SYNTHESIS, SPECTROSCOPIC CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF METAL COMPLEXES WITH A NEW SCHIFF BASES AS A LIGAND

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Abstract

A new series of VO(II), Mn(II), Fe(III), Co(II), Ni(II), Cu(II), Zn(II), ZrO(II), Ru(III), Sn(II), Cd(II) , Ho(III) Ti(II) and UO_2(II) complexes of (E)-2-(p-toluidino)-N'-(2-hydroxbenzylidene) acetohydrazide have been synthesized and characterized by elementals analyses, H^1-NMR, IR, UV-Vis. spectra, magnetic moments and conductance measurements. The IR data show that the ligand behaves monobasic tridentate or dibasic tridentate towards the metal ion. Molar conductances in DMF solution indicate that the complexes are non-electrolytes. Antibacterial and antifungal tests of the ligand and some of its metal complexes revealed that, the complexes are more potent bactericides and fungicides than the ligand.

Keywords: Syntheses, Spectroscopic Studies, Magnetism, Biological activity

Introduction

Current interest in the coordination chemistry of hydrazones has arisen through their uses in biological systems [1]. Interest in studying this class of compounds lies in its antibacterial, antitumor and antitubercular activities [2]. Also, it has been used as analytical reagent [3] and as polymer –coating, ink, pigment [4] and fluorescent materials [5]. Synthesis and characterization of metal complexes of a bishydrazone derived from isatin monohydrazone and 2-hydroxyl-1-naphthaldehyde showed interesting biological properties [6,7]. Transition metal complexes of salicyladehyde thiazolyl hydrazone were prepared and characterized [8]. Coordination chemistry of acylhydrazones as well as number of copper(II) complexes had been extensively studied [9]. Dinuclear copper and iron complexes were also studied because they were able to mimic bimetallic sites in various enzymes [10], and showed antifungal and antibacterial activities [11]. Metal(II) complexes of 2-acetypyridine benzoylhydrazone ligand were synthesized and crystallographically characterized [12]. Manganese(II), iron(III), nickel(II), cobalt(II) and zinc(II) complexes of 2,6-diformyl-4-methylphenoldibenzoylhydrazone had been prepared and characterized by elemental and spectroscopic measurements [13]. Cobalt(II), nickel(II), copper(II) and zinc(II) complexes of glyoxal bis(2-pyrazinoyl) hydrazone had been prepared and characterized on the basis of analytical data and various physicochemical studies

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[14]. Mono, di– or trinuclear dioxouranium complexes of vanillin benzoylhydrazone, salicylaldehyde benzoylhydrazone and 2-hydroxyacetyl benzene salicylhydrazone had been prepared and characterized by elemental, X-ray analyses and spectroscopic measurements [15]. Extensive investigations of this kind of complexes have been undertaken recently, however, we report the synthesis and characterterization of metal complexes of phenylamino acetoacetyl acetone hydrazone.

Experimental

Reagent grade chemicals were used. Elemental analyses were determined by the Analytical Unit of Cairo University of Egypt. Standard methods were used to determine the metal ion content. All metal complexes were dried in vacuum over anhydrous $CaCl_2$. The IR spectra were measured using a Perkin-Elmer 683 spectrophotometer (4000-200 cm^{-1}). Electronic spectra in DMF solutions were recorded on a Perkin-Elmer 550 spectrophotometer. The conductances of 10^{-3} M solution of the complexes in DMF were measured at 25 ^{0}C with a Bibby conductometer type MCl. The ^{1}H-NMR spectrum of the ligand in deuterated DMSO was recorded using a 300 MHZ Varian NMR spectrometer.

Preparation of the ligand [H_2L] (1), and its metal complexes

Preparation of ligand [H_2L] (1);

salicyladehyde (01.3 gm, 0.1 mol) was added dropwise to a solution of 2-(p-toluidino)acetohydrazide (1.8 gm, 0.01 mol) in 25 mL EtOH. The mixture was refluxed for 3 hours and cooled to room temperature. The solid product was filtered off, washed several times with EtOH and dried over anhydrous $CaCl_2$.

Preparation of the metal complexes (2) and (15-20);

These complexes were prepared by mixing stiochiometric ratios (2:1) of the ligand (30 mL EtOH) and metal salts (50 mL) ethanol. The mixture was refluxed on a hot plate with stirring for (1-2) hrs. Cooling to room temperature, and fine crystals which separated were filtered off, washed several times with EtOH and dried over anhydrous $CaCl_2$.

Preparation of the metal complexes (3-14);

These complexes were prepared by mixing stiochiometric ratios (1:1) of the ligand (30 mL EtOH) and metal salts (50 mL EtOH). The mixture was refluxed on a hot plate with stirring for (1-2) hrs. Cooling to room temperature, and the precipitate formed was filtered off, washed several times with EtOH and dried over anhydrous $CaCl_2$

Microbiology:

Fungus Media:

Czapek dox agar medium was prepared by standard method [16]. *Aspergillus Niger* was spread over each dish by using sterile bent Loop rod. Disks were cut by sterilized Cork borer and then taken by sterilized needle. The resulted pits are sites for the tested compounds .The Plates are incubated at 30 ^{0}C for 24- 48 hrs. and then any clear zones present were detected.

Bacteria Media:

Nutrient agar medium was prepared by standard method [16]. *E.coli* was spread over each dish by using sterile bent Loop rod. Disks were cut by sterilized cork borer and then taken by sterilized needle .The resulted pits are sites for the tested compounds. The plates are incubated at 37 ^{0}C for 24- 48 hrs. and then any clear zones present were detected

RESULTS AND DISCUSSION:

The reaction of the ligand (1) with metal salts using (1:1) or (2:1) molar ratios. The new complexes are intensely coloured, crystalline solids, and stable at room temperature. The complexes are insoluble in non polar and polar solvents but soluble in polar coordinating solvents such as DMSO and DMF. Elemental analyses and physical data (Table I), and spectral data (Tables II and III), are compatible with the suggested structures as shown in Figure 1.

^{1}H- NMR Spectrum

The ^{1}H-NMR spectrum of this ligand shows a singlet corresponding to the proton (CH=N-) at 8.30 ppm. The CH_2 protons appeared as a duplet at δ 3.80 ppm, and the aromatic proton at δ 6.50-8.20 (5H phenyl), δ 6.8-7.80 (4H phenyl), at δ 4.20 ppm shows a singlet corresponding to the two protons (NH2) and at δ 10.10 ppm broad singlet corresponding to the one proton (OH)

Conductivity Measurements

The molar conductance values of the complexes in DMF (10^{-3}M) are in the (2.1-8.3 Ω^{-1} cm^2 mol^{-1}) range (Table I), the low values indicate the non –electrolytic nature of the complexes [17].

IR Spectra

The bonding mode of the ligand in the metal complexes has been deduced from the IR spectroscopy. Important spectral bands of the ligand and its metal complexes are presented in Table (II). The IR spectrum of IR spectrum of the ligand showed broad band at $\bar{\nu}$ 3500 cm^{-1} assigned to (OH) group, the two bands at $\bar{\nu}$ 3450 and 3470 cm^{-1} assigned to (2 NH) groups and another band at $\bar{\nu}$ 1705 cm^{-1} and 1614 cm^{-1} due to ν (C=O) and ν(C=N) respectively [18-20]. Also, The bands appear at

1518 and 1326 cm^{-1}, correspond to v(CH=C)$_{Al}$ and v(C-O) respectively [19,21]. In order to know, the mode of coordination between the ligand and the metal ion, the IR spectrum of the ligand is compared with that of the metal complexes. The complexes show a broad band in the 3684 – 3100 cm^{-1} range, corresponds to a lattice water, except complexes (3), (9), (16), (18) and (19) and the coordinated water appears in the 3380 – 2750 cm^{-1} range except complexes (2) and (15-20) respectively [21-23]. The complexes show a band in the 1750-1650 cm^{-1} range (Table II) , which is assigned to v(C=O) group [24,25], however, the band appears in the 1625-1600, 1595-1546 and 1543-1462 cm^{-1} ranges are due to v(C=N), v(C=C)$_{Ar}$ and v(CH=C) vibrations respectively [19,26]. Extensive IR spectral studies reported on the metal acetato complexes [27], indicate that, the acetato ligand may be coordinated to a metal center in either a monodentate. The v$_a$(CO$_2$) and v$_s$(CO$_2$) band of the monodentate acetate ions are at 1560 and 1416 cm^{-1} respectively. as found for complexes (4), (6), (7), (8) (11) and (12), however, complex (9) shows band at 1466 cm^{-1} (Table II), assigned to terminal nitrate groups [27]. The complexes (5), (10), (12) (13) and (14) show two bands at (423-380) cm^{-1} range corresponding to terminal coordinate chloride atoms [19]. Complex (20) shows band at 918 cm^{-1} is due to O=U=O group [26]. The bonding of the metal ions to the ligand through the oxygen and nitrogen atoms is further supported by the presence of new band in the 693-610 and 623-505 cm^{-1} ranges, is due to v(M-O) and v(M-N) respectively [27].

The above results together with elemental analysis indicated that the hydrazone behaves as monobasic tridentate ligand towards the metal ion, coordinated via the carbonyl oxygen of the hydrazide moiety, oxygen of the salicyladehyde moiety in phenolic form and azomethine nitrogen atom.

Magnetic Moment

The room temperature magnetic moments of the complexes (2) - (20) are presented in Table 1. Ni(II) complex (7) gave moments 2.8 B.M., indicating octahedral geometry. The low moments indicates, spin exchange interactions take place between the Ni(II) ions through the acetate group. Cobalt(II) complexes (6) gave moments in the 4.9 B.M. (Table I), indicating high spin octahedral cobalt(II) complexes [28]. The magnetic moments for the copper(II) complexes (8), (9) and (10) are 1.6, 1.3 and 1.7 B.M. and for complexes (9) and (10), the moments are well below the spin-only moment (1.73 B.M.), indicating spin-exchange interactions take place between the copper(II) ion in a square planar or octahedral geometry [29]. The magnetic moment values for manganese(II) complexes (4) is 3.6 B.M. suggest octahedral geometry around the manganese(II) ion [28]. Iron(III) complex (5) gave moment 5.74 B.M., indicating high spin iron(III) octahedral geometry [6]. Ruthenium(III) complex (12) gave a magnetic moments 1.6 B.M., which is well below, than the spin only moment, indicating that the spin-exchange interactions take place between ruthenium(III) ion in an octahedral geometry [30]. Zirconium(IV) complex (17), Tin(II) complex (18), zinc(II) complexes (11), cadmium(II) complex (16) and uranyl complex (20) gave diamagnetic moments .

Electronic Spectra

The electronic spectral data of the ligand (1) and its metal complexes in DMF solution are presented in Table (III). The nickel(II) complex (7) shows a bands at 460and 520 nm, the bands are attributable to $^3A_{2g}(F) \rightarrow {}^3T_{1g}(F)$ (υ_2) and $^3A_{2g}(F) \rightarrow {}^3T_{2g}(F)$ (υ_1) transitions, respectively indicating an octahedral nickel(II) complex [32]. The υ_2 / υ_1 ratio for the complex is 1.13 which is less than the usual range of 1.5-1.75, indicating distorted octahedral nickel(II) complexes [33]. The cobalt(II) complexes (6) shows band in the 375, 580 and 650 nm. The bands are assigned to $^4T_{1g}$ (F) → $^4T_{1g}$ (P) , $^4T_{1g}$ (F) →$^4A_{2g}$ and $^4T_{1g}(F) \rightarrow {}^4T_{2g}(F)$, transitions respectively, corresponding to high spin cobalt(II) octahedral complexes [34]. The copper(II) complexes (8), (9) and (10) show different bands (Table III). The show bands at 350-375, 410-460 and 520-565 nm range are assigned to ligand → metal charge transfer,$^2B_1 \rightarrow {}^2E$ and $^2B_1 \rightarrow {}^2B_2$ transitions, indicating a distorted octahedral structure [9,33,36]. Manganese(II) complexes (4) show band at 460, 535 and 620 nm corresponding to $^6A_{1g} \rightarrow {}^4E_g$, $^6A_{1g} \rightarrow {}^4T_{2g}$ and $^6A_{1g} \rightarrow {}^4T_{1g}$ transitions which are compatible to an octahedral geometry around the manganese(II) ion [48]. Iron(III) complexes (5) show band at 460, 530 and 620 nm. The first two bands are due to charge transfer transition while the last band is considered to arise from the $^6A_1 \rightarrow {}^4T_1$ transition, these bands suggest, distorted octahedral geometry around the iron(III) [36,38]. Ruthenium(III) complex (12), shows bands at 420 and 675 nm respectively. First one is due to LMCT transition and the last band is assigned to $^2T_{2g} \rightarrow {}^2A_{2g}$ transition. The band position are similar to those observed for other octahedral ruthenium(III) complexes [39,40]. Vanadium(IV) complexes (2,3), Zinc(II) complex (11), Titanium(II) complex (13), Holmium(III) complex (14), Cadmium(II) complex (16), Zirconium(IV) complex (17), Tine(II) complexes (18), Ytterbium (III) complex (19) and, Uranyl(VI) complex (20) show bands (Table III) indicating intraligand transitions [38,41].

Antibacterial and Antifungal Screening

The ligand and its metal complexes have been screened for their antibacterial and antifungal activities and the results obtained are presented in Table (IV). All the metal complexes are more potent bactericides and fungicides than the ligand [42, 43]. This enhancement in the activity can be explained on the basis of chelation theory [44, 45]. Chelation reduces the polarity of the metal ion considerably; mainly because of the partial sharing of its positive charge with donor groups and possible π- electron delocalization on the whole chelate ring. The lipid and polysaccharides is some important constituent of cell walls and membranes, which are preferred for metal ion interaction. In addition to this, the cell wall also contains many amino phosphates, carbonyl and cysteinyl ligands, which maintain the integrity of the membrane by acting as diffusion barrier and also provides suitable sites for binding. Chelation can reduce not only the polarity of the metal ion, but increases the lipophilic character of the chelate, and the interaction between metal ion and the lipid is favoured. This may lead to the breakdown of the permeability barrier of the cell resulting in interference with the normal cell processes. If the geometry and charge distribution around the molecule are incompatible with geometry and charge distribution around the pores of the bacterial cell wall, penetration through the wall by the toxic agent can not take place and this will prevent the toxic reaction within the pores. Chelation is not the only criterion for the antibacterial activity. Some important factors such as the nature of the metal ion, nature of the ligand, coordinating sites, and geometry of the complex, concentration, hydrophilicity, lipophilicity and presence of co-ligands have considerable influence on antibacterial activity. Certainly, steric and pharmacokinetic factors also play a decisive role in deciding the potency of an antimicrobial agent. Apart from this, the mode of action of these compounds may also invoke hydrogen bond through the >C=N-N=CH- group with the active centers and thus interfere with normal cell process. The presence of lipophilic and polar substituents is expected to enhance antibacterial activity. The antibacterial and antifungal activities of the hydrazone ligands and metal complexes were screened using the disk diffusion [46]. The results (Table IV) showed that, cobalt(II) complex (6) shows higher antibacterial activity than the other complexes but complexes (8) and (13) show higher activity antifungal than the other complexes. The variation in the activity of different complexes against different microorganisms depends either on the impermeability of the cells of the microbes or differences in ribosome's in microbial cells [47,48].

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References

[1] T. D. Thangadurai and K. Natarajan; *Trans. Met. Chem.*, 27, 840 (2002)
[2] D. X. West, A. E. Libertia, S. B. Padhye, P. B. Chikate and A. S. Sonawane; *Coord. Chem. Rev.*, 123, 49 (1993)
[3] R. M. El-Bahnasawy, A. S. El-Tabl, E. El-Shereafy, T. I Kashar and Y. M. Issa, *Polish J. Chem.*, 73, 1952 (1999)
[4] D. F. Martin, G. A. Jamusonis and B. B. Martin, *J. Am. Chem. Soc.* 83, 73 (1961)
[5] S. K. Agrawal and R. Chandra, *Proc. Nat. Acad. Sci.*, 55(A), 11 (1985)
[6] B. Murukan and K. Mohanan, *Trans. Met. Chem.*, 31, 441 (2006)
[7] S. N. Pandeya, S. Smitha, M. Jyoti and S. K. Sridhar, *Acta pharm.*, 55, 27 (2005)
[8] A. Cukurovali, I. Yalmaz and S. Kirbag, *Trans. Met. Chem.*, 31, 207 (2006)
[9] E. W. Ainscough, A. M. Brodie, A. J. Dobbs, J. D. Ranford and J. M. Waters, *Inorg. Chem. Acta*, 267, 27 (1998)
[10] J. L. Buss, E. Arduini, K. C. Shephard and P. Ponka, *Biochem. Pharmacol.*, 65, 349 (2003)
[11] S. N. Pandeya, D. Siram, G. Nath and E. Deelereg, *Eur. J. Pharm. Sc.*, 9, 25 (1999)
[12] Y. J. Jang, U. Lee and B. K. Koo, *Bull. Korean Chem. Soc.*, 26, 925 (2005)
[13] P. Cheng, D. Lido, S. Yan, Z. Jiang and G. Wang, *Polyhedron,* 14 (1995), 2355.

[14] G. S. Sanyal and S. Garai, *Indian J. Chem.* 30A (1991), 375.

[15] C. C. Gatto, E. S. Lang, A. Kupfer, A. Hagenbach and U. Abram, *Z. Anorg. Allg. Chem.* 630 (2004), 1286.

[16] J. Patole,[a] U. Sandbhor,[a] S. Padhye,b,* D. N. Deobagkar[b], C. E. Anson[c] and A. Powell[c];

Bioorganic & Medicinal Chemistry Letters 13, 51 (2003).

[17] A. S. El-Tabl and R M. Issa; *J. Coord. Chem.*, 57, 509 (2004)

[18] A. S. El-Tabl, T.I.Kasher, R.M. El-Bahnaswy and A.E.Ibrahim; *Polish J. Chem.*, 73, 245 (1999)

[19] H. A. El-Boraey and A. S. El-Tabl; *Polish J. Chem.*,77, 1759 (2003)

[20] L. Mishra, A. Jha and A. K. Yadaw; *Trans. Met. Chem.*, 22,406 (1997)

[21] A. S. El-Tabl, K. El-Baradie and R. M.Issa; *J. Coord. Chem.*, 56,1113 (2003)

[22] W. H. Hegazy, *Monat For Chem.*, 132, 639 (2001)

[23] K. Nakamato " Infrared and Raman Spectra of Inorganic and Coordination Compounds, Fourth Ed., A Wiley – Interscience, publication, New York, 1986.

[24] N. Raman, A. Kulandaisamy, C. Thangaraja, P. Manisankar, S.V swanathan and C.Vedhi; *Trans. Met .Chem.*, 29,129 (2004)

[25] A. S. El-Tabl, *Trans. Met. Chem.* 27, 166 (2002)

[26] P.Athappan and G. Rajagopal, *Trans. Met. Chem.*, 22, 84 (1997)

[27] A. S .El-Tabl, *J. Chem. Res. (S)*, 529 (2002).

[28] K. B. Gudasi, S. A. Patil, R. S. Vadvavi, R. V. Shenoy and M. Nethaji, *Trans. Met. Chem;* **31**, 586 (2006)

[29] R. A. Lal and A. Kumar; *Ind. J. of Chem.* **38A**, 839 (1999)

[30] A. El-Motaleb, M. Ramadan, W. Sawodny, H. F. El-Baradie and M. Gaber; *Trans. Met. Chem.*, 22, 211 (1997)

[31] A. S. El-Tabl and M.I.Ayad, Synth. And React. *Inorg. and Met.-Org. Chem.* 33, 369 (2003)

[32] D. N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques, Orient Longman Limited © Universities press(India) Limited (2001)

[33] A. S. El-Tabl and S.A.El-Enein, *J. Coord. Chem*; 57, 281 (2004)

[34] C. H. Krishna C. M. Mahapatra and K. C. Dush, *J .Inorg. Nucl. Chem.*,39, 1253 (1977)

[35] R. Atkins, G. Brewer, E. Kokot, G.M.Mockier and E.Sinn, *Inorg. Chem.*, 24, 127 (1985)

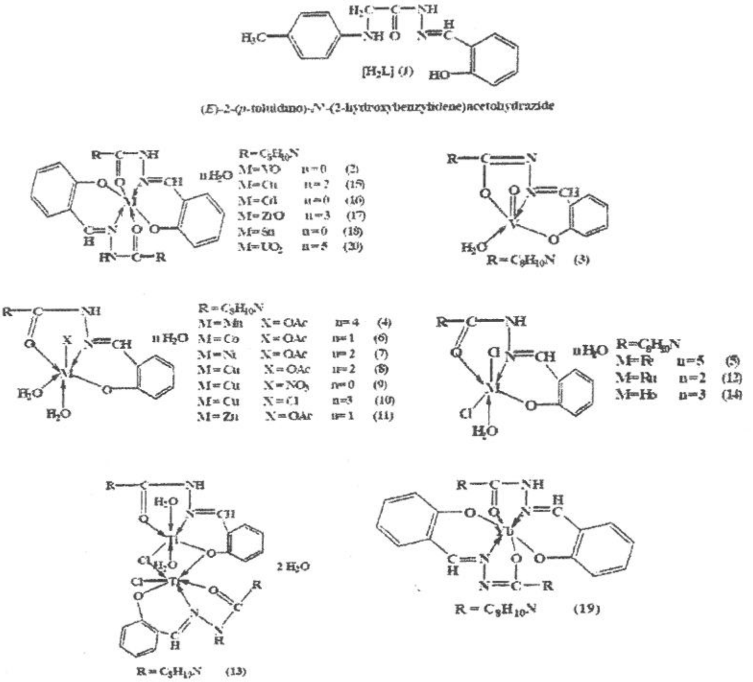
[36] S. A. Sallam, A. S. Orabi, B. A. El-Shetary and A. Lentz, *Trans. Met. Chem.*,27, 447 (2002)

[37] R. K. Parihari, R. K .Patel and R. N. Patel, *J. Ind .Chem. Soc.*, 77, 339 (2000)

[38] N. K. Singh and S. B. Singh, *Trans. Met. Chem.*, 26,487 (2001))

[39] K. Nehru, P. Athappan and G. Rajagopal, *Trans. Met. Chem.*, 26, 652 (2001)

[40] A. S. El-Tabl, R. M. Issa and M. A. Morsi, *Trans. Met. Chem.*, 29, 543 (2004)
[41] G. Knör and A. Strasser, *Inorg. Chem. Comm.*, 8, 471 (2005)
[42] D. Sriram, P. Yogeeswari and R. V. Devakaram, *Bioorg. & Med. Chem.*, 14 (2006), 3113.
[43] S. K. Sridhar, M. Saravanan, A. Ramsh, *Eur. J. Med. Chem.*, 36 (2001), 615
[44] K.N. Thimmaiah, W.D. Lioyd and G.T. Chandrappa, *Inorg .Chim. Acta*, 106, 81 (1985).
[45] T.J. Franklin and G.A. Snow, Biochemistry of Antimicrobial Action, 2nd edn., Chapman and Hall, London, 1971.
[46] C.H. Collins and P.M. Lyn, Microbial Methods, University Park Press, Baltimore, 1970.
[47] M. Kurtoğlu, E. Ispir, N. Kurtoğlu, S. Toroğlu and S. Serin, *Trans. Met. Chem.*, 30,765 (2005).
[48] M. Kurtoğlu, M. M. Dağdelen and S. Toroğlu, *Trans. Met. Chem.*, 31, 382 (2006)



Figure(1)

TABLE I : - Elemental analyses and physical properties of the Ligand (H_2L). (1) and its metal complexes

No.	Molecular formula	Colour	Ω^{-1} mol^{-1} cm^2	μeff (B.M)	Calcd (Found) %			
					C	H	N	Cl
1	$[H_2L]$, $[C_{16}H_{17}N_3O_2]$	White	----	-----	68.3(67.8)	5.5(6.0)	14.9(14.8)	-----
2	$[(HL)_2VO]$	Greenish	4.2	2.3	60.7(61.0)	5.0(5.7)	13.3 (13.8)	------
3	$[(L)VO(H_2O)]$	Greenish	8.3	2.6	52.5(53.0)	4.6(5.1)	11.5(11.2)	--------
4	$[(HL)\ Mn(OAc)(H_2O)_2]4H_2O$	Brown	7.5	3.6	45.3(45.5)	5.7(6.2)	8.8(8.5)	--------
5	$[(HL)\ FeCl_2\ (H_2O)]5H_2O$	Brown	2.1	3.9	37.1(37.0)	5.4 (5.5)	8.1(8.2)	14.0(14.2)
6	$[(HL)\ Co(OAc)(H_2O)_2]\ H_2O$	Voilet	4.1	4.9	47.6(48.0)	5.5(5.6)	9.3(9.5)	----
7	$[(HL)Ni(OAc)(\ H_2O)_2]2H_2O$	Green	6.2	2.8	45.8(46.0)	5.7(5.8)	8.9(9.1)	--
8	$[(HL)Cu(OAc)(\ H_2O)_2]2H_2O$	D.green	3.8	1.6	45.3(45.5)	5.7(5.7)	8.8(8.5)	-------
9	$[(HL)\ Cu(NO_3)(H_2O)_2]$	green	4.5	1.3	43.3(43.5)	4.5(4.4)	12.6(12.5)	-------
10	$[(HL)CuCl(H_2O)_2]3H_2O$	D. green	3.2	1.7	40.8(41.0)	5.5(5.5)	8.9(9.1)	8.0(8.1)
11	$[(HL)Zn(OAc)(\ H_2O)_2]\ H_2O$	White	3.2	Dia.	46.9(46.6)	5.4(5.2)	9.1 (9.3)	-------
12	$[(HL)Ru\ Cl_2\ (H_2O)]2H_2O$	Black	6.7	1.6	37.8(37.4)	4.3 (4.5)	8.3(8.5)	14.0(13.5)
13	$[(HL)_2Ti_2Cl_2]\ 2H_2O$	Green	4.2	2.5	47.8(47.3)	4.9(4.9)	10.5 (10.6)	9.0(9.2)
14	$[(HL)HoCl_2]4H_2O$	Green	8.3	----	32.5(32.5)	4.0(3.5)	7.1(7.2)	12.0(11.7)
15	$[(HL)_2Cu]2H_2O$	Pale green	7.5	Dia	57.9(58.0)	5.4(5.7)	12.7(12.2)	--------
16	$[(HL)_2Cd]$	White	2.1	Dia	56.8(57.2)	4.7(5.1)	12.4(12.6)	---------
17	$[(HL)_2ZrO]3H_2O$	Yellow	4.1	Dia	52.9(52.8)	5.2(5.2)	11.6(11.5)	----
18	$[(HL)_2Sn]$	White	6.2	Dia	56.2(56.0)	4.7(5.1)	12.4(12.6)	-------
19	$[(L)(HL)Yb]$	P.Yellow	4.5	-----	52.2(52.5)	4.2(3.9)	11.4(11.5)	-------
20	$[(HL)_2UO_2]\ 5H_2O$	Yellow	4.5	Dia	41.5(41.2)	4.5(4.3)	9.1(8.8)	-------

[a] Molar conductivity as 10^{-3} M solutions ($ohm^{-1}\ cm^2\ mol^{-1}$)

Table II. IR spectral assigument for the ligands and there metal complexes.

No.	ν(latticeH_2O)	ν(Coord.H_2O)	ν(NH)	ν(C=O)	ν(C=N)	ν(OAc)	ν(NO_3)	ν(M-O)	ν(M-N)	ν(M-Cl)
1	------	-------	3470,3450	1705	1614	--	----	--	--	------
2	3650-3300	---------	3407	1711	1617	--	---	614	535	-----
3	--------	3240-2980	3405, 3250	-----	1615	-----	---	681	623	-----
4	3684-3300	3250-3000	3420	1650	1601	1538	----	657	586	-------
5	3650-3265	3260-2980	3406	1655	1600	----	------	610	558	415
6	3675-3100	3300-2770	3420	1650	1600	1550,1414	------	657	613	------
7	3600-3130	3380-3180	3420	1655	1610	1517,1469	-----	640	580	------
8	3580-3270	3300-3100	3401	1670	1617	1533	----	693	508	-----
9	--------	3250-3115	3430	1660	1608	-----	1466	690	590	-----
10	3540-3220	3450-3230	3435	1690	1605	----	------	615	595	423
11	3600-3200	3270-2750	3370	1650	1618	1443	------	635	560	------
12	3600-3150	3260-2960	3420	1670	1625	1466	------	614	513	410
13	3520-3150	3200-3000	3410	1680	1616	---	------	687	554	419,380
14	3565-3220	3260-2750	3390	1690	1617	--	------	610	539	423
15	3610-3240	....	3460	1725	1624	--	-----	668	531	-----
16	--------	-----	3410	1680	1610	----	------	690	521	-----
17	3650-3140	-------	3390	1750	1622	-----	-----	680	514	-----
18	---------	--------	3400	1680	1615	----	------	687	596	------
19	--------	-----	3380	1690	1617	----	------	680	512	---
20	3660-3100	--------	3410	1650	1615	---	------	664	505	------

OAc = CH_3COO^-

TABLE III:- Uv.-Vis. spectra of the ligand (H_2L), (1) and its metal complexes

No.	Molecular formula	Bands in DMF
1	$[H_2L]$, $[C_{16}H_{17}N_3O_2]$	345, 365, 350,320
2	$[(HL)_2VO]$	540, 435, 360, 320

3	$[(L)VO(H_2O)]$	550, 430, 360, 305
4	$[(HL)\ Mn(OAc)(H_2O)_2]4H_2O$	620, 535, 460, 315, 225
5	$[(HL)\ FeCl_2\ (H_2O)]5H_2O$	620, 530, 460, 310, 255
6	$[(HL)\ Co(OAc)(H_2O)_2]\ H_2O$	650, 580, 375,215
7	$[(HL)Ni(OAc)(\ H_2O)_2]2H_2O$	520, 460, 360,255
8	$[(HL)Cu(OAc)(\ H_2O)_2]2H_2O$	530, 430, 375,310,220
9	$[(HL)\ Cu(NO_3)(H_2O)_2]$	550, 410, 350, 320, 260
10	$[(HL)CuCl(H_2O)_2]3H_2O$	565, 430, 375, 305, 260
11	$[(HL)Zn(OAc)(\ H_2O)_2]\ H_2O$	365, 310, 260
12	$[(HL)Ru\ Cl_2\ (H_2O)]2H_2O$	675, 420, 345, 310, 255
13	$[(HL)_2Ti_2Cl_2]\ 2H_2O$	495,355, 310, 255
14	$[(HL)HoCl_2]4H_2O$	500, 365,310, 255
15	$[(HL)_2Cu]2H_2O$	470, 350, 320, 260
16	$[(HL)_2Cd]$	565, 400, 380, 325, 310,
17	$[(HL)_2ZrO]3H_2O$	475, 395, 370, 335, 310,
18	$[(HL)_2Sn]$	445, 400, 380, 330,
19	$[(L)(HL)Yb]$	680, 390, 360, 345, 350,
20	$[(HL)_2UO_2]\ 5H_2O$	380, 355, 310, 300, 260

TABLE IV:- The effect zone of the ligand (1) and its metal complexes on microorganisms by cm

Comp. No.	at 250 µg / mL	
	Fungi	Bacteria
(1)	-Ve	-Ve
(4)	-Ve	1.4
(5)	0.8	-Ve
(6)	-Ve	2.8
(7)	-Ve	2
(8)	1.6	1.7

(10)	1.5	1.8
(11)	-Ve	2.5
(13)	1.6	2.5
(14)	-Ve	1.7
(19)	-Ve	-Ve

(Fungi = *Aspergillus Niger* Bacteria = *E. coli*