed- Ligand [L - Metal -Asn] Complexes

Comp.	Color	Yield%	M.P C°	M% Theoretical (exp)	Λm $\Omega^{-1}.Cm^2.mole^{-1}$
L $C_{19}H_{19}N_3O_5S$	yellow	82	194-196	-	-
$[Mn(L)(Asn)_2]$ $C_{27}H_{33}MnN_7O_{11}S$	brown	79	265 D	7.65 (6.96)	5.8
$[Co(L)(Asn)_2]$ $C_{27}H_{33}CoN_7O_{11}S$	brown	71	358 D	8.16 (6.852)	13.5
$[Ni(L)(Asn)_2]$ $C_{27}H_{33}NiN_7O_{11}S$	Yellow-Green	77	291 D	8.13 (7.11)	8.3
$[Cu(L)(Asn)_2]$ $C_{27}H_{33}CuN_7O_{11}S$	Blue	89	277-280	8.74 (7.55)	5.5
$[Zn(L)(Asn)_2]$ $C_{27}H_{33}ZnN_7O_{11}S$	White	58	218 D	8.96 (7.71)	3.8
$[Cd(L)(Asn)_2]$ $C_{27}H_{33}CdN_7O_{11}S$	Yellow	62	222 D	14.49 (13.15)	4.5
$[Hg(L)(Asn)_2]$ $C_{27}H_{33}HgN_7O_{11}S$	OFF-White	76	350 D	23.22 (22.58)	7.1

3-4 FT-IR of $[Mn(L)(Asn)_2]$ (1),$[Co(L)(Asn)_2]$ (2), $[Ni(L)(Asn)_2]$ (3), $[Cu(L)(Asn)_2]$(4) ,$[Zn(L)(Asn)_2]$ (5),$[Cd(L)(Asn)_2]$(6) and $[Hg(L)(Asn)_2]$ (7)complexes :

The coordination of ligand to the metal ion is shown by the presence of some characteristic (FT-IR) spectra. The assignments of the important characteristic IR bands for the free ligand (L), was summarized in (Table 2) , and (AsnH),are summarized in Table (3).The important IR peaks of the complexes are given in Table (4) . The assignment of the characteristic bands (FT-IR) spectra .

As regards the chelation of amino acids, the IR spectra exhibited significant features in υNH_2, υCOO– regions. It is worthwhile mentioning here that the free amino acids exist as zwitterions (NH_3^+ Asn H. COO^-) and the IR spectra of these cannot be compared entirely with those of metal complexes as amino acids in metal complexes do not exist as zwitterions.[18,19] . In all amino acids υ $NH3^+$ appears at (3030-3130) cm^{-1} region [20], in the spectrum of Asparagine Table (2) it appears at (3115) cm^{-1}, On complexation this band was vanished in all complexes with appears bands of coordinated (NH2) within the range (3265-3342)cm^{-1} . All free amino acids shows a strong carboxyl asymmetric stretching peak at(1560-1600)$cm^{-1}$and weaker symmetric stretching peak at ~ (1400)cm^{-1} [21,22].in the spectrum of L-Aspargine it appears at (1579 and 1400) cm^{-1} respectively. $\upsilon = [\upsilon_{asym}(COO^-) - \upsilon_{sym}(COO^-)]$ is (179 cm^{-1}) . In the complexes, the asymmetric stretching mode appears between(1581-1602) cm^{-1}, while the symmetric stretching mode appears in the range(1379-1393) cm^{-1} These values are quite agreeable with the values reported earlier [18,23]. The observed positive shift of the asymmetric stretching peak and the negative shift of the symmetric stretching peak.Δ(υas (COO–)- υs(COO–)at(200-221) cm^{-1} range. Moreover, Δ(aυs (COO–)- υs(COO–) values of complexes below 200 cm^{-1} would be expected for bridging or chelating carboxylates but greater than 200 cm^{-1} for the monodentate bonding carboxylate anions [18,23]. Is strong evidence of coordination through an ionized carboxyl group via one of the oxygen [21,24] , Informations about the ions coordination were obtained by comparing the IR frequencies of the ligands with those of the metal complexes.[18] IR spectra demonstrate that the IR spectra show that the amino acids act as bidentate ligands with coordination involving the carboxyl oxygen and the nitrogen atom of amino group.

Table (2): FT-IR spectrum data of the *L-Aspargine*

υ $(N-H_3^+)$	υ (CH_2)	υ (C–C)	υ(COO^-) asym.	υ(COO^-) sym.	Δυ $-COO^-$ (-asy-sym)
3115s	2966s2949s	1359vs	1579vs	1400vs	179

The FT-IR spectrum of the free ligand L (Table 3) exhibits a strong sharp band at 1649 cm^{-1}, due to the azomethine group vibration υ (HC=N-) . On complexation this band was shifted to lower frequency for all complexes in the υ (1618–1643)cm^{-1} rang , indicating the coordination of the azomethine (HC=N-) nitrogen atom with the metal ion. The vibrational assignments were determined by using the group frequencies tables and compared with the wave numbers of SMX compounds , found in the literature [25]. The band at 1352cm^{-1} due to ʋ (S=O)asym is shifted to higher frequency (1354-1363) cm^{-1} and at 1168 cm^{-1} due to ʋ (S=O) sym is shifted to lower frequency (1132-1161cm^{-1}). The un altered position of a band due to ring ʋ(N-S) in all the metal complexes indicates that, these groups are not involved in coordination. [26] .

In(L) coordination of the metal ion occur through the oxygen of the sulphone group and nitrogen of the azomethine group [26] .Some new bands of weak intensity observed in the regions around (545-559) cm-1and (428-459) cm-1 may be ascribed to M-N and M-O vibrations, respectively [11,23].It may be noted that, these vibrational bands are absent in the spectra of the ligands .All the complexes are in agreement with octahedral geometry as proposed .[23,27].

Table (3): FT-IR spectrum data of the *SMX and L*

	Asm NH2 As NH2 amine – & –NH sec	ʋ (C–H); Arom	ʋ (C–H) + Aliph.	ʋ C=C arom	ʋ HC=N-	ʋ SO_2 asy	ʋ (C–N)	ʋ (C–O)	ʋ (SO_2) sy	ʋ (S-N)	ʋ (C-S)	ʋ (N-O)
SMX	(3468, 3379) 3300	3070	2976 w, 2931w	1504 Vs	.....	1365 s	1267s	1236 ms	1148	987 w	831 vs	1309
L	-,3228	3058	2941m	1494	1649	1352	1257	1228	1168	927	846s	1300

Table (4) Infrared spectral data(wave number ύ) cm^{-1} for the mixed- ligand (L_3-Asn) metal complexes.

Compounds	ʋ (NH_2) Asy-sym in Asn	ʋ (C-H) + : CH_2 Aliphatic	ʋ C=C arom	ʋ(-HC=N-)	ʋ (-COO)asy	ʋ (-COO)sym	Δʋ (-COO) asy-sym	ʋSO_2- (asym)	ʋ (C-O)	ʋSO_2- (sym)	ʋ (S-N)	ʋ (M-N)	ʋ (M-O)
L	----	2941m	1494s	1649 vs	--	--	--	1352 s	1257	1168	927w	--	--
1) Mn	3311, 3232	2960m 2922	1525	1637 sh-vs	1598	1379s	219	1361	1236	1159s	927w	549	432
2) Co	3340, 3265	2953m 2968	1525	1641s	1593	1393	200	1361	1236	1151s	928s	559	430
3) Ni	3390, 3336	2945 2888	1500	1618 vs	1597	1386	211	1356	1257	1161s	929w	551	459
4) Cu	3298, 3267	2928 2866	1517	1631 s	1587	1379	208	1363 s	1224	1161s	927w	551	446
5) Zn	3349, 3269	2938 2863	1483s	1631s	1602 vs	1381s	221	1354	1230	1132	927w	545	457
6) Cd	3309, 3265	2953 2929	1472s	1643s	1591 sh-vs	1383	208	1361	1236	1151s	933w	559w	430
7) Hg	3342, 3299	2953s 2937s	1529	1639s	1581 sh-vs	1379	203	1361	1236s	1149	930w	557	428

Table (5): Electronic Spectral data of the mixed- ligand (L-Asn) metal complexes

Comp.	λnm	ε max $Mol^{-1}L.cm^{-1}$	νcm^{-1}	Assignments	μeff B.M
$[Mn(L_1)(Asn)_2]$	566	241	17667	$^6A_1g^{(S)} \rightarrow {}^4T_2g^{(G)}$	4.98
	364	513	27472	C.T	
	288	1626	34722	C.T	
$[Co(L_1)(Asn)_2]$	653	99	15313	$^4T_1g \rightarrow {}^4A_2g^{(F)} \upsilon_2$	5.11
	443	198	22573	$^4T_1g \rightarrow T_1g^{(P)}) \upsilon_3$	
	281	1686	35587	C.T	
	248	503	40322	L.F	
$[Ni(L_1)(Asn)_2]$	535	99	18691	$^3A_2g^{(F)} \rightarrow {}^3T_1g^{(F)} \upsilon_2$	2.04
	389	199	25706	$^3A_2g^{(F)} \rightarrow {}^3T_1g^{(P)} \upsilon_3$	
	336	387	29761	C.T	
	290	1213	34482	C.T	
	279	1297	35842	L.F	
$[Cu(L_1)(Asn)_2]$	621	92	16103	$^2Eg \rightarrow {}^2T_2g$	1.6
	267	805	37453	C.T	
$[Zn(L_1)(Asn)_2]$	275	1043	36363	C.T	Dia magnatic
	250	265	40000	C.T	
$[Cd(L_1)(Asn)_2]$	356	385	28089	C.T	Dia magnatic
	260	1208	38461	C.T	
$[Hg(L_1)(Asn)_2]$	295	1322	33898	C.T	Dia magnatic
	254	651	39370	C.T	
	247	572	40485	C.T	

3-5- The ultra violet visible spectra and Magnetic measurements for the mixed- ligand : $[Mn(L)(Asn)_2]$, $[Co (L)(Asn)_2]$, $[Ni (L)(Asn)_2]$,$[Cu (L)(Asn)_2]$, $[Zn(L)(Asn)_2]$, $[Cd (L)(Asn)_2]$ and $[H g(L)(Asn)_2]$ metal complexes:

$[Mn(L)(Asn)_2]$

The magnetic moments shown in Table (5) of the brown Mn(II) d^5 (Term ^6S) complex is 4.98B.M. corresponding to five unpaired electrons . However, their electronic spectrum , show high intensity absorption at (27472- 34722) cm^{-1} due to charge transfer transitions (C . T)and at (566nm)(17667cm^{-1}) due to $^6A_1g^{(S)} \rightarrow {}^4T_2g^{(G)}$, (d-d)transitions.[28,29]

$[Co(L)(Asn)_2]$

The magnetic susceptibility measurement after diamagnetic corrections yielded amagnetic moment of 5.11BM which is close to that expected for an octahedral Co (II)complexes [23, 29].The (U.V- Vis) Co(II) d^7 (Term ^4F) spectrum, exhibits four peaks , the first high intense peak at (248nm)(40322 cm^{-1})(ε max =503 $molar^{-1}$. cm^{-1}), is due to the ligand field ,and[(281 nm)(35587 cm^{-1})(ε max =1686 $molar^{-1}$. cm^{-1}),and [(443 nm)(22573 cm^{-1})(ε max =198 $molar^{-1}$. cm^{-1}) are due to the charge transfer. The electronic absorption spectrum showed two absorption bands (d-d) transitions (as shown in table (5) at (389 nm)(25706 cm^{-1}))(ε max =199 $molar^{-1}$. cm^{-1}), and (535 nm)(18691 cm^{-1})(εmax =99 $molar^{-1}$. cm^{-1}), which is considered as$^4T_1g \rightarrow T_1g^{(p)}$) υ_3 and , $^4T_1g \rightarrow {}^4A_2g^{(f)} \upsilon_2$. This electronic spectral bands suggest octahedral geometry around the Co (II) ion. [23,28] The calculated 10 Dq value which is the υ_1 transition = 8507 cm^{-1} is found to be in the near infrared region which is out of the range of our absorption apparatus. The calculated B value (824 cm^{-1}) for the complex is lower than the respective B^- value of (971 cm^{-1}) for the free cobalt ion, Indicating delocalization of the metal electrons over molecular orbitals that encompass not only the metal but encompass the ligand also [5,6,23]. The ratio represented to the value of ($B_{complex}$ / B^-_{ion}) shows a value of (0.867), As a result of the electronic spectrum data as well as the magnetic moment value which Supported suggestion the octahedral geometry around the Co(II) ion.[29]

$[Ni (L)(Asn)_2]$

The magnetic moment of the **Ni** (II) d^8 (Term ^3F) complex is 2.04B.M, indicating the octahedral configuration of this complex. [30]. In the electronic spectrum of the Ni (II) complex , shows three distinct bands appears at (279 nm) 35842 Cm^{-1} and[(290 nm) 34482 Cm^{-1}, (336 nm) 29761 Cm^{-1}] which may be assigned to ligand field and charge transfer transitions respectively ,and show two bands in the (389nm) 25706 cm^{-1} (υ_3) and (535nm) 18691 cm^{-1} (υ_2), (Table5)which are assignable to $^3A_2g^{(F)} \rightarrow {}^3T_1g^{(p)} \upsilon_3$ and $A_2g^{(F)} \rightarrow {}^3T_1g^{(f)} \upsilon_2$ transitions, respectively[28]. Experimental υ_2 and υ_3 values have been employed to calculate the position of υ_1[$^3A_2g^{(F)} \rightarrow {}^3T_2g^{(F)}$] band from Lever tables. Also these tables have been used to calculate the ligand field parameters, 10 Dq and B which were found to be 10383 cm^{-1} and 883.2 cm^{-1} respectively. The calculated 10 Dq value which is the 1^{st} transition is found to be in the near infrared region which is out of the range of our absorption apparatus. The calculated B value (883.2 cm^{-1}) for the complex is lower than the respective B^- value of (1030 cm^{-1}) for the free nickel ion, The value which is the ratio of (B_{comple} / B^-_{ion}) shows a value of 0.857. On the basis of spectral bands, an octahedral geometry is therefore proposed for the Ni(II) complex.[28,30]

[Cu (L)(Asn)$_2$]

The magnetic moment of the Cu(II) d^9 (Term ^2D) , exhibit normal magnetic moments (1.60B.M.) which is in agreement with data reported by several research workers [31,32].This complex (Table 5), show broad asymmetric bands in the region at (621nm)16103 Cm^{-1}, (267nm) 37453 Cm^{-1} and (250nm) 40000 Cm^{-1} assignable $^2Eg \rightarrow {}^2T_2g$, charge transfer transitions respectively.This bands are characteristic in position and width with those reported for octahedral copper (II) complexes [28,33]

[Zn (L)(Asn)$_2$],[Cd(L)(Asn)$_2$] and [Hg(L)(Asn)$_2$]

The Zn(II), Cd (II)and Hg (II) complexes showed diamagnetic as expected from their electronic configuration and did not display any peak in the visible region, no ligand field absorptions band was observed, therefore the bands appeared in the spectra of complexes could be attributed to charge transfer transitions.[28,32,34].The electronic spectra of d^{10} [Zn(II) ,C d(II)and Hg(II)]complexes shows an absorption bands at range (36363-40485) cm^{-1} ' attributed to the M → L (charge transfer) transition, which is compatible with this complexes having a octahedral structure [23.35].

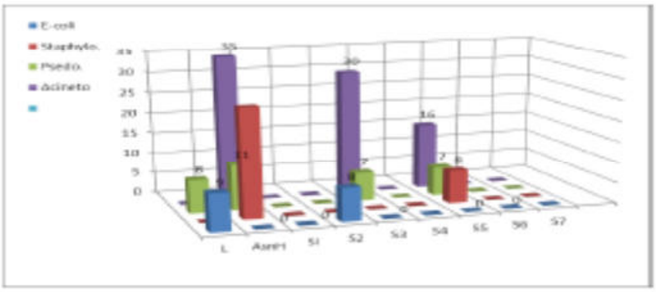
3-6 – Biological (Antibacterial &GOT ,GOT Enzyme)Activities

The ligands and synthesized metal complexes were screened for their antimicrobial activity by well plate method in nutrient agar. The activities were expressed in terms of millimeter (mm) by measuring inhibition zone diameters.(IZ) and compared with the standard DMSO (as control) . [24-26]. Table 5 reveal that the synthesized compounds were potent as bacteriostatic agents. The plates were incubated in incubator at 37°C for 24 hours.. In order to ensure that solvent had no effect on bacteria, a control test was performed with DMSO and found inactive in culture medium. Antibacterial activities were evaluated solutions alone of DMSO and they showed no activity against any bacterial strains. The zone of inhibition of the both ligands and complexes against the growth of different bacteria types are given in Chart (1). Generally the antibacterial activities were in the following order; SMX > AsnH > L > > DMSO.

The prepared ligand L showed no effect against growth of Staphylococcus aureus,(+) and Acineto(-)see Chart(1)

Table (6) The antibacterial activity (IZ mm) data of compounds

Sym.	Comp.	E-coli	staphylococcus	Pseudomonas	Acineto
C	Control (DMSO)	0	0	0	0
	L	9	0	8	0
	AsnH	0	26	11	35
S_1	[Mn(L_1)(Asn)$_2$]	0	0	0	0
S_2	[Co(L_1)(Asn)$_2$]	8	0	0	0
S_3	[Ni(L_3)(Asn)$_2$]	0	0	7	30
S_4	[Cu(L_3)(Asn)$_2$]	0	0	0	0
S_5	[Zn(L_3)(Asn)$_2$]	0	8	7	16
S_6	[Cd(L_3)(Asn)$_2$]	0	0	0	0
S_7	[Hg(L_3)(Asn)$_2$]	0	0	0	0



Chart(1) Biological effect of the L-Asparagine, Schiff base ligand and mixed-ligand metal complexes

The effect of some compounds on the activity of GOT and GPT enzymes in human serum [36-37]

A set of stock solution (0.01 M) of selected compounds [L, S_1 and S_5] were prepared by dissolving each compound in DMSO, then working solution (10^{-3} M) were prepared by diluting with DMSO. The GOT and GPT activities in the presence of these compounds were measured in the same way mentioned above by replacing

100 µl of buffer with 100 µl of selected compounds under the same conditions. The inhibition and activation percentage were calculated by comparing the activity with and without selected compounds under the same conditions, according to the equation:

% Inhibition = 100 - (The activity in the presence of inhibitor / The activity in the absence of inhibitor) x 100

% Activation= 100 x (The activity in the presence of activator / The activity in the absence activator) - 100

The results obtained from this study have shown that the prepared compound have variable effects on the enzymatic activities of GOT and GPT and it can be noticed for tables (4-10) and (4-11) that some complexes exhibit an activation effect on both enzymes while other complexes inhibit their activities, these results can be attributed to several factors including the metal type, the ligand type and its donor atoms.

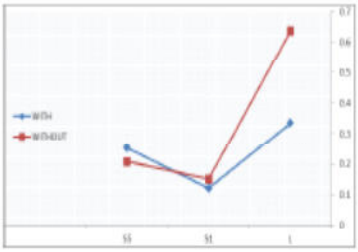


Chart (2) Activity of GOT Enzyme

Table (7) The activity of GOT Enzyme in presence and absence of some prepared compounds

symbol	Compound	Activity of Enzyme		Inhibition%	Activation%
		with	With out		
L	$C_{19}H_{19}N_3O_5S$	0.335	0.637	47.4	
S_1	$[Mn(L)(Asn)_2]$	0.120	0.150	20	
S_5	$[Zn(L)(Asn)_2]$	0.252	0.207		21.73

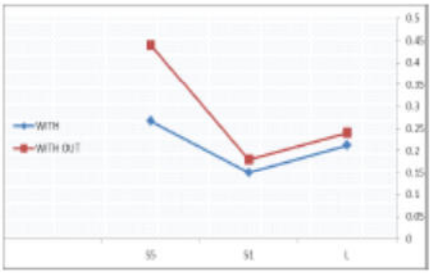


Chart (3) Activity of GPT Enzyme

Table (8) The activity of GPT Enzyme in presence and absence of some prepared compounds

symbol	Compound	Activity of Enzyme		Inhibition %	Activation %
		With	With out		
L	$C_{19}H_{19}N_3O_5S$	0.212	0.240	11.6	
S_1	$[Mn(L)(Asn)_2]$	0.150	0.180	16.6	
S_5	$[Zn(L)(Asn)_2]$	0.267	0.44	39.32	

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