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Synthetic, Spectroscopic And Antibacterial Studies Of Fe(II),Co(II),Ni(II),Cu(II),and Zn(II)Mixed Ligand Complexes Of Nicotinamide And Cephalexin antibiotics

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Abstract

Mixed ligand complexes of bivalent metal ions, viz; M= Co(II), Ni(II), Cu(II) and Zn(II) of the composition [M(Ceph)$(NA)_3$]Cl in 1:1:3 molar ratio, (where Ceph = Cephalexin and NA = Nicotinamide have been synthesized and characterized by repeated melting point determination, Solubility, Molar conductivity, determination the percentage of the metal in the complexes by flame(AAS), FT-IR, magnetic susceptibility measurements and electronic spectral data. The ligands and their metal complexes were screened for their antimicrobial activity against six bacteria(gram +ve) and (gram -ve).

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

1. Introduction

Semi-synthetic β-lactamic antibiotics are the most used anti-bacteria agents, produced in hundreds tons/year scale. It may be assumed that this situation will even increase during the next years, with new β-lactamic antibiotics under development. The wider use of antibiotics in humans and animals and in areas other than the treatment and prophylaxis of disease have resulted in a serious problem of drug resistance. Various strategies have been worked out and tried to cope with the resistance problem and enhance the activity, or broaden the spectrum of drugs [1].In 2003 Juan Anacona and Ibranyellis[2],Synthesized cephalexin with transition and d10 metal ions have been investigated. The complexes [M(cepha)Cl].nH_2O [M= Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II), Hg(II)] were characterized by physicochemical and spectroscopic methods.The IR and ^{1}HNMR 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 andN,Ndiethylnicotinamide 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].El-Said and co-workers [5], Synthesized Mixed ligand complexes of Zn(II) and Cd(II) containing ceftriaxone (Naceftria) or cephradine (Hcefphr) antibiotics and other ligands have been prepared and characterized by elemental analysis, spectral, biological and thermal studies.

The complexes have the general formulae: [Zn(ceftria)(diamine)(OAc)].xH_2O, [M(ceftria)(L)$(H_2O)_2$].xH_2O,[Cd_2(cephr)(diamine)$Cl_3(H_2O)$].xH_2O,[Cd_3(cephr)(μHL)$Cl_5(H_2O)$].$2H_2O$ where diamine= 2,2'-bipyridyl or o-phenanthroline; M= Cd(II) or Zn(II), L= glycine, proline or methionine and x=0-6. Ceftriaxone chelates to the metal ions as a bidentate monoanion ligand through the β– lactam carbonyl and carboxylate group. The complexes containing O,N donor atoms are very important owing to their significant antibacterial and anticancer activity [5-9].The study of mixed ligand complex formation is relevant in the field of analytical chemistry, where the use of mixed ligand complexes allows the development of methods with increased selectivity and sensitivity. They have also great importance in the field of biological and environmental chemistry [10]

The work presented in this paper concerns the preparation, characterization and biological evaluation of Fe(II),Co (II), Ni (II) ,Cu(II), Zn(II)Mixed Ligand Complexes Of Nicotinamide and Cephalexin in 1:3:1 ratio.

2. Experimental

2.1. Chemicals

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

2.2. Instrumentals

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)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^{-3}M of complexes in DMSO at 25^{o}C using (conductivity meter, Jewnwary, model 4070). Magnetic measurements were recorded on a Bruker BM6 instrument at 298°K following the Farady's method .. 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) Synthesis of (Mixing ligands) complexes with some metal ions

(2.3.1) Synthesis of $[Cu(Ceph)(NA)_3]Cl$ complex: [2, 11]

A solution of (Ceph) (0.366 gm, mmole) in methanol (5 ml) with KOH (0.05 gm) and a solution of (NA) (0.366 gm, mmole) in methanol (5 ml) were added to stirred of Cu(II) Chloride dihydrate (0.17 gm, mmole) in methanol (5 ml). The resulting mixture was stirred for (4 hours). Then the mixture was filtered and washed with an excess of ethanol and dried at room temperature during (24 hours). A green solid was obtained, m.p (196-200 ºC) ,yield 87% .

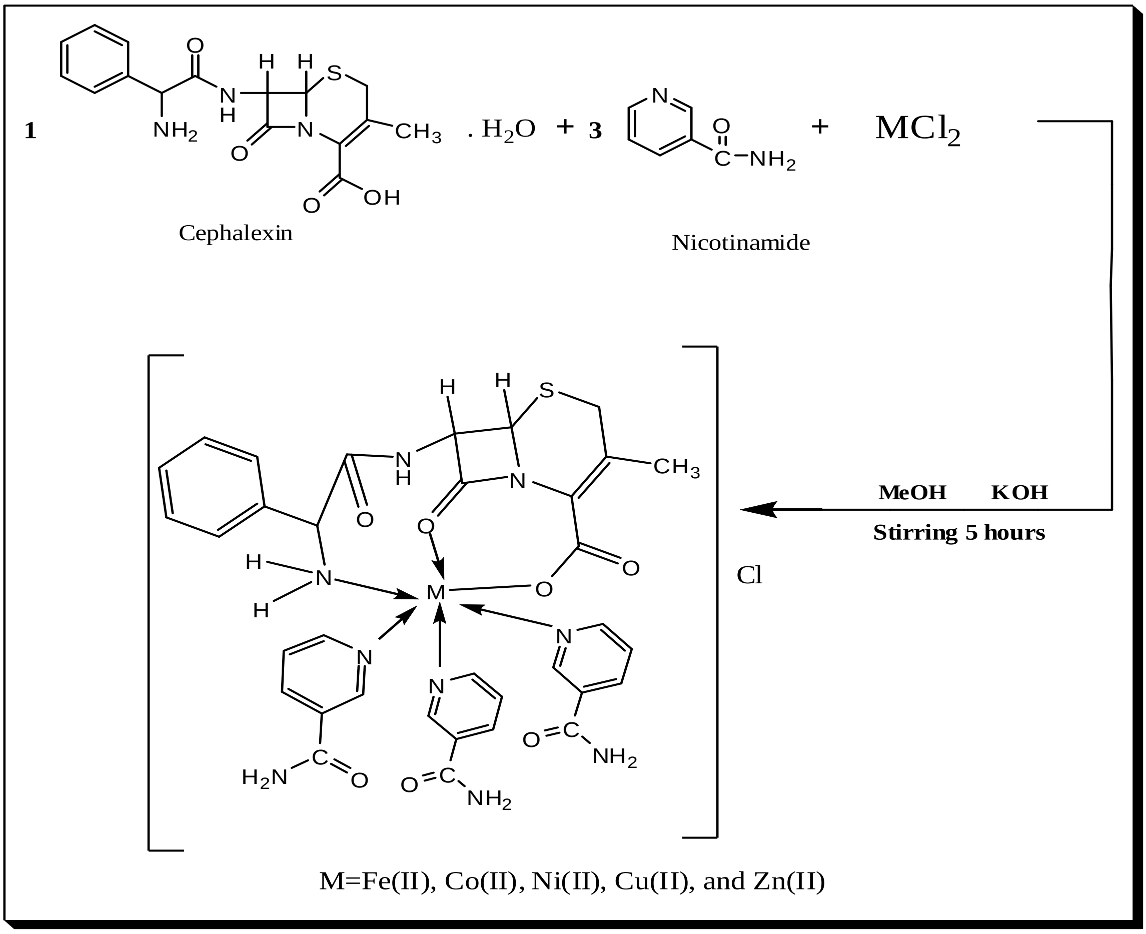
(2.3.2) Synthesis of $[Fe(Ceph)(NA)_3]Cl$, $[Co(Ceph)(NA)_3]Cl$, $[Ni(Ceph)(NA)_3]Cl$, and $[Zn(Ceph)(NA)_3]Cl$,complexes :

The method used to prepare these complexes was similar method to that mentioned in preparation of $[Cu(Ceph)(NA)_3]Cl$ complex in paragraph (2.3.1) , but obtained a solution complexes with Fe(II), Co(II), Ni(II), dried them, and washed with an excess of ethanol and dried at room temperature during (24 hours). yield 83% . (2.3.1) Synthesis of $[Cu(Ceph)(NA)_3]Cl$ complex:
[2, 11]

A solution of (Ceph) (0.366 gm, mmole) in methanol (5 ml) with KOH (0.05 gm) and a solution of (NA) (0.366 gm, mmole) in methanol (5 ml) were added to stirred of Cu(II) Chloride dihydrate (0.17 gm, mmole) in methanol (5 ml). The resulting mixture was stirred for (4 hours). Then the mixture was filtered and washed with an excess of ethanol and dried at room temperature during (24 hours). A green solid was obtained, m.p (196-200 ºC) , good yield .
The complexes of the mixed ligands (cephalexin monohydrate, as primary ligand with nicotinamide as a secondary ligands with M(II) = Fe(II), Co(II), Ni(II), Cu(II), and Zn(II) are prepared by shown in **(Figure. 1)**.

2.4. Antimicrobial activities

Antimicrobial activities of the ligands and **synthes**ed complexes have been carried out against the pathogenic bacteria like Escherichia coli, Bacillus subtilis, Staphylococcus aureus, and Pseudomonas aeruginosa, using nutrient agar medium by disc diffusion method [8] . The test solution were prepared in DMSO and soaked in filter paper of 5 mm diameter and 1mm thickness. These discs were placed on the already seeded plates and incubated at 37 o C for 24 h. The diameters (mm) of the inhibition zone around each disc were measured after 24 hours. [2-12].



(Figure. 1) :Schematic representation of synthesis of Mixed ligand complexes

3. Results and Discussion

3.1. 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 cephalexin and two moles of nicotinamide.

The formula weights and melting points,are given in(Table I).Based on the physicochemical characteristics (Table I), 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(Table2).They are not soluble in water .All complexes are soluble in dimethyl formamide (DMF)and dimethyl sulfoxide (DMSO) solvent(Table 2).The complexes were analyzed for their metal by atomic absorption measurements and chloride contents were determined by standard methods [16].(Table-1) for all complexes gave approximated values for theoretical values. The observed molar conductance (Table 1) values measured in DMSO in 10^{-3}M solution lie in the .(33-37 Ω^{-1} cm^{2} mol^{-1}) range, indicating their electrolytic nature with(1: 1). [13].

The atomic absorption measurements and Chloride contents (Table-1) for all complexes gave approximated values for theoretical values.

FT-IR spectra data:

In general ,the complexes exhibited very comparable I.R features suggesting that they were of similar structure .Relevant bands were given in (Table-3).

FT-IR of $[Fe(Ceph)(NA)_3]Cl$(1), $[Co(Ceph) (NA)_3]$ Cl (2) ,$[Ni(Ceph)(NA)_3]Cl$(3), $[Cu(Ceph)(NA)_3]Cl$(4), $[Zn(Ceph)(NA)_3]Cl$(5) complexes:[15-18]

The (FT-IR) spectrum for the free ligand (Ceph.), which exhibits band at (3275), and (3367, 3159) cm^{-1} due to υ(N–H) primary amine stretching vibration, on complexation this band has been shifted to higher frequency (3367), (3410), (3475) , (3402), and (3541) $cm^{-1}$for complexes (1), (2), (3), (4), and (5), :[15] showing that the coordination is through the Nitrogen atom of amine group. The band at (1699) cm^{-1} is due to υ(C=O) cm^{-1} stretching vibration for (amide), and the band at (1759) cm^{-1} is due to υ(C=O) cm^{-1} stretching vibration for (COOH), but in the complexes was at (1667), (1666), (1697) , (1757, 1707), and (1759) cm^{-1} for complexes (1), (2), (3), (4), and (5). The band at (1689) cm^{-1} stretching vibration is due to υ (C=O) for β-Lactum group, but these band has been shifted to lower frequency (1678), (1666), (1681) , (1670, 1624), and (1666, 1631) $cm^{-1}$for complexes (1), (2), (3), (4), and (5), showing that the coordination is through the Oxygen atom of β-Lactum group. :[17-18] The bands at (1595), and (1398) 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 [(1620), (1620), (1604), (1604), and (1616) cm^{-1} for $υ_{as}(COO^{-})$], and [(1396), (1392), (1392) , (1379), and (12392) cm^{-1},for $υ_{s}(COO^{-})$] for the compounds (1) , (2) , (3) , (4) , and (5), showing that that the coordination with metal was occurred through the oxygen atom of carboxylate ion. The pyridyl C–C and C–N stretching vibration absorptions are observed in the form of medium bands between 1400 and 1575 cm-1.The bands in the region of 1600–1230 cm-1 can be assigned to the CH in-plane or out-of - plane bend, ring ,breathing and ring deformation absorptions of the pyridine ring of nicotinamide. The bands at (493), (497), (455) , (487), and (459)cm^{-1} were assigned to υ(M–O) for compounds (1), (2), (3), (4),and (5), indicating that to the carbocylic oxygen, and oxygen of β-Lactam group of the ligand are involved in coordination with metal ions. The bands at (540), (563), (563), (549), and (536) cm^{-1} were assigned to υ(M–N)for compounds (1), (2),(3),(4),and (5)respectively,indicating that the amine nitrogen is involved in coordination with metal ions.

The UV-Visible Spectroscopy and Magnetic measurements for the mixed ligand complexes : $[Fe(Ceph)(NA)_3]Cl$, $[Co(Ceph) (NA)_3]$ Cl ,$[Ni(Ceph)(NA)_3]Cl$, $[Cu(Ceph)(NA)_3]Cl$, and$[Zn(Ceph)(NA)_3]Cl$ complexes:

The magnetic moments of the complexes shown in Table (4).were calculated from the measured magnetic susceptibilities after employing diamagnetic corrections. The electronic spectral data of the complexes are summarized in (4) together with the proposed assignments and suggested geometries. The results obtained are in good agreement with other spectra and the literature.[19-26]

$[Fe(Ceph)(NA)_3]$ Cl:

The(U.V- Vis) spectrum, exhibits two peaks , the first high intense peak at (278 nm)(37037cm^{-1})(ε_{max} =1645 molar^{-1}.cm^{-1}) is due to the (C.T) , while the second weak peaks at(990 nm)(10101 cm^{-1})(ε_{max} =18 molar^{-1}.cm^{-1}), which assigned to ($^5T_{2g}$→^5E_g), transition and μ eff = 4.97μB, which suggests an octahedral geometry around the central metal ion. :[19-21]

$[Co(Ceph)(NA)_3]$ Cl:

The (U.V- Vis) spectrum, exhibits four peaks . The assignment of the electronic spectral bands, their positions, and the spectral parameters for Co(I1) 4T1(F) →4T2g(F) υ1= (992 n nm) 10080 cm^{-1} , (ε_{max} =14 molar^{-1}.cm^{-1}), 4T1(F) →4A2 g, υ2= (833nm) 12004cm^{-1}, (ε_{max} =5 molar^{-1}.cm^{-1}), ,(F) →4TI g ,υ3= (728nm) 13736 cm^{-1}, (ε_{max} =7 molar^{-1}.cm^{-1}), υ_2/ υ_1 =1.19, υ_1/ υ_2 = 0.38, Δ/B= 10.38 from Tanabe-Sugano diagram for d^7 octahedral field the value of 10Dq equal to 10.080 cm^{-1} , *B'=950* cm^{-} , β =0.978 cm^{-1}, The Co(II) complex under present investigation process interelectronic repulsion parameter (B') 950 cm^{-1}. The Racha parameter (B) is less than free ion value (971) suggesting a considerable orbital overlap and delocalization of electrons on the metal ion. The nephelauxetic ratio (β) for the present Co(II) complex (0.974). This is less than one, suggesting partial covalency in the metal ligand bond. suggest the octahedral geometry for Co(II) complex and fourth high peak at (268 nm)(37313 cm^{-1})(ε_{max} =1489 molar^{-1}.cm^{-1}) is due to the (C.T) , The room temperature magnetic moment (μ_{eff} = 4.54μB) corresponded to octahedral symmetry. [2, 19,21]

$[Ni(Ceph)(NA)_3]$ Cl:

The (U.V- Vis) spectrum, exhibits three peaks. The assignment of the electronic spectral bands for, Ni(II) are ^{3}A2g →^{3}T2,(F) υ1=(993nm) 10070cm-1)(ε max =19 molar-1.cm-1), 3A2g (F) →3T1g(F) υ2= (800nm) 12500 cm^{-1})(ε max =11 molar^{-1}.cm-1) , and (267nm) 37453 cm-1 for ligand filed transitions ,*10Dq*=10070 cm^{-1}, *B'=966* cm^{-1},β =0.93. Ni (II) complex exhibited a value of μ eff = 3.18 μB, which suggests an octahedral geometry around the central metal ion. [2,19,22,23]

$[Cu(Ceph)(NA)_3]$ Cl:

The (U.V- Vis) spectrum, exhibits two peaks , the first peak at (271 nm)(36900 cm^{-1}) (ε_{max} =1883 molar^{-1}.cm^{-1}) is due to the (LMCT), while the second weak peaks at (994 nm)(10060 cm^{-1})(ε_{max} =30 molar^{-1}.cm^{-1}), which assigned to *(2Eg→2T2g)* transition in an octahedral geometry . [2,13,24,] Cu(II) complex exhibited a value of μ eff =1.86 *μ*B, which suggests an octahedral geometry around the central metal ion. [2,21,25]

$[Zn(Ceph)(NA)_3]$ Cl:

The (U.V- Vis) spectrum, exhibits one high peak at (270 nm)(37037 cm^{-1})(εmax =1556 molar^{-1}.cm^{-1}) is due (C.T) The Zn(II), complex did not display any peak in the visible region, no ligand field absorptions band was observed, therefore the bands appeared in the spectrum of complex could be attributed to charge transfer transition. in fact this result is a good agreement with previous work of octahedral geometry. Magnetic susceptibility measurements for Zn(II) (d^{10})(white complex) showed diamagnetic as expected from their electronic configuration . [2,15,21]

Discussion of the biological effect results for prepared compounds:

The newly synthesized metal complexes were screened in vitro for their antibacterial activity against bacteria: Staphyloccus aureus, E-coli , Klebsiella, Salmonella Typhi, Acinetobacter baumannii and Pseudomonas. The zone of inhibition of the ligands and their complexes against the growth of bacteria were given in Table (5), **(Figure. 2)** were tested utilizing the agar diffusion technique [26]. The antibacterial activity results revealed that the ligands and there complexes (DMF) . mixed ligand metal shown weak to good activity when compared to the Control complexes have higher biological activities compared to the free ligands . The increased inhibition activity of the metal complexes can be explained on the basis of Tweedy's chelation theory [27] . In metal complexes, on chelation the polarity of the metal ion will be reduced to a greater extent due to the overlap of the ligand orbital and partial sharing of the positive charge of the metal ion with donor groups. Further, it increases the delocalization of π- electrons over the whole chelate ring. The ring of nicotinamide moiety makes the complexes more lipophillic[28] .

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, Current Medicinal Chemistry, Volume 17, Number 32

2- Juan Anacona R. And Ibranyellis Rodriguez,(2004) " Synthesis And Antibacterial Activity Of Cephalexin Metal Complexes" , J. Coord. Chem., Vol. 57, No. 15, 15 October, Pp. 1263–1269.

3-Icbudak1 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. 76 837–851.

4-Sangeeta Jain,Sheela Longia,V.K. Ramnani, People’s Journal of Scientific Research, .(2009).Vol.2(1), Jan

5- El-Said A. I., Aly A. A. M. , El-Meligy M. S. And Ibrahim M. A., (2009)."Mixed *Ligand Zinc(II) And* Cadmium(II) Complexes Containing Ceftriaxone Or Cephradine Antibiotics And Different Donors",The Journal Of The Argentine Chemical Society Vol. 97 N °2,149-165 .

6- 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, International Journal Of Pharmacy &Technology,(IJPT)| April- | Vol. 4 | Issue No.1 |pp 4067-4078

7-Louie AY, Meade TJ: Metal complexes as enzyme inhibitors.(1999),Chemical .Reviews,;999:pp2711-2734.

8-Sakurai H, Kojima Y, Yoshikawa Y, Kawabe K, Yasui H,(2002) Antidiabetic vanadium(IV) and zinc (II) complexes))Coordination Chemistry Reviews,; 226 : 187-198l

9- 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, Advances in Physics Theories and Applications, Vol 9 pp 1-13

10- Sharma R.C, Giri P.P, Devendra Kumar and Neelam(2012), Synthesis, spectral and antimicrobial activity of mixed ligand complexes of Co(II),Ni(II), Cu(II) and Zn(II) with N,O and S donor ligands J. Chem. Pharm. Res., 4(4): 1969-1973

11-Katircioglu H,Beyat Y,Aslim B,Yuksekdag Z,Atici T.(2006) Internet Journal of Microbiology, 2(2).

12-Awetz. J. ,Melnick and Delbrgs A,“ Medical Microbiology “2nd McGraw Hil-USA (2007).

13-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 J. Biol. & Chem., 35 (2), pp123-128.

14-W.J.Geary,“***The use of conductivity measurements in organic solvents for the characterization of coordination compounds,*** ”Coordination Chemistry Reviews, vol. 7, no. 1, pp. 81–122, (1971).

15- Nakamoto; K “***Infrared spectra of Inorganic and coordination compounds*** “4ED th ; J.Wiely and Sons, New york, (1996) .

16- Y.,Nishida. A.Niinuma., K.Abe., Inorg. Chem. Commun. 12 pp 198–200(2009).

17- Fayad N.K., Taghreed H. Al-Noor and Ghanim F.H, (2012) , Synthesis ,characterization and antibacterial activity of mixed ligand complexes of some metals with 1-nitroso-2-naphthol and L-phenylalanine**,** Chemistry and Materials Research, Vol 2, No.5, pp18-29.

18- Chaudhary Rakhi and Shelly, Synthesis, Spectral and Pharmacological Study of Cu(II), Ni(II) and Co(II)Coordination Complexes, *Res. J. Chem. Sci*., **1(5)**, pp1-5, **(2011).**

19- Lever ABP. (1984) “ ***Inorganic Spectroscopy***“;, 2nd (Elsevier Science Publisher, Amsterdam),

20- Yilmaz Veysel; Yilmaz Fatih; Kazak Canan, (2005). J “Transition Metal Chemistry” Volume 30, Number 1, February, pp. 95-102(8).

21-Shriver D.W, Atkins P.W.(2006)."***Inorganic Chemistry***" 4th Ed, Freeman, New York.

22- Philip H. Rieger (1994), Electron paramagnetic resonance studies of low-spin d5transition metal complexes Coordination Chemistry Reviews, Volumes 135–136, pp203-286

23-Mrinalini L. and A.K. Manihar Singh , (2012) Res.J.chem.sci.,2(1), pp. 45-49.

24- Bhalla Aman, Bari S.S, Vats Sunil and Sharma M.L, (2012) Res. J .chem. sci., 2(1), 59-64.

25-IiojojiPhilip H. Rieger (1994), Electron paramagnetic resonance studies of low-spin d5transition metal complexes Coordination Chemistry Reviews, Volumes 135–136, pp203-286

26- Chohan ZH(2006) Antibacterial and antifungal ferrocene incorporated dithiothione and dithioketone compounds. Appl, Organomet Chem;20: pp.112-116.

27- Tweedy BG. Possible mechanism for reduction of elemental sulfur by monilinia fructicola. Phytopathology 1964;55:910-4.

28- Mazumder UK, Gubta M, Bera A, Bhattacharya S, karki S, Manikandan L,(2003).Synthesis, antitumor and antibacterial activity of some Ru(bpy) 2+2/4- Substituted thiosemi-carbazide complexes. Indian J Chem;42A:pp313-317.

Table (1) The physical properties of the compounds

Compounds (**Chemical Formula**)	**M. wt** Calc	**Color**	**Yield %**	**M .p ℃ (de) ℃**	Λ_m Ω^{-1} cm^2 mol	**Metal%**	**Cl%**
						Theory (exp)	**Theory (exp)**
$[Fe(Ceph)(NA)_3]Cl$ $[FeC_{34}H_{36}N_9O_7S]Cl$	**806.07**	Brown	73	101	37	**6.93** **(7.0)**	4.40 (4.92)
$[Co(Ceph)(NA)_3]Cl$ $[Co\,C_{34}H_{36}N_9O_7S]Cl$	809.16	Brown	83	100	35	7.28 **(7.1)**	4.39 (4.65)
$[Ni(Ceph)(NA)_3]Cl$ $[Ni\,C_{34}H_{36}N_9O_7S]Cl$	808.92	Deep Bro	80	300 Dec	33	7.26 **(7.16)**	4.39 (4.72)
$[Cu(Ceph)(NA)_3]Cl$ $[Cu\,C_{34}H_{36}N_9O_7S]Cl$	810.13	Green	90	200	34	7.83 **(8.87)**	4.37 (4.62)
$[Zn(Ceph)(NA)_3]Cl$ $[Zn\,C_{34}H_{36}N_9O_7S]Cl$	811.13	Yellow	82	200	34	8.04 **(8.82)**	4.36 (4.72)

Λm = Molar Conductivity, Dec. =decomposition

Table (2) The solubility of the mixed ligands complexes in different solvents

Compounds	**H_2O**	**DMF**	**DMS**	**MeOH**	**EtOH**	**Aceton**	**C_6H_6**	**CCl_4**	**$CHCl_3$**	**2-propar**	**Petroleum ethe**
$[Fe(Ceph)(NA)_3]Cl$	+	+	+	÷	÷	÷	-	-	-	-	-
$[Co(Ceph)(NA)_3]Cl$	+	+	+	÷	÷	÷	-	-	-	-	-
$[Ni(Ceph)(NA)_3]Cl$	-	+	+	÷	÷	÷	-	-	-	-	-
$[Cu(Ceph)(NA)_3]Cl$	+	+	+	÷	÷	÷	-	-	-	-	-
[Zn(Ceph)(NA)3]Cl	-	+	+	÷	÷	÷	-	-	-	-	-

(+) Soluble , (–) Insoluble , (÷) Sparingly

Table(3):Data from the Infrared Spectra for the Free Lingands and there Metal Complexes (cm-1).

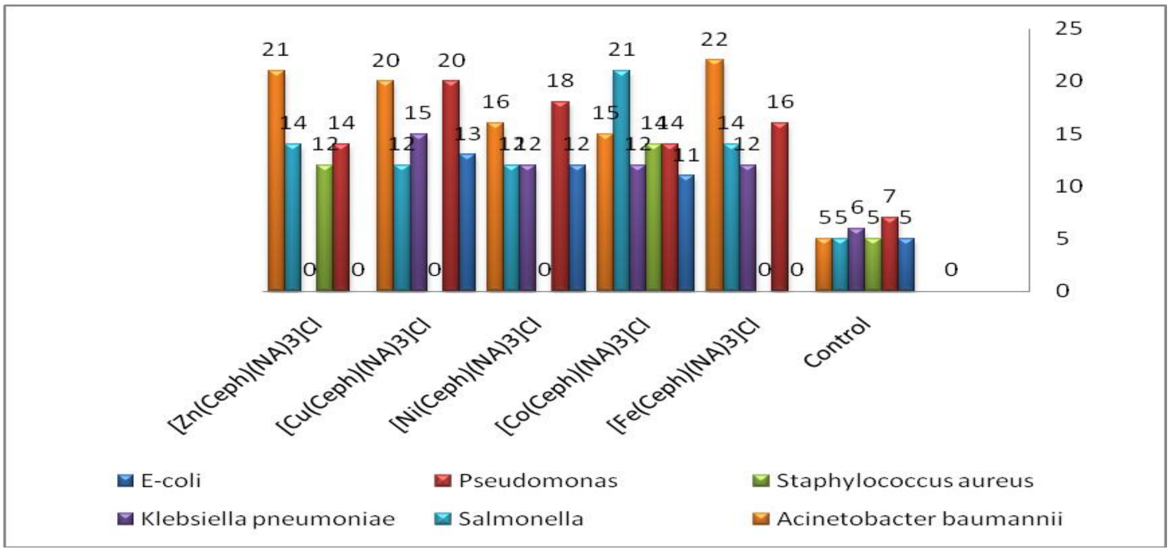
Compound	(N-H) primary a	υ(N-H) Secondary a	υC=O)	υ(C= β-lacta	υ(C am	υ a C	sy C	υΔ (-COO)asy	υ(C ar	υ(C	υ(C	υ(C ar	υ(C ali	υ(M	υ(M
Cephalexin	3275	3219 3049	1759	1689	---	15	13	197	15	12	12	30	28	--	---
Nicotine ami	3367, 31	--------	-------	------	16	--	---	-	15	12	--	30	27	---	--
Fe(Ceph)(NA)	3367	3186	1667 ove	1678	--	16	13	224	15	12	12	30	27	5	4
Co(Ceph)(NA)	3410	3323 3190	1666 ove	1666	--	16	13	243	14	12	12	30	38	5	4
Ni(Ceph)(NA)	3475	3414 3236	1697	1681	--	16	13	224	15	12	12	30	28	5	4
Cu(Ceph)(NA)	3402	3266 3167	1757 1707	1670 1624	---	16	13	227	15	12	12	30	28	5	4
Zn(Ceph)(NA)	3541	3468 3236	1759	1666 , 1	---	16	13	224	15	12	11	30	28	5	4

Compound	**λ nm**	**ύ cm**	**ε_{max} (molar^{-1}.cm^{-1})**	**Assignments**	μ_{eff} (μ B	Probable figur
Ceph	279	35842	770	$\pi \to \pi^*$	-	-
NA	220 261	45454 38314	1548 1104	$\pi \to \pi^*$ $\pi \to \pi^*$	-	-
[Fe(Ceph)(NA)$_3$] Cl	278 990	37037 10101	1645 18	C-T $^5T_{2g} \to ^5E_g$	4.97	Octahedra
[Co(Ceph)(NA)$_3$] Cl	268 728 833 992	37313 13736 12004 10080	1489 7 5 14	C-T 3A2g → 4T1g(P) 3A2g → 4T1g(P) 3A2g (F) →3T1g(F)	**4.54**	Octahedra
[Ni(Ceph)(NA)$_3$]Cl	267 800 993	37453 12500 10070	1319 11 19	L-F 3A2g → 4T1g(P) $^3A2g \to ^3T2,(F)$	83.1	Octahedra
[Cu(Ceph)(NA)$_3$] Cl	271 994	36900 10060	1883 30	CT $2Eg \to 2T_{2g}$	1.86	Octahedral
[Zn(Ceph)(NA)$_3$]Cl	270	37037	1556	C-T	0.00	Octahedral

Table (4) Electronic data for the mixed ligands complexes

Table(5):Biological activity of the mixed ligands complexes(Zone of inhibition) (mm)

Compound	**E-col**	**Pseudomonas**	***Staphylococcus aur***	**Klebsiella pneumonia**	**Salmonella Typhi**	***Acinetobacter baumannii***
Control	5	7	5	6	5	5
[Fe(Ceph)(NA)$_3$]Cl	0	16	0	12	14	22
[Co(Ceph)(NA)$_3$] Cl	11	14	14	12	21	15
[Ni(Ceph)(NA)$_3$] Cl	12	18	0	12	12	16
[Cu(Ceph)(NA)$_3$] Cl	13	20	0	15	12	20
[Zn(Ceph)(NA)$_3$] Cl	0	14	12	0	14	21



(Figure. 2) **Chart of biological effects of some of the studied complexes**

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