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SYNTHESIS, PHYSICO-CHEMICAL AND ANTIMICROBIAL PROPERTIES OF SOME METAL (II) -MIXED LIGAND COMPLEXES OF TRIDENTATE SCHIFF BASE DERIVES FROM Β-LACTAM ANTIBIOTIC {(CEPHALEXIN MONO HYDRATE)-4-CHLOROBENZOPHENONE} AND SACCHARIN

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ABSTRACT

A new Schiff base (4-chlorophenyl)(phenyl methanimine (6R,7R)-3-methyl-8-oxo-7-(2-phenylpropanamido)-5-thia-1-azabicyclo[4.2.0]oct-2-ene-2-carboxylate=HL=$C_{29}H_{24}ClN_3O_4S$*) has been synthesized from β-lactam antibiotic (cephalexin mono hydrate (CephH)=(*$C_{16}H_{19}N_3O_5S.H_2O$*) and 4- chlorobenzophenone. Metal mixed ligand complexes of the Schiff base were prepared from chloride salt of Fe(II), Co(II), Ni(II), Cu(II), Zn(II) and Cd(II), in 50% (v/v) ethanol – water medium in aqueous ethanol(1:1) and Saccharin(*$C_7H_5NO_3S$*) containing sodium hydroxide. Several physical tools in particular; IR, C:H:N ,* ^{1}*H NMR,*^{13}*C NMR for ligand, melting point, molar conductance, magnetic moment. and determination of the percentage of the metal in the complexes by flame(AAS). The ligand and their metal complexes were screened for their antimicrobial activity against four bacteria (gram +ve) and (gram -ve) [Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus and Bacillus]. The proposed structure of the complexes using the program, Chem office 3D (2006) and the general formula have been given for the prepared mixed ligand complexes [M(Sac)*$_3$*(L)].*

Keywords: Cephalexin antibiotics, Saccharin, Schiff base, Spectral studies, Antibacterial activities.

Contribution/ Originality

This study contributes in the existing literature Synthesized compound from β-lactam antibiotic. This study uses new estimation methodology several physical tools .This study originates new formula. Compounds were screened for their antimicrobial activity against the bacterial strains.

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1. INTRODUCTION

Schiff bases complexes continues to attract many researchers because of their wide application in food industry, dye industry, analytical chemistry, catalysis, antimicrobial activity and pharmacological application like antitumoral, antifungal, antibacterial, antimicrobial etc. In the field of coordination chemistry, Schiff bases and their allied derivatives continue to provide the most interesting facts as evident by their long list of publications [1-3]. However, it is still a challenge to bioinorganic chemists to deepen the investigation on the relationship between structures and biological activities. The study of the nitrogen, oxygen and sulfur (N,O/ S) donor ligands continue to be of great interest, since the properties of these ligands can be modified through organic substituents, which were widely used in the development of metal based drugs, analytical, industrial, medicinal, agricultural, biological and clinical areas [4]. Schiff bases are compounds which contain an azomethine group (C=N) and are usually formed by the condensation of a primary amine with an active carbonyl compounds (aldehydes or ketones). Interactions of metal ions with N, O and S containing organic moieties have attracted much attention in recent years (references needed). Raheem, et al. [5] A large number of tetradendate Schiff base ligands and tridentate Schiff bases are reported in literature [5-7]. Saccharin ($C_7H_5NO_3S$), also called o-sulfobenzoimide, is widely used as an artificial sweetening agent. Saccharin is a weak acid [8].

Studying the coordination nature of saccharin and determining the binding sites to metal ions is perhaps a key to understanding the bioinorganic chemistry [9, 10]. In this paper we present the synthesis and study of Fe(II), Co(II), Ni(II), Cu(II),Zn(II), and Cd(II) complexes with tridentate Schiff base derivative from β-lactam antibiotic [(cephalexin monohydrate)- 4-chlorobenzophenone] as a primary ligand and Saccharin as secondary ligand.

2. EXPERIMENTAL

2.1. Chemicals

All chemical reagents and solvents used were of analytical grade and were used without further purification and were used as received , $CuCl_2.H_2O$, $CdCl_2.H_2O$, $ZnCl_2$, $FeCl_2.9H_2O$, $MnCl_2.2H_2O$, $CoCl_2.6H_2O$, $NiCl_2$ $.6H_2O$, NaOH (supplied by either Merck or Fluka). Ethanol, methanol, dimethylforamaide, and KBr, acetone, benzene, and chloroform from (B.D.H). Cephalexin powder DSM (Spain) and 4-chlorobenzophenone (Merck).

2.2. Instrumentals

Elemental micro analysis for the ligands was performed on a (C:H:N) Euro EA 3000 in Ibn Al-Haitham College of Education, University of Baghdad, Iraq.1H NMR spectra were recorded using Brucker DRX system 500 (500 MHz) and 13 C-1H hetero nuclear 2D correlation spectroscopy (COSY), HETCOR), in the Department of Chemistry Sharif University, Tehran, Iran.

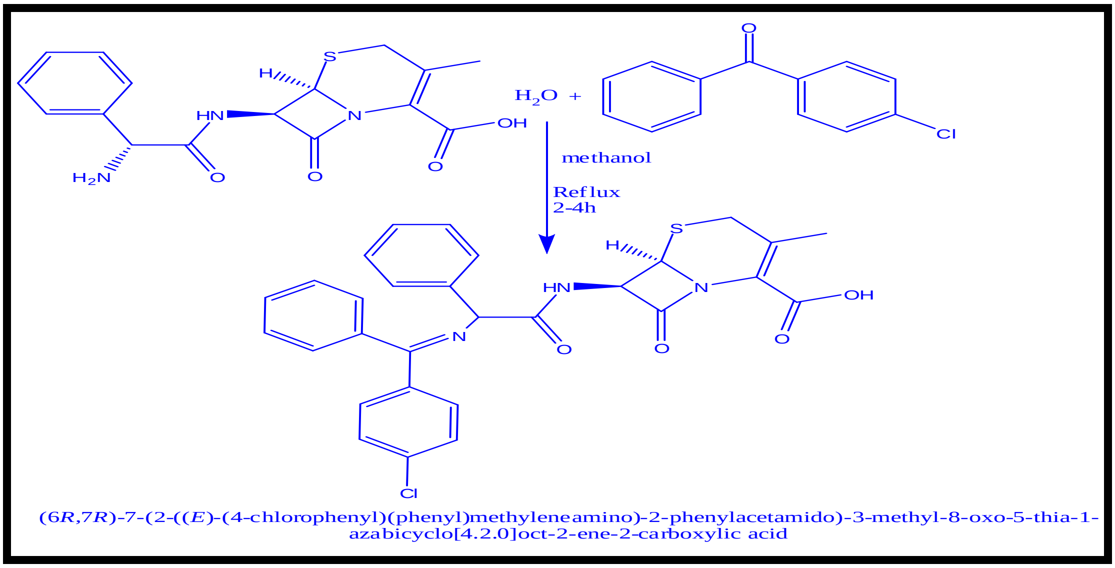
UV-Vis spectra were recorded on a (Shimadzu UV- 160A) Ultra Violet-Visible Spectrophotometer. IR-spectra were taken on a (Shimadzu, FTI R- 8400S) Fourier Transform Infrared Spectrophotometer (4000- 400) cm^{-1} with samples prepared as KBr discs. Metal contents of the complexes were determined by atomic absorption (A.A.S) technique using a Shimadzu AA 620G atomic absorption spectrophotometer. The Chloride contents of complexes were determined by potentiometric titration method using (686-Titro processor-665 Dosimat Metrohn Swiss). Conductivities were measured for 10-3M of complexes in DMSO at 25oC using (conductivity meter, Jewnwary, model 4070). Magnetic measurements were recorded on a Bruker BM6 instrument at 298°K following the Faraday's method. In addition, melting points were obtained using (Stuart Melting Point Apparatus). The proposed molecular structure of the complexes were drawn using chem. office program, 3DX (2006).

2.3. Synthesis of Schiff Base (HL)

The Schiff base ligand was prepared by condensation of (2.92 gm, 8mmol) of Cephalexin monohydrate in (15ml) of methanol and (1.73gm, 8mmol) of 4-chlorobenzophenone in (15ml) methanol was refluxed on water bath for 3-4 hours in the presence of a few drops of glacial acetic acid. The yellow colored solid mass formed during refluxing was cooled to room temperature, filtered and washed thoroughly with methanol, washed with hot acetone and recrystallized from acetone to get a pure sample. Yield: 91%, m p: 180-185oC. M.W=546.04, ($C_{29}H_{24}N_3$ ClO_4S). See scheme (1).

% Calculated: C: 63.079; H: 4.43; Cl: 6.49; N: 7.170; O: 11.72; S: 5.87

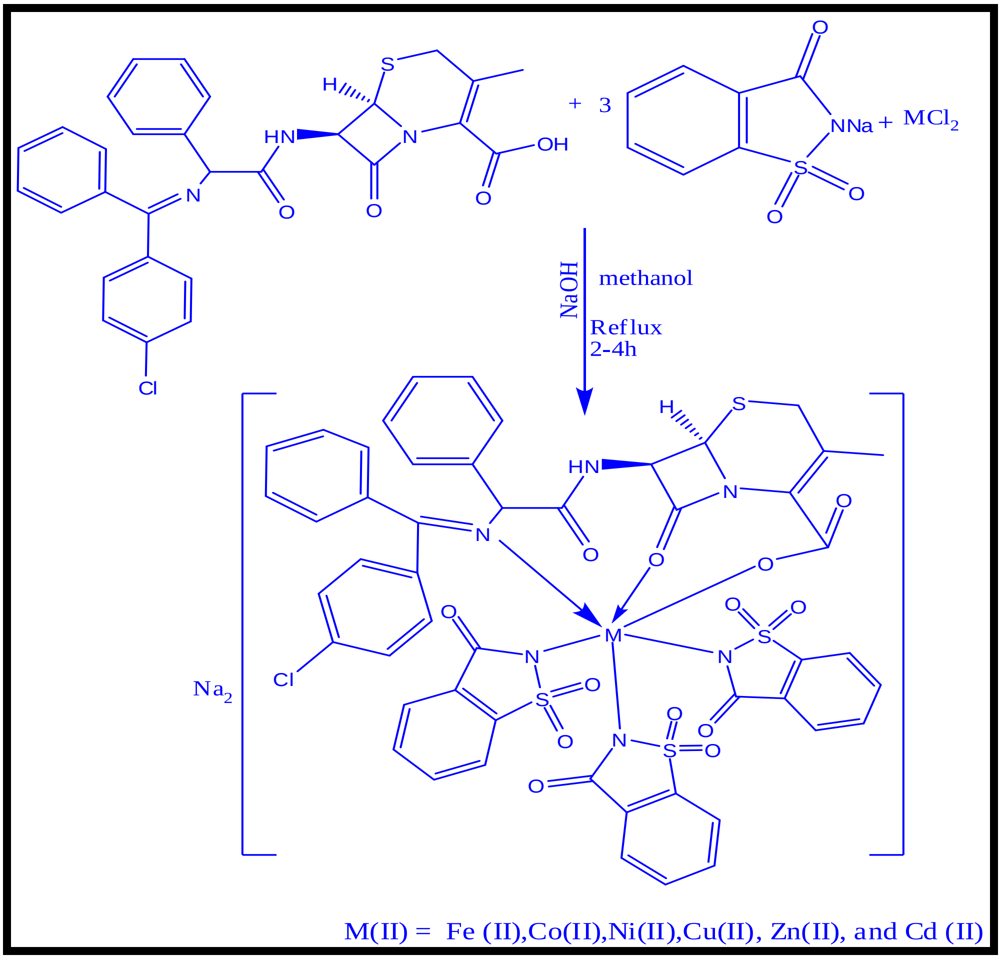
% Found: C: 62.80, H: 4. 610, N: 7.125.



Scheme-1. The synthesis route of ligand (HL)

2.4. General Preparing of the Mixed Ligands Metal Complexes

The metal complexes were prepared using metal chlorides and the Schiff base by the general method. The complexes were preparing by a similar method of synthesis using the reagents in molar ratio of M: L : 3Sac. A methanolic solution (15 mL, 1m mol) of the appropriate $FeCl_2$ $.6H_2O$, (0.180gm, 1mmol), $CoCl_2.6H_2O$(0.237gm, 1mmol), $NiCl_2.6H_2O$(0.238gm, 1mmol), $CuCl_2.2H_2O$(0.176gm, 1mmol), $ZnCl_2$(0.136gm, 1mmol),$CdCl_2$ (0.183gm, 1mmol); was added to a methanolic solution (15ml) of the Schiff base, primary ligand [HL] /(1m mol) and methanolic solution (0. 549g, 3mmol) of the secondary ligand sodium saccharinate was added to the previous solution and the reaction mixture was refluxed for about 2-3 hours on a water bath and then aqueous alcoholic solution of Na OH (V:V) was added to the mixture to adjust the pH from 6 to 8 and further refluxed for about an hour with constant stirring . The complexes precipitated were filtered and washed with distilled water, then with methanol and recrystallized using acetone solvent. $Na_2[M(L)(Sac)_3]$ (Scheme 2) . Yields: 80-90%.



Scheme-2. The synthesis route of metal (II) -(Schiff base HL –Sac) mixed ligand Complexes

Table-1. The physical properties of the Schiff base mixed ligand Na_2 [M(L)$(Sac)_3$]complexes

M. wt = Molecular Weight , Λm = Molar Conductivity , dec. = decomposition

Compounds Chemical Formula)(	M. w t	Color	M .p °c (de) °c	Λ_m Ω^{-1} cm^2 mol^{-1} In DMSO	M% Theory	M% experimental
$Na_2[Fe(L)(Sac)_3]$	1181.5	Pale Brown	135 dec	68.51	4.84	4.06
$Na_2[Co(L)(Sac)_3]$	1184.5	Brown	110-115dec	77.36	4.98	4.37
$Na_2[Ni(L)(Sac)_3]$	1183.5	pale Green	› 255	75.11	4.90	4.15
$Na_2[Cu(L)(Sac)_3]$	1189.5	pale Green	180 dec	66.56	5.40	4.86
$Na_2[Zn(L)(Sac)_3]$	**1190**.5	White	78-85	76.18	5.46	4.19
$Na_2[Cd(L)(Sac)_3]$	1237.5	Yellow	240-252 dec	63.55	9.05	8.73

3. RESULTS AND DISCUSSION

The data obtained from analytical and physico-chemical studies have been correlated in a logical way to explain the properties, bonding and structures of the compounds.

3.1. Characterization of the Ligand

Generally, the complexes were prepared by reacting the respective metal salts with the ligands using 1:1:3 mole ratios [M: L3 :3(Sac)], i.e. one mole of metal salt : one mole of Schiff base(HL) and three moles of sodium Saccharinate The synthesis of mixed ligand metal complexes may be represented as follows

$$3Sac\ H + 3NaOH \rightarrow 3Sac\ Na + 3H_2O$$

$$3\ Sac\ Na + HL + MCL_2\ .n\ H_2O \rightarrow [M(Sac)_3(L)] + n\ H_2O + Na\ Cl$$

(where HL is Schiff base derives from selected β-lactam antibiotic (cephalexin monohydrate) with 4-chlorobenzophenone, and SacH is Saccharin).

M (II) = Fe (II), Co(II), Ni(II), Cu(II), Zn(II), and Cd (II)

The formula weights and melting points are given in table (1). Based on the physicochemical characteristics, it was found that all the complexes were non- hygroscopic. All complexes are insoluble in most organic solvent, but soluble in ethanol , DMF and DMSO .The complexes were dissolved in DMSO and the molar conductivity values of 10-3 M solution at 25 o C of the complexes are in the range 63.55-77.36 $ohm^{-1}mol^{-1}$ cm^2. It is obvious from these data that complexes are electrolytes types 1:2 [11]. The test for chloride ion with $AgNO_3$ solution was negative indicating that chloride ion is not contents the Chemical Formula of complexes. [12]. The ligand HL was yellow in color with a melting point of 162oC. The analytical data showed closed agreement with the suggested formula of $C_{29}H_{24}ClN_3O_4S$. It was further characterized by ^1H NMR, ^{13}C NMR and IR spectral data.

FT-IR of $Na_2[Fe(L)(Sac)_3]$ (1), $Na_2[Co(L)(Sac)_3]$ (2), $Na_2[Ni(L)(Sac)_3]$(3), $Na_2[Cu(L)(Sac)_3]$ (4) ,$Na_2[Zn(L)(Sac)_3]$ (5) and $Na_2[Cd (L)(Sac)_3]$ (6) complexes:

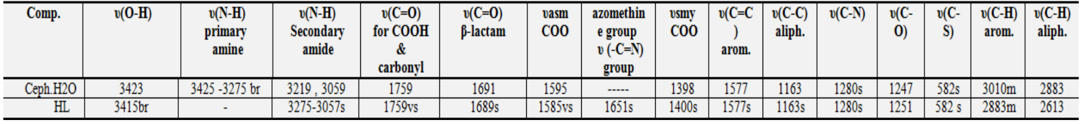
The assignment of the characteristic bands (FT-IR) spectra for the free ligand (HL) and (SacH) are summarized in Table (2) and (3) respectively .

The FT-IR spectra for compounds (1), (2), (3), (4), (5), and (6), of the characteristic bands are summarized in table (4). The spectrum of the (HL) displays a new band at (1651) cm^{-1} due to υ (HC=N-) group of the azomethine stretching vibrations of the ligand [15-16]. On complexation this band has been shifted to higher frequencies (1583), (1585), (1581), (1581), (1585) and (1585) cm^{-1} for complexes (1), (2), (3), (4), (5) and (6).This bands gets shifted to higher frequency in the complexes, indicating the coordination through azomethine nitrogen to metal atom [12].

The bands at(1498),and(1354) cm^{-1} were assigned to stretching vibration (COOH) asymmetric and symmetric stretching vibration respectively. On complexation these bands have been shifted to higher and lower frequencies [(1558), (1560), (1558), (1560), (1558) and (1585) cm-1 for $(-COO)_{asym}$], and [(1338), (1338), (1352), (1354), (1319), and (1375) cm-1, for υ $(-COO)_{sym}$] for the compounds (1) ,(2),(3),(4) ,(5) and (6), indicating that the coordination with metal occurred through the oxygen atom of carboxylate ion. Moreover, $\Delta(\upsilon_{asym}(COO–)- \upsilon_{sym}(COO–)$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 [10].The unaltered position of a band due to ring υ(C-S) in all the metal complexes indicates that, these groups are not involved in coordination.

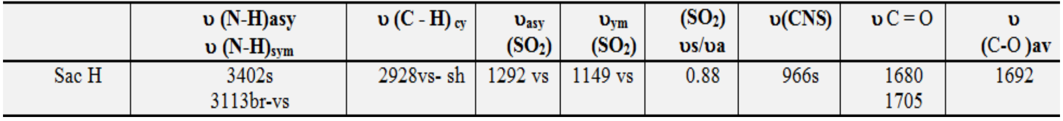
Some new bands of weak intensity observed in the regions around (526-474) $cm^{-1}$and (418-486) cm^{-1} may be ascribed to M-N and M-O vibrations respectively [8-10]. It may be noted that, these vibrational bands are absent in the spectra of the ligands.

Table-2. Data from the Infrared Spectrum for the Free Ligand Ceph (cm^{-1}) and Schiff base HL



Comp.	υ(O-H)	υ(N-H) primary amine	υ(N-H) Secondary amide	υ(C=O) for COOH & carbonyl	υ(C=O) β-lactam	υasm COO	azomethine group υ (-C=N) group	υsmy COO	υ(C=C) arom.	υ(C-C) aliph.	υ(C-N)	υ(C-O)	υ(C-S)	υ(C-H) arom.	υ(C-H) aliph.
Ceph.H2O	3423	3425 -3275 br	3219 , 3059	1759	1691	1595	-----	1398	1577	1163	1280s	1247	582s	3010m	2883
HL	3415br	-	3275-3057s	1759vs	1689s	1585vs	1651s	1400s	1577s	1163s	1280s	1251	582 s	2883m	2613

Figure-3. Infrared spectral data (wave number ύ) cm^{-1} for the Saccharin (SacH)



	υ (N-H)asy $\upsilon\ (N\text{-}H)_{sym}$	$\upsilon\ (C - H)_{cy}$	υ_{asy} (SO_2)	υ_{ym} (SO_2)	(SO_2) υs/υa	υ(CNS)	υ C = O	υ (C-O)av
Sac H	3402s 3113br-vs	2928vs- sh	1292 vs	1149 vs	0.88	966s	1680 1705	1692

Sym: symmetric, asy: asymmetric, am: amide, v.s: very strong, s: strong, m: medium, w: week, sh: shoulder , arom. = aromatic , aliph = aliphatic

(U.V-Vis) Spectral data for the Schiff bases mixed ligands complexes $[Fe(L)(Sac)_3]$, $[Co(L)(Sac)_3]$,$[Ni(L)(Sac)_3]$,$[Cu(L)(Sac)_3]$,$[Zn(L)(Sac)_3]$and $[Cd (L)(Sac)_3]$.

The UV-Vis spectrum of the ligand (HL) shows peaks at 300 nm (33333 cm^{-1}) (εmax=880 molar^{-1}cm^{-1}), assigned to (n – π *) electronic transitions within the organic ligand [13, 14]. The absorption data for complexes are given in Table (5).

Table-4. Infrared spectral data (wave number ύ) cm-1 for the ligand HL, and their complexes

Comp.	υ(N-H) Secondary amide	υ(C-H) arom υ(C-H) aliph. υ (C-H) Sac	υ(C=O) β-lactam &Sac	υ (HC=N-)	$υ_{as}$ COO	$υ_s$ COO	Δ COO- asm-sm	υ as SO$_2$ asym	υSO$_2$ sym	υ (CNS	υ (C-S)	υM-N	υM-O
HL	3215 *	3057 2383 -	1759vs	1651-sh	1498	1354	144	-	-	-	582m 524	-----	-----
Fe	3223	3101 3064 3037*	1651vs 1622	1583m	1558	1338	220	1284 vs	1153 vs	958m	576m 542	503 474	447 418
Co	3566-34049*	3088 3064 3032	1734 1635	1585s	1560vs*	1338s	222	1259 vs	1153vs	966vs	574w 526	526 509	486 474
Ni	3363vs*	3115 3101 3080*	1699* 1620vs	1581vs*	1558vs*	1352s	206	1296 vs	1157vs	962s	543m 526	486 509	451 418
Cu	3221*	3099 3045 3037*	1697* 1618vs	1581vs*	1560vs*	1354s	206	1267 vs	1163vs	962s	543m 524	446	486 418
Zn	3284*	3089br 3062 3026*	1691* 1651vs	1585s*	1558vs*	1319	239	1284 vs	1147s	939s	574	503	467
Cd	3442 3385*	3088br 3064 3032*	1749 1635 1624vs*	1585s*	1585vs*	1375	210	1286s	1151s	960s	543m 532w	509	456 428

br, broad; m, medium; s, strong; v, very; w, weak. Overlap=*

3.1.1. Na$_2$ [Fe(L)(Sac)$_3$]

The electronic spectrum of the Fe(II) complex exhibited three bands as shown in table (5), the first at 299 nm (33444 cm^{-1}), due to the ligands fields and 344 nm (29069 cm^{-1}), 350 nm (28571 cm^{-1}) due to the presence of a charge transfer (LMCT), the fourth band at 704nm(14204cm^{-1}) due to the 5T2g →5E2g. The magnetic moment value of this complex was found to be 4.82 BM, which was very close to the value of octahedral environment [13, 14].

3.1.2. Na$_2$ [Co(L)(Sac)3]

The electronic absorption spectrum of Co(II), showed two absorption bands (as shown in table (5) at (10131 and 15873) cm^{-1} which is considered as ν 2 and ν 3 respectively. These transitions may be assigned as: ν 2 = 4T1g (F) →4A2g (F), ν 3 = 4T1g (F) → 4T1g (P). Experimental ν 2 and ν 3 values have been employed to calculate the position of ν 1[4T1g (F) 4T2g (F)] band from Lever tables [13, 14]. Also these tables have been used to calculate the ligand field parameters, 10 Dq and B which were found to be (7187 and 899) cm^{-1} respectively. The calculated 10 Dq value which is the ν 1 transition is found to be in the near infrared region which is out of the range of our absorption apparatus. The calculated B value (899 cm^{-1}) for the complex is lower than the respective B' value of (971 cm^{-1}) for the free cobalt ion, indicating the presence of covalent bonding between the metal ion and the ligand. The value which is the ratio of (β) shows a value of 0.9258, and this reduction in the B' value indicates that ligand non-bonding orbitals have been used to delocalize the metal d-electrons i. e, increasing back donation from cobalt to the ligand [13].

3.1.3. $Na_2[Ni(L)(Sac)_3]$

The electronic absorption spectrum Ni(II) showed three absorption bands as shown in table (5) at 275nm (36363) cm^{-1},due to the ligands fields and at 641nm(15640) cm^{-1} and 983nm (10172) cm^{-1} which are considered as ν3 and ν 2 respectively. These transitions may be assigned as: ν3=3A 2g(F)3→T1g(P) and ν2 =3A2g(F) → 3T1g(F) [13, 14].

Experimental ν 2 and ν 3 values have been employed to calculate the position of ν1[3A 2g(F) →3T2g(F)] band from Lever tables [15, 16]. Also these tables have been used to calculate the ligand field parameters 10 Dq and B, which were found to be 11691 and 799.8 cm^{-1} respectively. The calculated 10 Dq value which is the ν 1 transition is found to be in the near infrared region which is out of the range of our absorption apparatus. The calculated B value (799.8 cm^{-1}) for the complex is lower than the respective B' value of (1041 cm^{-1}) for the free nickel ion, indicating the presence of covalent bonding between the metal ion and the ligand.The value which is the ratio of (β) shows a value of 0.86, and this reduction in the B' value indicates that ligand non-bonding orbitals have been used to delocalize the metal d-electrons i. e, increasing back donation from nickel to the ligand. On the basis of spectral bands, an octahedral geometry is therefore proposed for the Ni (II)complex [17].

3.1.4. $Na_2[Cu(L)(Sac)_3]$

The electronic absorption spectrum for Cu(II) complex shows three bands broad asymmetric bands in the region at 11933 Cm^{-1}, 30674 cm^{-1} and 33222 cm^{-1} assignable 2B1g → 2A1g, charge transfer and ligand field transitions respectively [12]. These results reveal the distorted octahedral geometry for these complexes. The former band may be due to 2Eg →2T2g accounted due to Jahn Teller effect suggesting thereby a distorted octahedral geometry for these complexes [17, 18].

3.1.5. $Na_2[Zn(L)(Sac)_3]$ and $Na_2[Cd(L)(Sac)_3]$

The electronic spectra of d^{10} [Zn(II) and C d(II)]complexes do show the charge transfer. The magnetic susceptibility shows that the two complexes have diamagnetic moments because d-d transitions are not possible, hence electronic spectra did not give any fruitful information. In fact this result is a good agreement with previous work of octahedral geometry [17, 19].

3.2. Magnetic Susceptibility

The observed magnetic moment values of the prepared complexes are summarized in table (6). Examination of these data reveals that magnet moment of 0.0 B.M for Cd (II) and Zn complexes confirms that the complexes are essentially diamagnetic. The magnetic moment found for Fe(II), Co(II),Ni(II),Cu(II)are 4.82,3.67, 2.71, and 1.73 B.M respectively. These values suggest octahedral geometry, which is in good agreement with data of electronic transition. The electronic spectra and the magnetic moments support the stereochemistry of the complexes [20, 21]

Table-5. Electronic Spectral data, magnetic moment, of the mixed ligands complexes

Compounds	λ_{max} (nm)	ύ (cm^{-1})	ε_{max} $L.mol^{-1}.cm^{-1}$	Assignments	μ_{eff} (BM)
HL	300	33333	880	$\pi \rightarrow \pi^*$	-
	340	29411	237	$n \rightarrow \pi^*$	
$Na_2[Fe(L)(Sac)_3]$	299	33444	2111	L.f	4.82
	344	29069	2082	C-T	
	350	28571	1338	C-T	
	704	14204	22	5T2g →5E2g	
$Na_2[Co(L)(Sac)_3]$	279	35842	2015	L.f	3.67
	350	28571	1306	C-T	
	371	26954	837	4T1g→ 4T1g (P)(ν3)	
	630	15873	42	4T1g→ 4A2g (ν2)	
	987	10131	33	4T1g→ 4T2g (ν1)	
$Na_2[Ni(L)(Sac)_3]$	275	36363	1814	L.f	2.71
	641	156400	17	^3A2g (F)→ ^3T1g(P) (ν3)	
	983	10172	26	^3A2g(F) → ^3T1g(F)(ν2)	
$Na_2[Cu(L)(Sac)_3]$	301	33222	1160	L.f	1.73
	326	30674	1105	C-T	
	838	11933	79	2Eg→2T2g	
$Na_2[Zn(L)(Sac)_3]$	275	36363	1812	C-T	0.0
	345	28985	676	C-T	
$Na_2[Cd(L)(Sac)_3]$	301	33222	536	C-T	0.0
	359	27855	548	C-T	

Table-6. The magnetic measurements data of the prepared complexes

Complex	$X_g.10^{-6}$	$X_m.10^{-6}$	$X_A.10^{-6}$	μeff (B.M)
$Na_2[Fe(L)(Sac)_3]$	8.336	9850.014	9944.014	4.82
$Na_2[Co(L)(Sac)_3]$	4.787	5671.006	5765.006	3.67
$Na_2[Ni (L)(Sac)_3]$	2.576	3049.447	3143.447	2.71
$Na_2[Cu(L)(Sac)_3]$	1.00	1187.031	1281.215	1.73

3.3. NMR Spectral Studies

The ^1H NMR spectrum of the ligand has the expected characteristic signals. The chemical shift of CH protons of the azomethine group of HL was assigned at 8. 84 ppm. Beta lactam antibiotics form a bulky family of zwitterionic and therefore show no resonance in the range (δ= 9–12ppm). This could be attributed to (N(14)H and carboxyl C-O-H) indicated the losing of these protons upon of zwitterionic [20]. 9. 31 ppm (1H, s,–NH–CO) ; and 7.70 (4H, m, –phenyl).

The ^{13}C NMR spectrum of the ligand [HL] in DMSO-d6 solvent. (C6; C7; C8; β-lactam); 134.52; 133. 11; 129 .94). The resonance at (δ=139.97, δ= 139. 27, δ= 138. 24, δ= 137.26 ppm) assigned to carbon atoms of aromatic ring (C1, C2, C4, C3) respectively. (–HC=N); 140.30.

3.4. The Proposed Molecular Structure for $Na_2[M (L)(Sac)_3]$

Studying complexes on bases of the above analysis, the existence of Hexa coordinated

[M(L) $(Sac)_3$] were, M= Fe(II),Co(II),Ni(II),Cu(II),Zn(II),and Cd(II). The proposed models of the species were built with chem.3D and shown in figure (1).

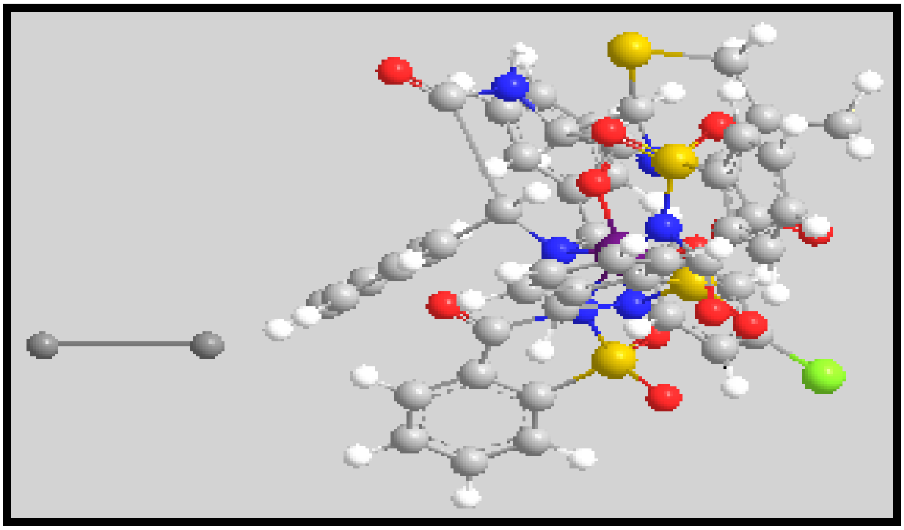


Figure-1. 3D molecular modeling proposed complexes $Na_2[M(L)(Sac)_3]$

M= Fe(II),Co(II),Ni(II),Cu(II),Zn(II) and Cd(II)

4. ANTIBACTERIAL ACTIVITIES STUDIES: [22-24]

The effectiveness of an antimicrobial agent in sensitivity is based on the zones of inhibition. The synthesized metal complexes were screened for their antimicrobial activity by well plate method in nutrient agar. The invitro antibacterial activity was carried against 4 hold cultures of pathogenic bacteria like gram (+) and gram (-) at 37^o C. In order to ensure that solvent had no effect on bacteria, a control test was performed with DMSO and found inactive in culture medium. Antimicrobial activity was evaluated by measuring the diameter of the inhibition zone around the hole. Most of the tested compounds showed remarkable biological activity against different types of gram positive and gram negative bacteria. The diameter of the susceptibility zones was measured in mm and the results are presented in Scheme (1) [24]. Compounds were considered as active when the was greater than 6 mm. The zone of inhibition of the complexes against the growth of bacteria were show in figure (2).

*The complex $Na_2[Cu(L)(Sac)_3]$ show good antibacterial activity
against 4- organisms.

*The complexes $Na_2[Co(L)(Sac)_3]$, $Na_2[Ni(L)(Sac)_3]$and
$Na_2[Zn(L)(Sac)_3]$ show negative against all bacteria.

*$Na_2[Fe(L)(Sac)_3]$, $Na_2[Cu(L)(Sac)_3]$and $Na_2[Cd(L)(Sac)_3]$
Showed very good antibacterial activity against Bacillus type organisms (+ve) > organisms (-ve)

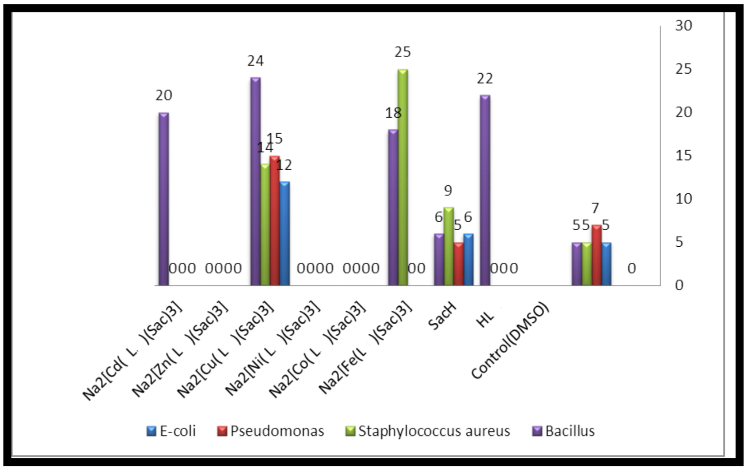


Figure-2. Chart of biological effects of the Na_2[M(L)$(Sac)_3$]

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