

Preparation , Characterization and Antimicrobial activities of {Fe(II),Co(II),Ni(II),Cu(II),and Zn(II)}Mixed Ligand Complexes Schiff base derived from Cephalexin drug and 4(dimethylamino)benzaldehyde with Nicotinamide

Taghreed . H. Al-Noor , Ahmed .T.AL- Jeboori , Manhel Reemon Aziz
Department of Chemistry.Ibn -Al-Haithem College of Education for pure science
Baghdad University-Iraq
Corresponding author: e-mail- taghreedalnoor@yahoo.com

Abstract

New Schiff base ligand (Z)-7-(2-(4-(dimethylamino)benzylideneamino)-2-phenylacetamido)-3-methyl-8-oxo-5-thia-1-azabicyclo[4.2.0]oct-2-ene-2-carboxylic acid = (HL) was prepared via condensation of Cephalexin and 4(dimethylamino)benzaldehyde in methanol . Polydentate mixed ligand complexes were obtained from 1:1:2 molar ratio reactions with metal ions and HL, 2NA on reaction with $MCl_2 \cdot nH_2O$ salt yields complexes corresponding to the formulas $[M(L)(NA)_2Cl]$,where $M = Fe(II),Co(II),Ni(II),Cu(II),and Zn(II)$ and NA=nicotinamide .

The ¹H-NMR, FT-IR, UV-Vis and elemental analysis were used for the characterization of the ligand. The complexes were structurally studied through AAS, FT-IR, UV-Vis, chloride contents, conductance, and magnetic susceptibility measurements. All complexes are non-electrolytes in DMSO solution. Octahedral geometries have been suggested for each of the complexes.

The Schiff base ligands function as tridentates and the deprotonated enolic form is preferred for coordination. In order to evaluate the effect of the bactericidal activity, these synthesized complexes, in comparison to the uncomplexed Schiff base has been screened against bacterial species., Staphylococcus aureus, Escherichia coli and the results are reported.

Key words:(Cephalexin drug, Nicotinamide ,mixed ligand) Complexes, Antibacterial activities, and spectral studies

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]. There are a number of multidentate ligands that play important roles in coordination chemistry and catalyst designing. A large number of multidentate ligands have been synthesized and investigated for their metal binding character. Several such ligands possessing C=N (azomethine) group are known as Schiff bases [2]. The IR and ¹HNMR spectra of the complexes suggest that cephalexin behaves as a monoanionic tridentate ligand. In vitro antibacterial activities of cephalexin and the complexes were tested. Icbudak and co-workers [3], are reported the mixed-ligand p-hydroxybenzoate complexes of Ni(II),Cu(II) and Zn(II) with nicotinamide and N, N diethylnicotinamide were synthesized and characterized by elemental analysis, magnetic susceptibility measurements and mass spectrometry. When a metal ion combines with a ligand (Drug), the resulting substance is said to be a complex. If the ligand (Drug) which combine with the metal forms one or more rings with the metal, the resulting structure is said to be a metal chelate and the process is known as chelation [4]. Beta lactam antibiotics form a bulky family of zwitterionic drugs that are potent inhibitors of bacterial wall biosynthesis, which account for approximately 60% of commercial antibiotics formulations. [5]. Cephalexin (structure given in Scheme (1) is one of the most used first generation cephalosporin based antibiotics to treat infections due to its broad antibacterial activity. Its crystalline structure was published by Kennedy et al. [6]. In 2006 Jian-ning and co-workers [7], synthesized 4-(Benzeneazo)salicylaldehyde which was synthesized with aniline, sodium nitrite and salicylaldehyde. Two tetradentate ligands, N,N-bis[4-(benzeneazo) salicylaldehyde]-o-phenylenediamine (H₂L) and N,N-bis[4-(benzeneazo) salicylaldehyde]ethylenediamine (H₂L) were formed by the 2:1 molar condensation of 4-(benzeneazo) salicylaldehyde with o-phenylenediamine or ethylenediamine. Their Cu(II), Ni(II), Zn(II),Co(II), Mn(II) and Cd(II) complexes were synthesized and characterized by elemental analysis, molar conductivity measurements, and infrared and electronic spectral data. In 2007 Dursun and co-worker [8], Synthesized Nicotinamide-acetylsalicylate complexes of Co(II), Ni(II), Cu(II), and Zn(II) were

synthesised and their structural properties were investigated by employing elemental analysis, magnetic susceptibility, solid state UV-vis, direct injection probe mass, FTIR and thermoanalytic TG-DTG methods. It was found that ratio of metal:ligand:ligand is 1:2:2 and the decomposition of each complex starts with dehydration and follows by decomposition of the nicotinamide and acetylsalicylate, respectively. In 2009 El-Said and co-workers [9], Synthesized Mixed ligand complexes of Zn(II) and Cd(II) containing ceftriaxone (Nacefria) or cephadrine (Hcefpnr) antibiotics and other ligands have been prepared and characterized by elemental analysis, spectral, biological and thermal studies.

The complexes have the general formulas $[Cd_2(cephr)(diamine)Cl_3(H_2O)] \cdot xH_2O$, $[Cd_3(cephr)(\mu HL)Cl_5(H_2O)] \cdot 2H_2O$ where diamine= 2,2'-bipyridyl or o-phenanthroline; M= Cd(II) or Zn(II), L= glycine, proline or methionine and $x=0-6$. In 2010 Suresh and co-worker [10], synthesized A novel .aminoantipyrine) and vanillin and forms stable complexes with transition metal ions such as Cr (III), Mn (II), Co (II), Ni (II), Cu (II), Zn (II) and Cd (II). Their structures were investigated by elemental analysis, infrared spectroscopy, electronic spectroscopy, NMR spectroscopy; thermo gravimetric analysis and electron spin resonance spectroscopy. On the basis of the studies the coordination sites were proven to be through oxygen of the ring C = O and Nitrogen of the azomethine (-CH = N-)group. The microbiological studies revealed the anti bacterial nature of the complexes. In (2011) Sunil Joshi, and co-workers [11], synthesized the present study, Schiff bases have been synthesized by the condensation of cephalixin with p-chlorobenzaldehyde and cinnamaldehyde respectively in methanol. Further metal salts of Mn (II), Co (II), Ni (II) and Zn (II) have synthesized their metal complexes.

The work presented in this paper concerns the Preparation , Characterization and Antimicrobial activities of {Fe(II),Co(II),Ni(II),Cu(II),and Zn(II)}Mixed Ligand Complexes Schiff base derived from Cephalixin drug and 4(dimethylamino)benzaldehyde with Nicotinamide in 1:1:2(M:L:2NA) ratio.

2. Experimental

2.1- Chemical

All chemicals used were of reagent grade (supplied by either Merck or Fluka , and used as received., ethanol, methanol and dimethylforamide , and KBr, from (B.D.H). Cephalixin mono hydrate powder) and 4(dimethylamino)benzaldehyde from Riedial-Dehaen DSM (Spain).

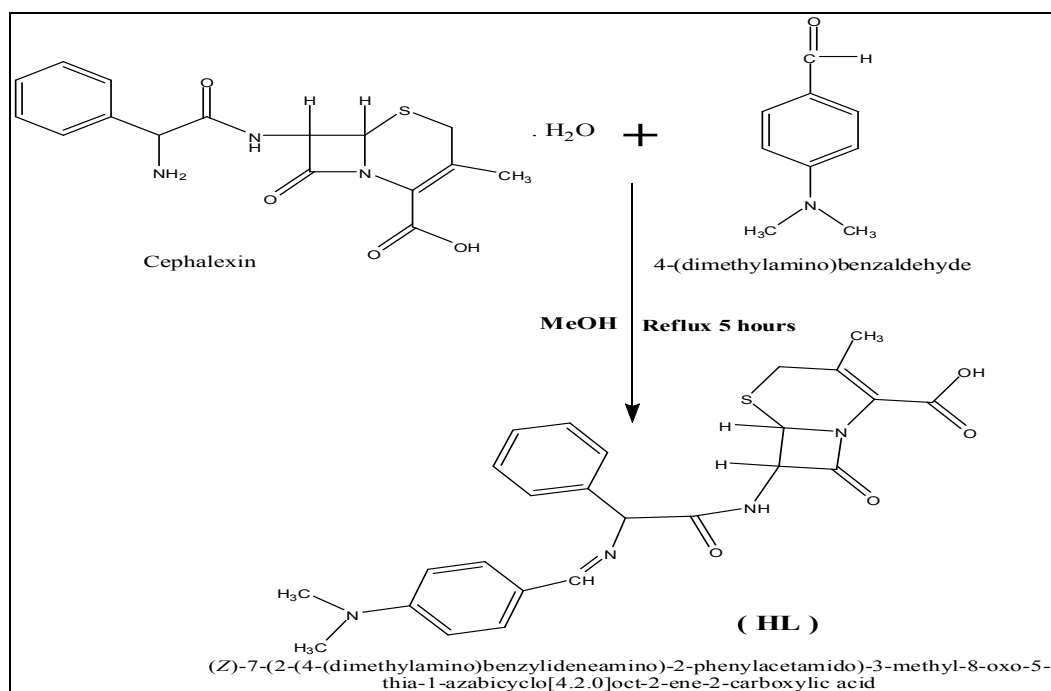
2.2- Instrumentation

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. Elemental micro analysis for the ligand was performed on a (C.H.N.S.O) Perkin Elmar 2400. While metal contents of the complexes were determined by atomic absorption (A.A) 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).

Molecular weight determined by Rast Camphor method, confirming the monomeric nature of the compounds. Conductivities were measured for $10^{-3}M$ of complexes in DMSO at $25^{\circ}C$ using (conductivity meter, Jewnwary, model 4070). Magnetic measurements were recorded on a Bruker BM6 instrument at $298^{\circ}K$ following the Farady's method .Nuclear magnetic resonance spectrum 1H NMR for ligand was recorded in DMSO- d_6 using a Bruker 300 MHz instrument with a tetra methyl silane (TMS) as an internal standard. The samples were recorded at Queen Mary, university of Al-Albeit, Jordon, Amman. In addition melting points were obtained using (Stuart Melting Point Apparatus). The proposed molecular structure of the complexes were drawing by using chem. office prog, 3DX (2006).

2.3- preparation of ligand (HL): [11]

A solution of (Ceph) (0.365 gm, mmole) in methanol (20 ml) was added to a solution of (4DMAB) (0.149 gm, m mole) in methanol (10 ml). The mixture was refluxed for (5 hours) with stirring. The resulting was an orange solution allowed to cool and dried at room temperature, then re-crystallization to the precipitate with ethanol, orange solid was obtained by evaporation of ethanol during (24 hours) Scheme (1), m. p ($76-80^{\circ}$). yield 78% . Anal. Calcd for ligand(HL) C = 62.74%, H = 5.48%, N = 11.71 % . = Found: C = 61.71%, H = 6.11%, N = 11.90%.



Scheme (1) : Schematic representation of synthesis of the ligand(HL)

2.4 -Synthesis of [Cu(L)(NA)₂Cl] complex : [11]

A solution of (HL) (0.478 gm, mmole) in methanol (10 ml) and a solution of (NA) (0.244 gm, m mole) in methanol (10ml), were added to a stirred solution of Cu (II) chloride dihydrate (0.09 gm, m mole) in methanol (5 ml).The resulting mixture was heated under reflux for (5 hours). Then the mixture was filtered and the precipitation was washed with an excess of ethanol and dried at room temperature during (24 hours).A green solid was obtained, m.p (272-276) ° C.

2.5- Synthesis of [Fe(L)(NA)₂Cl], [Co(L)(NA)₂Cl], [Ni(L)(NA)₂Cl], and [Zn(L)(NA)₂Cl] complexes :

The method used to prepare these complexes was similar method to that mentioned in preparation of [Cu(L)(NA)₂Cl] complex in paragraph above.

2.6 - Preparation of Microorganism suspension

A) The micro- organism suspension was prepared by taking 2–4 colonies from all the studied micro-organism. Then it was inserted in the physiological solution in 0.85% concentration and was compared with Macferr land tube number 0.5 which is equal to 1.5×10^8 cell/mm. It is used for Petri dish preparation for the examination of biological activity against the under studied chemical compound.

B) Inhibition Activity Selection for the complexes in studied Microorganism

The agar well diffusion method was used to see the effect of under studied chemical complexes on the microorganism growth. This is done by using 20–25 ml from Nutrient agar medium for each Petri dish. The dish was incubated in incubator for 24 hours at (37°C) to make sure that no contamination would occur in the dish. Bore was made on the cultured medium surface by using cork borer. The chemical complexes were made as 100 m ml per bore and left the central bore containing only DMF. The biological activity for the complexes was defined by measuring the diameter of the inhibition area surrounding each bore in millimeters. [12]

3. Results and Discussion

Physical Properties

Ligand (L) is soluble in(N,N-dimetylformamide (DMF), dimethylsulphoxide (DMSO), methanol (MeOH), ethanol (EtOH), acetone (C₃H₆O), 2-propanol (C₃H₈O) and completely insoluble in water (H₂O), carbon tetra chloride (CCl₄), benzene(C₆H₆), Petroleum ether and chloroform (CHCl₃).

Characterization of Metal 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 salt : one mole of HL and two moles of nicotinamide. The formula weights and

melting points are given in (Table I based on the physicochemical characteristics, it was found that all the complexes were non-hygroscopic, stable at room temperature and appears as powders with high melting points. The solubility of the complexes of ligands was studied in various solvents. They are not soluble in water. All complexes are soluble in (DMF) and (DMSO) solvent. The complexes were analyzed for their metal by atomic absorption measurements and chloride contents were determined by standard methods. (Table-1) for all complexes gave approximated values for theoretical values.

Molar conductance values of the soluble complexes in DMSO show values ($5.3-5.8 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$) indicating that they are all non-electrolytic in nature. [13]

FT-IR spectrum of the ligand (L):

The (FT-IR) spectrum for the starting material cephalixin exhibits band at $(3275) \text{ cm}^{-1}$ due to $\nu(\text{N-H})$ primary amine stretching vibration [14]. The bands at $(3219, 3049) \text{ cm}^{-1}$ are due to the $\nu(\text{N-H})$ secondary amine stretching vibration. The carboxylic acid group of cephalixin free ligand shows strong absorptions at 1759 cm^{-1} for $\nu(\text{C=O})$ and 3406 cm^{-1} for $\nu(\text{O-H})$ stretchings and $1595, 1398 \text{ cm}^{-1}$ due to the $\nu_{\text{asym}}, \nu_{\text{sym}}$ stretchings of (COO) group respectively [6]. Where $\Delta \nu = [\nu_{\text{asym}}(\text{COO}), \nu_{\text{sym}}(\text{COO})]$ is 197 cm^{-1} . These values are quite agreeable with the values reported earlier [14]. The band at $(1689) \text{ cm}^{-1}$ stretching vibration is due to $\nu(\text{C=O})$ for β -Lactum group [14]. The carbonyl stretching frequencies for amide, acid and β -lactum groups in cephalixin free ligand have been assigned at 1595 cm^{-1} [109], 1759 cm^{-1} and 1760 cm^{-1} [5], respectively. The bands at $(1595), (1398) \text{ cm}^{-1}$ were assigned to stretching vibration $\nu(\text{COO}^-)$ asymmetric and symmetric stretching vibration, respectively, $\Delta \nu(\text{COO}^-)_{\text{asym}} - \nu(\text{COO}^-)_{\text{sym}} = 197$ [14]. The bands at $(1577), (3010), (1163), (2388)$ were assigned to $\nu(\text{C=C})$ aromatic, $\nu(\text{C-H})$ aromatic, $\nu(\text{C-C})$ aliphatic, and $\nu(\text{C-C})$ aliphatic stretching vibration respectively. The band at $(1280) \text{ cm}^{-1}$ is due to $\nu(\text{C-N})$ stretching vibration. The band at $(1247) \text{ cm}^{-1}$ was assigned to $\nu(\text{C-O})$ stretching vibration. The band at $(580) \text{ cm}^{-1}$ was assigned to $\nu(\text{C-S})$ ring stretching vibration [14 - 15]. The spectrum for the starting material 4(dimethylamino)benzaldehyde (DMBA) exhibits a band due to $\nu(\text{C-N})$ were observed in the $(1371) \text{ cm}^{-1}$. The bands at $(1165) \text{ cm}^{-1}$ and $(2796) \text{ cm}^{-1}$ were assigned to the $\nu(\text{C-C})$ and $\nu(\text{C-H})$ aliphatic stretching vibration [16-17]. The very strong bands due to carbonyl group $\nu(\text{C=O})$ stretchings of (DMBA) were observed in the $(1662-1600) \text{ cm}^{-1}$ regions [15], while the bands at $(1548) \text{ cm}^{-1}$ and $(2819) \text{ cm}^{-1}$ were assigned to the $\nu(\text{C=C})$ aromatic and $\nu(\text{C-H})$ aromatic stretching vibration respectively [18]. The (FT-IR) spectrum for the ligand (L), the band at $(3228) \text{ cm}^{-1}$ due to $\nu(\text{N-H})$ secondary amine stretching vibration, and disappeared The band for the $\nu(\text{N-H})$ primary amine stretching vibration. The spectrum displays a new band at $(1678) \text{ cm}^{-1}$ is due $\nu(\text{HC=N-})$ group of the azomethine stretching vibrations of the ligand [15]. The band at $(1678) \text{ cm}^{-1}$ is due to $\nu(\text{C=O}) \text{ cm}^{-1}$ stretching vibration for (COOH) overlapping with azomethine group $\nu(\text{-HC=N-})$. The band at $(1678) \text{ cm}^{-1}$ stretching vibration is due to $\nu(\text{C=O})$ for β -Lactum group overlapping with $\nu(\text{-HC=N-})$ and $\nu(\text{C=O})$ stretching vibrations. The bands at (1597) and $(1373) \text{ cm}^{-1}$ were assigned to stretching vibration (COOH) asymmetric and symmetric stretching vibration, respectively. The bands at $(1531), (3062), (1168)$ and (2924) were assigned to $\nu(\text{C=C})$ aromatic, $\nu(\text{C-H})$ aromatic, $\nu(\text{C-C})$ aliphatic, and $\nu(\text{C-C})$ stretching vibration respectively. The band at $(1315) \text{ cm}^{-1}$ is due to $\nu(\text{C-N}) \text{ cm}^{-1}$ stretching vibration. The band at $(1230) \text{ cm}^{-1}$ was assigned to $\nu(\text{C-O})$ stretching vibration [14-16]. The band at $(584) \text{ cm}^{-1}$ was assigned to $\nu(\text{C-S})$ stretching vibration [13 -15-19-]. The assignment of the characteristic bands for the starting materials, intermediate compounds and the ligand are summarized in Table (2).

FT-IR of spectral data for the Schiff base mixed ligands complexes [Fe(L)(NA)₂Cl](1), [Co(L)(NA)₂Cl](2), [Ni(L)(NA)₂Cl](3), [Cu(L)(NA)₂Cl](4), [Zn(L)(NA)₂Cl](5):

The characteristic bands in Schiff base are used to determine the binding modes found in the system are $\nu(\text{HC=N-})$ group of the azomethine, $\nu(\text{N-H})$, $\nu(\text{M-O})$, $\nu(\text{M-N})$. The assignments of the characteristic bands are summarized in Table (2). On complexation these band has been shifted to lower frequencies $(1597), (1624), (1624), (1660), (1593) \text{ cm}^{-1}$ for complexes (1), (2), (3), (4), and (5), (6) This band gets shifted to lower frequency in the complexes, indicating the coordination through azomethine nitrogen to metal atom. [14-15]. The bands at $(1597), (1373) \text{ cm}^{-1}$ were assigned to stretching vibration (COOH) asymmetric and symmetric stretching vibration, respectively. On complexation these bands have been shifted to lower and higher frequencies $[(1681), (1600), (1624), (1678), (1539) \text{ cm}^{-1}]$ for $\nu(\text{-COO})_{\text{asy}}$, and $[(1377), (1396), (1396), (1375), (1377) \text{ cm}^{-1}]$ for $\nu(\text{-COO})_{\text{sy}}$ for the compounds (1), (2), (3), (4), and (5), that the coordination with metal was occurred through the oxygen atom of carboxylate ion.

and the band at $(1678) \text{ cm}^{-1}$ stretching vibration is due to $\nu(\text{C=O})$ for β -Lactum group, but these band has been shifted to higher frequency at 1681 for complex showing that the coordination is through the Oxygen atom of β -Lactum group. The bands at $(439), (482), (459), (478), (489) \text{ cm}^{-1}$ were assigned to $\nu(\text{M-O})$ for

compounds (1), (2), (3), (4), and (5), indicating that the carbocyclic oxygen, and oxygen of β -Lactum group of the ligand are involved in coordination with metal ions.

The bands at (540), (582), (528), (505) and (551) cm^{-1} were assigned to $\nu(\text{M}-\text{N})$ for compounds (1), (2), (3), (4), and (5), respectively, indicating that the amine nitrogen is involved in coordination with metal ions.

(U.V-Vis) Spectrum for the Schiff base ligand:

The electronic spectrum of the ligand has been measured in DMSO solution between 200- 1100 nm at room temperature. In the spectrum of the Schiff base ligand(L), the absorption band observed at 212 nm (47169 cm^{-1}), 242 nm (41322 cm^{-1}) (267 nm) (59880 cm^{-1}) which are assigned to benzene ($\pi-\pi^*$) transition, and the band at (336 nm) (29761 cm^{-1}) is assigned due to ($n-\pi^*$) transition associated with the azomethine chromosphere ($-\text{C}=\text{N}$) [14-15,20].

(U.V-Vis) Spectral data for the Schiff base mixed ligands complexes:

The absorption data for complexes are given in Table (3).

[Fe(L)(NA)₂Cl]: The (U.V- Vis) spectrum, exhibits four peaks, the first middle peak at 269 nm (37174 cm^{-1}), is due to the ligand field, while the second high peak at 342 nm (29239 cm^{-1}) (is due to the (C.T), the third and fourth weak peaks at 803 nm (12453 cm^{-1}), and 977 nm (10235 cm^{-1}), which assigned to ($^5\text{E} \rightarrow ^5\text{T}_2$) (d-d), and ($^5\text{E} \rightarrow ^5\text{T}_2$) (d-d) transition respectively in an octahedral geometry.

[Co(L)(NA)₂Cl]: The (U.V- Vis) spectrum, exhibits three peaks, the first high peak shoulder with at 269 nm (37174 cm^{-1}) is due to the ligand field and (C.T), while the second and third weak peaks at (897 nm) (11148 cm^{-1}), and (992 nm) (10080 cm^{-1}) which assigned to ($^5\text{E} \rightarrow ^5\text{T}_2$) (d-d), and ($^5\text{E} \rightarrow ^5\text{T}_2$) (d-d) transition respectively in an octahedral geometry.

[Ni(L)(NA)₂Cl]: The (U.V- Vis) spectrum, exhibits two peaks, the first high intense peak at (268 nm) (37313 cm^{-1}) is due to the ligand field and (C.T), while the second weak peaks at (992 nm) (10080 cm^{-1}), which assigned to ($^5\text{E} \rightarrow ^5\text{T}_2$) (d-d), transition in an octahedral geometry.

[Cu(L)(NA)₂Cl]: The (U.V- Vis) spectrum, exhibits two peaks, the first high broad peak at (272 nm) (36764 cm^{-1}) is due to the ligand field and (C.T), while the second weak broad peak at (924 nm) (10822 cm^{-1}), which assigned to ($^5\text{E} \rightarrow ^5\text{T}_2$) (d-d), transition in an octahedral geometry.

[Zn(L)(NA)₂Cl]: The (U.V- Vis) spectrum, exhibits two high peaks, the first middle peak at 271 nm (36900 cm^{-1}) is due to the ligand field and, the second high peak at (339 nm) (29498 cm^{-1}) is due to the (C.T) in an octahedral geometry.

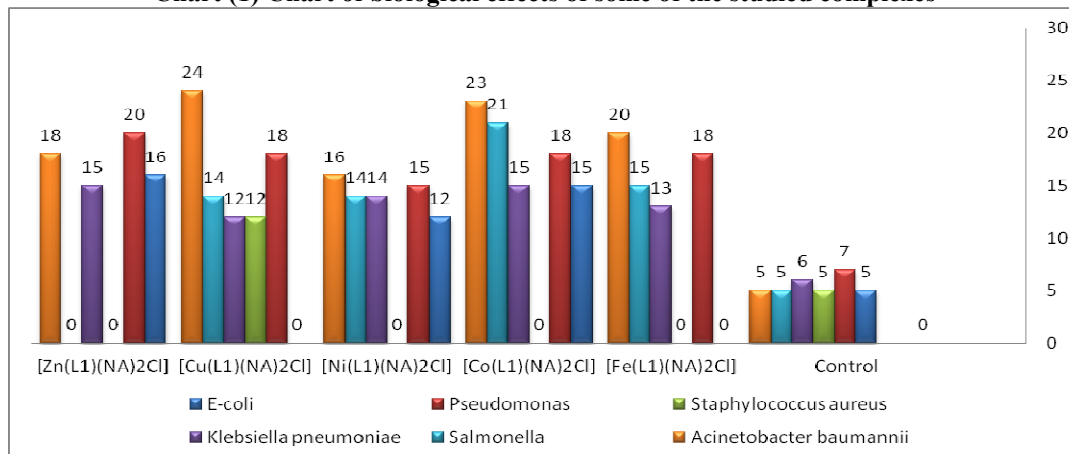
Also, the values of the magnetic moment Table (3). may be taken as additional evidence for their octahedral structure.

Molecular weight determined by Rast Camphor method and were found in accordance with calculated value the range of metal complexes (1060-1092), [11].

Antimicrobial activity:

The in vitro antimicrobial screening results are given in Table 4, Chart (1). On the basis of observed zones of inhibition, all the metal-mixed ligand complexes are active against all six tested organisms which in fact is in agreement with the literature [24]. The antibacterial results evidently show that the activity of the Schiff base became more upon coordination to the metal atoms.

Chart (1) Chart of biological effects of some of the studied complexes



REFERENCES

- [1] Volpato, G.; C. Rodrigues, R.; Fernandez-Lafuente, R. (2010) *Use of Enzymes in the Production of Semi-Synthetic Penicillins and Cephalosporins: Drawbacks and Perspectives*, Journal Of Current Medicinal Chemistry, Volume 17, Number 32.
- [2] Juan Anacona R. And Ibranyellis Rodriguez,(2004) " Synthesis And Antibacterial Activity Of Cephalexin Metal Complexes" , *Journal Of Coord. Chem., Vol. 57, No. 15, 15 October, Pp. 1263–1269.*
- [3] Icbudakl H., Heren Z ., Ali Kose D. And Necefoglu H, (2004) "*Bis(Nicotinamide) And Bis(N,N-Diethyl Nicotinamide) P-Hydroxybenzoate Complexes Of Ni(II), Cu(II) And Zn(II) Spectrothermal Studies* ", *Journal Of Thermal Analysis And Calorimetry, Vol. 76, pp 837–851.*
- [4] Sangeeta Jain, Sheela Longia, V. K. Ramnani, (2009), Metal Complexes as Magic Bullet - An Overview, People's *Journal of Scientific Research, Vol.2(1),pp37-40.*
- [5] Leithner, K.; Grabovac, V.; Albrecht, K.; Hombach, J.; Klima, G.; Bernkop-Schnürch, A. (2011). Permeation studies on freshly excised rat gastric mucosa: influence of pH. *Drug Dev. Journal Of Ind. Pharm., 37, pp518-525.*
- [6] Kennedy AR, Okoth MO, Sheen DB, Sherwood JN, Teat SJ, Vrcelj RM.(2003) Cephalexin: a chanel hydrate. *Journal Of Acta Cryst; C59(11): pp650-652.*
- [7] Jian- Ning Liu, Bo-Wan Wu, Bing Zhang, Yongchun Liu, (2006) "Synthesis And Characterization Of Metal Complexes Of Cu(I), Ni(II), Zn(II), Co(II),Mn(II) And Cd(II) With Tetradentate Schiff_Bases", *Turk Journal Of Chem 30, pp 41 - 48.*
- [8] Dursun Ali Kose, Hasan Icbudak, Hacali Necefoglu,(2007) " Synthesis And Characterization Of The Nicotinamid Acetylsalicylato Complexes Of Co(II), Ni(II), Cu(II), And Zn(II)", Hacettepe, *Journal Of Biol. & Chem., 35 (2), pp 123-128.*
- [9] Al. El-Said, A. A. M. Aly, M. S. El-Meligy(The Late) And M. A. Ibrahim, (2009.) "Mixed Ligand Zinc(II) And Cadmium(II) Complexes Containing Ceftriaxone Or Cephadrine Antibiotics And Different Donors" , *Journal Of The Argentine Chemical Society Vol. 97 N° 2, pp 149-165.*
- [10] M. S. Suresh And V. Prakash ,(2010.)"Preparation And Characterization Of Cr(III), Mn(II), Co(III), Ni(II), Cu(II), Zn(II) And Cd(II) Chelates Of Schiff's Base Derived From Vanillin And 4-Amino Antipyrine", *International Journal Of The Physical Sciences Vol. 5(14), Pp. 2203-2211, 4 November.*
- [11] Sunil Joshi, Vatsala Pawar , And V. Uma,(2011) Antibacterial And Antioxidant Properties Of Mn (II), Co (II), Ni (II) And Zn (II) Complex Of Schiff Base Derived From Cephalexin", *Research Journal Of Pharmaceutical, Biological And Chemical Sciences, RJPBCS Volume 2 Issue 1.*
- [12] Vignolo M.; Suriant F.;Holgado A.P. and Oliver G.,(1993). Antibacterial activity of Lado bacillus strains isolated from dry fermented sausage; *Journal Of App. Bac. 75:pp 344-349.*
- [13] Geary W. J., *The Use of Conductivity Measurements in Organic Solvents for the Characterisation of Coordination Compounds. Journal Of coord. Chem. Rev. 7, 81-122.(1971).*
- [14] Nakamoto K.; (1996) "*Infrared spectra of Inorganic and coordination compounds*" 4ED th ; J. Wiley and Sons, New York,
- [15] Juan R. Anacona And Ibranyellis Rodriguez, " Synthesis And Antibacterial Activity Of Cephalexin Metal Complexes"(2004) , *Journal Of Coord. Chem., Vol. 57, No. 15, 15 October, pp. 1263–1269.*
- [16] Aldo Caiazzo, Shadi Dalili, Christine Picard, Mikio Sasaki, Tung Siu, and Andrei K.Yudin, (2004) New methods for the synthesis of heterocyclic compounds, ; *Journal Of Pure Appl. Chem., Vol. 76, No. 3, pp. 603–613.*
- [17] Taghreed H.Al-Noor, Ibtisam Dawood and Ibtihaj. Malih, Synthesis, (Spectroscopic and Antibacterial) Studies of Tin (II) and Lead (Anthranilic acids and nicotinamide) Complexes, *Journal of International Journal for Sciences and Technology Vol. 7, No. 3, September 2012 pp 32-42*
- [18] Dhivya Priya D., Akila E., Usharani M. And Rajavel R., (2012) Synthesis, Spectral And Biological Activity Of Mixed Ligand Schiff Base Complexes Derived From Salicylaldehyde, *Journal of International Journal Of Pharmacy & Technology, (IJPT), April- Vol. 4 , Issue No.1, pp 4067-4078.*
- [19] Fayad N.K., Taghreed H. Al-Noor and Ghanim F.H, (2012) Synthesis, Characterization, And Antibacterial Activities Of Manganese (II), Cobalt(II), Iron (II), Nickel (II) , zinc (II) And Cadmium(II) Mixed- Ligand Complexes Containing Amino Acid(L-Valine) And Saccharin, *Journal of Advances in Physics Theories and Applications, Vol 9, pp1-12.*
- [20] Lever A.B.P., (1984) "*Inorganic Electronic spectroscopy*", Elsevier, New York.
- [21] Fayad N.K. , Taghreed H. Al-Noor and F.H Ghanim, Synthesis ,characterization and antibacterial activity of mixed ligand complexes of some metals with 1-nitroso-2-naphthol and L-phenylalanine , *Journal of Chemistry and Materials Research, Vol 2, No.5,pp18-29(2012).*

- [22] Chaudhary Rakhi and Shelly, (2011) Synthesis, Spectral and Pharmacological Study of Cu(II), Ni(II) and Co(II) Coordination Complexes, *Res. J. Chem. Sci.*, 1(5), pp1-5.
 [23] Shriver & Atkins (1999) “*Inorganic Chemistry*”, 3rd Ed., , Freeman.
 [24] Taghreed H. Al-Noor, Sajed. M. Lateef and Mazin H. Rhayma, (2012) Synthesis, Characterization, Schiff Base Phenyl 2-(2-hydroxybenzylideneamino)benzoate and its complexes with La(III), Cr (III), and Pr (III), *Journal of Chemical and Pharmaceutical Research*, 4(9): pp 4141-4148.

Table(1):The physical properties of the compounds

| Compounds | M. wt Calc. | M. wt Rats method. | Color | Yield % | M .p° c (de) °c | Λ_m | Metal% | Cl% |
|--|-------------|--------------------|------------|---------|-----------------|--------------------------------------|--------------|-------------|
| | | | | | | s.cm ² .mol ⁻¹ | theory (exp) | |
| L C ₂₅ H ₂₆ N ₄ O ₄ S | 478.17 | 498.17 | orange | 78 | 76-80 | - | - | - |
| [Fe(L)(NA) ₂ Cl] C ₃₇ H ₃₇ ClFeN ₈ O ₆ S | 813.10 | 823.0 | Grey green | 87 | 172 Dec. | 5.3 | 6.87 | 4.36 (4.50) |
| [Co(L)(NA) ₂ Cl] C ₃₇ H ₃₇ Cl Co N ₈ O ₆ S | 815.16 | 843.5 | Violet | 77 | 280 Dec. | 5.3 | 7.22 | 4.34 (4.50) |
| [Ni(L)(NA) ₂ Cl] C ₃₇ H ₃₇ Cl Ni N ₈ O ₆ S | 815.95 | 833.10 | Yellow | 82 | 280 Dec. | 5.8 | 7.19 | 4.34 (4.50) |
| [Cu(L)(NA) ₂ Cl] C ₃₇ H ₃₇ Cl Cu N ₈ O ₆ S | 820.80 | 829.50 | Green | 84 | 272-276 | 5.4 | 7.74 | 4.32 (4.33) |
| [Zn(L)(NA) ₂ Cl] C ₃₇ H ₃₇ Cl Zn N ₈ O ₆ S | 822.67 | 843.80 | Brown | 87 | 102-116 | 8.6 | 7.95 | 4.31 (4.50) |

M. wt = Molecular Weight , Λ_m = Molar Conductivity , dec. = decomposition , Calc.=calculation

Table(2):Data from the Infrared Spectra for the Free Lingands and there Metal Complexes (cm⁻¹).

| Compound | (N-H) primary amine | ν (N-H) Secondary amide | ν (C=O) for COOH | ν (C=O) β -lactam | ν (C=O) amide | ν (C=N) | ν_{as} COO | ν_s COO | ν (C=C) arom. | ν (C-C) aliph. | ν (C-N) | ν (C-O) | ν (C-S) | ν (C-H) arom. | ν (C-H) aliph. | ν (M-N) | ν (M-O) |
|-----------------------------|---------------------|-----------------------------|----------------------|-----------------------------|-------------------|--------------|----------------|-------------|-------------------|--------------------|-------------|-------------|-------------|-------------------|--------------------|-------------|-------------|
| L | ----- | 3228 overlap | 1678 overlap | 1678 overlap | ----- | 1678 overlap | 1597 | 1373 | 1531 | 1168 | 1315 | 1230 | 594 | 3062 | 2924 | ----- | ----- |
| Nicotine amide | 3367, 3159 | ----- | ----- | ----- | 1679vs | ----- | ----- | ----- | 1593 | 1124 | 1201 | ----- | ----- | 3061 | 2787 | ----- | ----- |
| [Fe(L)(NA) ₂ Cl] | 3441 | 3441 overlap | 1681 overlap | 1681 overlap | ----- | 1597 | 1597 overlap | 1377 | 1539 | 1168 | 1288 | 1248 | 597 | 3070 | 2970 | 540 | 439 |
| Co(L)(NA) ₂ Cl] | 3402 | 3306 , 3267 | 1666 overlap | 1666 overlap | ----- | 1624 | 1600 | 1396 | 1581 | 1199 | 1296 | 1238 | | 3078 | 2940 | 582 | 482 |
| Ni(L)(NA) ₂ Cl] | 3406 | 3321 , 3267 | 1666 overlap | 1666 overlap | ----- | 1624 | 1624 overlap | 1396 | 1581 | 1195 | 1292 | 1234 | | 3078 | 2950 | 528 | 459 |
| Cu(L)(NA) ₂ Cl] | 3406 | 3236 | 1678 overlap | 1678 overlap | ----- | 1660 overlap | 1678 overlap | 1435 | 1531 | 1134 | 1284 | 1249 | | 2966 | 2924 | 505 | 478 |
| Zn(L)(NA) ₂ Cl] | 3410 | 3363 , 3232 | 1678 overlap | 1678 overlap | ----- | 1593 | 1593 overlap | 1377 | 1535 | 1166 | 1288 | 1230 | | 3066 | 2850 | 551 | 489 |

Table 3- Electronic Spectral data, magnetic moment, of the studied compounds

| Compound | λ nm | ABS | $\tilde{\nu}$ cm ⁻¹ | ϵ_{\max} molar ⁻¹ .cm ⁻¹ | Assignments | μ_{eff} (BM) |
|-----------------------------|--------------|-------|--------------------------------|--|---------------------------------|-------------------------|
| Ceph | 279 | 0.770 | 35842 | 770 | $\pi \rightarrow \pi^*$ | - |
| NA | 220 | 1.548 | 45454 | 1548 | $\pi \rightarrow \pi^*$ | - |
| | 261 | 1.104 | 38314 | 1104 | $\pi \rightarrow \pi^*$ | |
| 4DMAB | 208 | 0.338 | 48007 | 338 | $\pi \rightarrow \pi^*$ | - |
| | 342 | 0.493 | 29239 | 493 | $n \rightarrow \pi^*$ | |
| | 336 | 1.961 | 29761 | 1961 | $n \rightarrow \pi^*$ | |
| L | 212 | 0.953 | 47169 | 953 | $\pi \rightarrow \pi^*$ | - |
| | 242 | 0.629 | 41322 | 629 | $\pi \rightarrow \pi^*$ | |
| | 267 | 0.507 | 59880 | 507 | $\pi \rightarrow \pi^*$ | |
| | 336 | 1.482 | 29761 | 1482 | $n \rightarrow \pi^*$ | |
| [Fe(L)(NA) ₂ Cl] | 269 | 0.878 | 71743 | 878 | L-F | 4.66 |
| | 342 | 1.556 | 29239 | 1556 | C-T | |
| | 803 | 0.012 | 12453 | 12 | $^5T_{2g} \rightarrow ^5E_g$ | |
| | 977 | 0.010 | 10235 | 10 | $^5T_{2g} \rightarrow ^5E_g$ | |
| [Co(L)(NA) ₂ Cl] | 269 | 1.580 | 37174 | 1580 | L-F | 4.83 |
| | 897 | 0.007 | 11148 | 7 | C-T | |
| | 992 | 0.012 | 10080 | 12 | $^4T_{1g} \rightarrow ^4A_{2g}$ | |
| [Ni(L)(NA) ₂ Cl] | 268 | 1.562 | 37313 | 1562 | C-T | 2.91 |
| | 992 | 0.011 | 10080 | 11 | $^3A_{2g} \rightarrow ^3T_{1g}$ | |
| [Cu(L)(NA) ₂ Cl] | 272 | 1.957 | 36764 | 1957 | C-T | 2.11 |
| | 924 | 0.037 | 10822 | 37 | $^2E_g \rightarrow ^2T_{2g}$ | |
| [Zn(L)(NA) ₂ Cl] | 271 | 0.998 | 36900 | 998 | C-T | Diamag |
| | 339 | 1.608 | 29498 | 1608 | C-T | |

Table(4): Biological activity of the Schiff bases mixed ligands complexes (Zone of inhibition (mm))

| Compound | <i>E-coli</i> | <i>Pseudomonas</i> | <i>Staphylococcus aureus</i> | <i>Klebsiella pneumoniae</i> | <i>Salmonella Typhi</i> | <i>Acinetobacter baumannii</i> |
|-----------------------------|---------------|--------------------|------------------------------|------------------------------|-------------------------|--------------------------------|
| Control | 5 | 7 | 5 | 6 | 5 | 5 |
| [Fe(L)(NA) ₂ Cl] | 0 | 18 | 0 | 13 | 15 | 20 |
| [Co(L)(NA) ₂ Cl] | 15 | 18 | 0 | 15 | 21 | 23 |
| [Ni(L)(NA) ₂ Cl] | 12 | 15 | 0 | 14 | 14 | 16 |
| [Cu(L)(NA) ₂ Cl] | 0 | 18 | 12 | 12 | 14 | 24 |
| [Zn(L)(NA) ₂ Cl] | 16 | 20 | 0 | 15 | 0 | 18 |

This academic article was published by The International Institute for Science, Technology and Education (IISTE). The IISTE is a pioneer in the Open Access Publishing service based in the U.S. and Europe. The aim of the institute is Accelerating Global Knowledge Sharing.

More information about the publisher can be found in the IISTE's homepage:

<http://www.iiste.org>

CALL FOR PAPERS

The IISTE is currently hosting more than 30 peer-reviewed academic journals and collaborating with academic institutions around the world. There's no deadline for submission. **Prospective authors of IISTE journals can find the submission instruction on the following page:** <http://www.iiste.org/Journals/>

The IISTE editorial team promises to review and publish all the qualified submissions in a **fast** manner. All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Printed version of the journals is also available upon request of readers and authors.

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digital Library, NewJour, Google Scholar

