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Synthesis, Characterization and Antimicrobial Activity of Fe (III), Zn(II), Co(II), Ni(II), Cu(II) and Mn(II) Complexes with Schiff Base Mixed Ligands

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Abstract: *Fe(III), Zn(II), Co(II), Ni(II), Cu(II) and Mn(II) complexes of Schiff bases have been prepared and characterized by their physical, spectral and analytical data. The newly synthesized mixed ligands metal complexes having a composition [M $(L_1/L_2)X_2$] where M=Fe(III), Zn(II), Co (II), Ni (II), Cu (II) and Mn (II) L_1/L_2= bidentate ligand (derived from salicylaldehyde, o-vanilline with P-anisidine) X=H_2O shows an octahedral geometry. In order to evaluate the biological activity of Schiff bases ligands and their metal complexes. The Schiff-base ligands and their new metal complexes have been screened for their antibacterial and antifungal activity (i.e Staphylococcus aureus, Bacillus substilis, antifungal activity against Aspergillus niger, Fusarium oxysporum, Staphylococcus aureus and Bacillus substilis). The X-ray diffraction studies and monoclinic crystal structure has been proposed for the mixed ligands metal complexes.*

Keywords: Mixed ligand metal complexes, biological activity, and X-ray diffraction study

1. Introduction

Compounds containing imines bases have not only found extensive application in organic synthesis, but several of these molecules display significant biological activity [1-4]. They easily form stable complexes with most transition metal ions. Schiff base complexes have increased the interest in the development of the field of bioinorganic chemistry [5]. The successful application has led to the formation of series of novel compounds with a wide range of physical, chemical and biological properties [6-9], spanning a broad spectrum of reactivity and stability. Keeping in view of the pronounced biological activity of the metal complexes of Schiff bases derived from heterocyclic compounds. It was thought of worthwhile to synthesize and characterized some new metal ligand complexes of Fe(III), Zn(II), Co (II), Ni (II), Cu (II) and Mn(II) with Schiff base (derived from salicylaldehyde o-vanilline p-anisidine). In donor Schiff base complexes(having the composition [M (L1/L2) X_2], where X =H_2O), compelled to prepare and report on the proceeding paper, which describe the biological role against bacterial and fungal strains like- Escherichiacoli, Staphylococcusaureus, Klebsiella and Psuedomonas.

In view of the coordinating ability of Schiff bases derived from o-hydroxyaromatic aldehyde along with their biological activity. We have synthesized and characterized the two aryl Schiff bases. The biological activity of the compound is mainly dependent on their molecular structure. It is known that the spectral behavior is strongly related to the ground state and excited state structures of the compound

2. Experimental

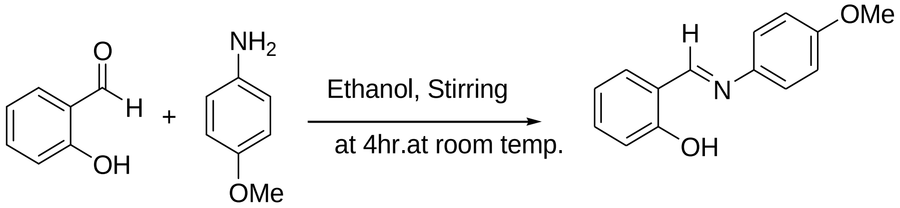
Material and Methods

All chemicals and solvents used were of A.R. grade. The metal (II) nitrates obtained from Rare Earth Ltd. (India) were used without further purification. Salicylaldehyde, o-vanilline and 4-methoxyaniline was obtained from Alfa Acer Chemicals and solvents were obtained from Aldrich Chemical Company. The powders XRD were characterized by recorded on Perkin Elmer TA/SDT-2960 and Philips 3701, respectively. ^{1}H-NMR spectra of ligand and metal complexes were recorded on a spectra were taken in d_6-DMSO & the chemical shifts were given in parts per million (ppm) with respect to tetramethylsilane (TMS) used as internal standard. UV-visible spectra were recorded in DMSO solution Concentration of 10^{-6} m, at 25°C and wavelength was reported in (nm) using a UV-visible Spectrophotometer. The magnetic measurements were carried out at room temperature with a Gouys balance and Mercury tetrathiocyanato Cobalt (II) was used as a standard for calibration.

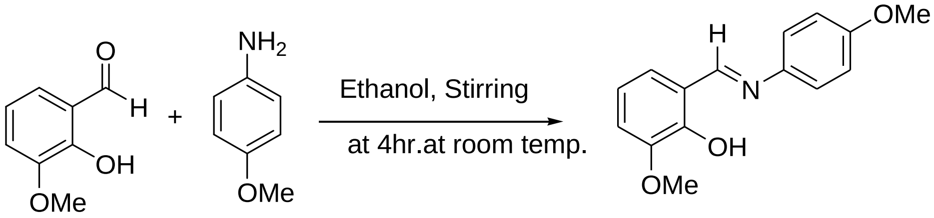
Synthesis of Schiff base ligand

The synthesis of Schiff base ligand was prepared by modification of reported method [10].The synthesis of L^1 in 50 ml solution of ethanol contain 0.001mol of salicylaldehyde (0.122g), and 0.001mol of o-vanilline (0.152 g) were continuously stirred for 4 hours at room temperature at show in scheme-I. The gray color was obtained. The ligands are collected, filtered by using Buckner funnel, washed with ethanol and dried in the desiccators. Purity of the ligands was checked by TLC plates. The product was purified and recrystallized with a hot ethanol. Obtained yield were 80%.

The synthesis of L^2 in 50 ml solution of ethanol contain 0.001mol of o-vanilline (0.152 g) and 0.001mol of 4-methoxyphenylamine (0.123 g) were continuous stirred for 4 hours at room temperature at show in scheme-II. The orange color was obtained. The ligands were collected, filtered by using Buckner funnel, washed with ethanol and dried in the desiccators. Purity of the ligand was checked by TLC plates. The product was purified and recrystallized wit a hot ethanol. Obtained yield were 78%.



Scheme-I synthesis of ligand (L^1)



Scheme-II synthesis of ligands ligand (L^2)

Synthesis of metal complexes

Synthesis of metal (II) complexes such as Fe(III), Zn(II), Co (II), Ni (II), Cu (II) and Mn(II) the mixture of hot ethanolic solution (25ml) of ligands $L^1$and L^2 in (0.01mol) simultaneously and metal (II) nitrate (0.01mol) was added under constant stirring for 3 hours at room temperature .The precipitated complexes were filtered off and washed with ethanol, diethyl ether and dried under vacuum over anhydrous calcium chloride ($CaCl_2$). Decomposition point of lanthanide (III) complexes were observed greater than 200 ^{0}C.

3. Result and Discussion

^{1}H-NMR spectra of ligands

The ^{1}H-NMR spectra of mixed ligands ($L^1$and L^2) in $CDCl_3$ at room temperature shows in the first scheme(L1) following signals 10.85δ (s,1H,phenolic OH), 7.5-9.3 δ (m 7H, Ar-H), 7.4 δ (s, 1H,N=C-H), 3.94 δ (s 3H,OCH_3). Second scheme(L2) shows the following signals 13.91 δ (s,1H,phenolic OH),6.8-7.3 δ (m 7H, Ar-H),8.6 δ (s,1H,N=C-H),3.8-3.9 δ (s,6H,OCH_3). It should be noted that the phenolic proton have always given a singlet in off-set at high δ values, thus confirming its involvement in an intramolecular hydrogen bond with the neighboring nitrogen atom [11].

Elemental Analysis

Table (1) lists the elemental analysis, yield, melting point, molecular weight and molar conductance of the ligands (L^1&L^2) and its metal complexes. All the Fe(III), Zn(II), Co(II), Ni (II), Cu(II) and Mn(II) complexes are stable in air, on-hydroscopic powder with different color of the Fe(III), Zn(II), Co(II), Ni(II), Cu(II) and Mn(II) ions soluble in DMSO, DMF, DCM, $CHCl_3$ and $CDCl_3$ but slightly soluble in methanol, ethanol, ethyl acetate, benzene and in soluble in water and diethyl ether.

Table 1: Analytical data of ligands:

Ligands	M.wt.	Color	M.P	Yield (%)	Elemental analysis (%) found (cal.)			
					C	H	N	O
$C_{14}H_{13}NO_2(L^1)$	227.25	Gray	85^{0}c	80	73.02 (73.30)	5.77 (5.71)	6.16 (6.11)	14.08 (14.00)
$C_{15}H_{15}NO_3(L^2)$	257.28	Orange red	90^{0}c	78	70.02 (70.11)	5.88 (5.52)	5.44 (5.40)	18.66 (18.60)

Table 2 : Physical characterization, analytical data of ligands and its metal complexes:

Ligands/ complexes	F.W	M.P. Temp(°C)	Color	Yield (%)	Elemental analysis found (calculated)				
					C	H	N	O	M(Ln)
$[Mn(L^1,L^2)(H_2O)_2]$	513.51	250	Gray	55	60.52 59.21)	5.60 (4.40)	4.87 (4.21)	19.46 (18.90)	9.55 (8.25)
$[Fe(L^1,L^2)(H_2O)_2]$	514.41	210	Brown	59	60.43 61.00)	5.60 (4.58)	4.86 (4.41)	19.43 (18.74)	9.69 (8.30)
$[Co(L^1,L^2)(H_2O)_2]$	517.5	230	Brick red	52	60.10 (57.80)	5.57 (5.82)	4.83 (4.21)	19.33 (18.73)	10.17 (11.50)
$[Ni(L^1,L^2)(H_2O)_2]$	517.26	235	orange	56	60.13 (59.60)	5.57 (4.89)	4.84 (4.53)	19.33 (18.91)	10.13 (10.56)
$[Cu(L^1,L^2)(H_2O)_2]$	522.11	210	Gray	54	59.63 (57.94)	5.52 (4.69)	4.80 (4.22)	19.17 (18.65)	10.88 (9.85)
$[Zn(L^1,L^2)(H_2O)_2]$	523.98	200	Orange	61	59.44 (60.77)	5.50 (5.49)	4.78 (4.45)	19.11 (19.46)	11.16 (10.39)

Infrared Spectroscopy Characterization

In the FT-IR study of free Schiff base mixed ligand & metal complexes to find out the way of chelation of ligand to the central metal atom. The Schiff base ligand shows strong bands around at 1602 and 1613 cm^{-1} which indicate the presence of azomethine ν (C=N) and the phenolic –OH indicate in the presence of Ph-OH (ν_{OH}) group respectively 1244 and 1243 cm^{-1} In the mixed ligands complexes both peaks are shifted towards lower frequency at 1507-1569-, 1243-1244 cm^{-1} respectively i.e azomethine-N and deprotonated –O atom indicating both are involved in the chelation [12]. All the mixed ligands complexes show an additional peak in the region 2835-3604, 816-848, and 727-787 due to νOH stretching, rocking and wagging mode of coordinated water molecules respectively. The absence of a weak broad band in 3200-3400cm^{-1} region, in the spectra of the metal complexes suggests deprotonation of the intramolecular hydrogen bonded OH group on complexation and subsequent coordination of phenolic oxygen to the metal ion. This is further supported by upward shift in υ C-O (phenolic) to the extent of 25-50 cm-1[26]. On complexation, the υ (C=N) band is shifted to lower wave number with respect to free ligand, denoting that the nitrogen of the azomethine group is coordinated to the metal ion. This is supported by upward shift in υ (C-N) to the extent of 10-35 cm-1[27]. The IR spectra of metal chelates showed new bands in 500-550 and 400-450 cm-1 regions which can be assigned to υ (M-O) and (M-N) vibrations respectively [13]. The IR spectra show a strong band in 3200-3600 cm^{-1} region, suggesting the presence of coordinated water in these metal complexes [14].

Table 3: Major Infrared spectral data for the Schiff base ligands and Metal complexes (cm^{-1})

Ligands/Complexes	C-H Aromatic	ν(C=N)	ν(Ar-O)	ν(M-O)	ν(M-N)	ν(C=C)	ν(C-O)	νNO_3
$C_{14}H_{13}NO_2(L^1)$	2841	1602	1244	-	-	1490	1150	-
$C_{15}H_{15}NO_3(L^2)$	2835	1613	1243	-	-	1466	1194	-
$Mn(L^1,L^2)(H_2O)_2$	2980	1634	1254	615	565	1456	1142	1456
$Fe(L^1,L^2)(H_2O)_2$	2980	1620	1243	602	502	1456	1168	1489
$Co(L^1,L^2)(H_2O)_2$	2990	1610	1242	611	574	1477	1150	1440
$Ni(L^1,L^2)(H_2O)_2$	3017	1613	1245	653	572	1466	1169	1436
$Cu(L^1L^2)(H_2O)_2$	2980	1618	1244	607	569	1462	1144	1462
$Zn(L^1,L^2)(H_2O)_2$	2980	1639	1262	637	569	1496	1164	1438

Magnetic moments and electronic spectral data

The electronic absorption spectra of metal complexes were recorded in DMSO in the range of 200-800 nm and are listed in table (). The electronic spectrum of ligand first shows three bands at 279 nm (3584 cm^{-1}), 346 nm (28901cm^{-1}) and 429nm (23310cm^{-1}) and ligand second shows four bands at 211nm (47393cm-1), 268nm (37313cm^{-1}), 341nm (29325cm^{-1}), 459nm (21786cm^{-1}) suggesting the presence of π-π∗ transition [22]. The electronic spectrum of Mn (II) complex showed three bands at 26737cm-1,27954cm-1,27548cm^{-1} corresponding to the transitions $^6A_{1g}\rightarrow{}^4T_{1g}(\nu_1)$,$^6A_{1g}\rightarrow{}^4T_{1g}(\nu_2)$,$^6A_{1g}\rightarrow{}^4E_g(\nu_3)$. The electronic spectrum of Fe(III) complex showed three bands at 30674cm^{-1}, 31948cm^{-1},34602cm^{-1} corresponding to the transitions $^6A_{1g}\rightarrow{}^4T_{1g}(\nu_1)$,$^6A_{1g}\rightarrow{}^4T_{1g}(\nu_2)$,$^6A_1g\rightarrow{}^4T_{2g}(\nu_3)$The electronic spectrum of Ni(II) complex showed three bands at 24271 cm^{-1}, 2702 cm^{-1} and 30769-37735 cm^{-1} corresponding to the transitions $^3A_{2g}(F)\rightarrow{}^3T_{2g}(\nu_1)$, $^3A_{2g}(F)\rightarrow{}^3T_{1g}(F)$ (ν_2) and $^3A_{2g}(F)\rightarrow{}^3T_{1g}(P)$ (ν_3). The magnetic moment of Ni-complex was seen at 3.54 B.M within the range of 2.5-3.5 B.M for octahedral Ni (II) complexes [15-16]. The electronic spectrum of Co(II)-complex shows bands at 29761cm^{-1}, 35335cm^{-1} and 36363cm^{-1} corresponding to the transitions $^4T_{1g}(F) \rightarrow {}^4T_{2g}(F)$ (ν_1) , $^4T_{1g}(F) \rightarrow{}^4A_{2g}(F)$ (ν_1) and $^4T_{1g}(F)\rightarrow{}^4T_{1g}(P)$ (ν_3). The magnetic moment of Co (II) complex was seen at 4.71 B.M within the expected range of 4.7-5.2B.M [17]. The absorption spectrum of the Cu (II) complex shows bands at 34722cm-1 attributed to charge transfer respectively in an octahedral field [18]. The magnetic moment of Cu (II) complex was seen at 1.51 B.M. corresponding to one unpaired electron with a slight orbital contribution to the spin-only-value and the absence of spin-spin interactions. On the basis of electronic spectra and magnetic susceptibility measurements, a distorted octahedral geometry around Cu (II) is suggested. The Zn (II) complex shows no d-d bands as is expected for a d_{10} system and found in diamagnetic in nature. Zn (II)complex exhibits electronic spectral bands at 38314 cm^{-1} which can be assigned to charge transfer in an octahedral field . All the Mn (II), Fe (III) and Co (II) complexes were paramagnetic in nature and Ni(II), Cu(II) and Zn(II) complexes were diamagnetic in nature.

Antimicrobial Activity

The antibacterial activity of mixed ligands and its metal complexes: The metal salts and control (DMSO solvent were tested in vitroagainst gram + ve bacteria (Staphylococcus aureus) and gram –ve bacteria (Aspergillus niger) by paper disc method [19]. Sterile (10mm) diameter Whatmann No. 42 paper discs were soaked in different concentrations of the ligand/ complexes (250ppm and 500ppm) in DMSO dried and then placed on the lawn culture of nutrient agar plates. The plates were then incubated for 24h at 32°C and the inhibition zone around each disc was measured. The results obtained were compared with known antibiotics, standard drug ciprofloxacin. Three replicates were taken and average value is given. The mixed ligand and its metal complexes, metal salts and control were screened for antifungal activity against the fungi Aspergillus niger and Trichoderma at 250 ppm and 500ppm levels respectively shown in Table-4

Table 4: Antibacterial and antifungal activities of ligands and its metal complexes (Diameter of inhibition Zone in (mm)

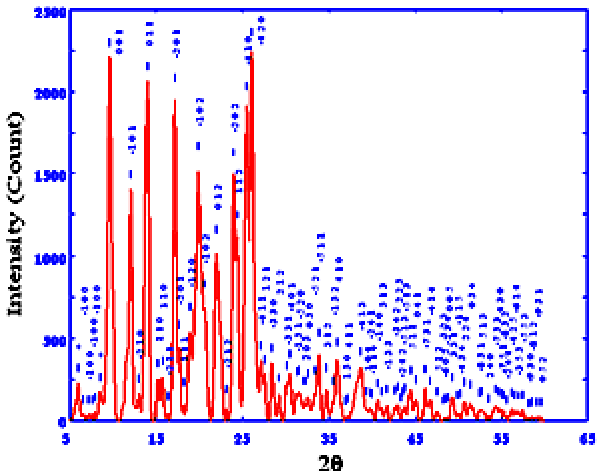
Compounds	Antibacterial activity				Antifungal activity			
	S.aureus		Bacillus substilis		Aspergillus niger		Fusarium Oxysporum	
	250 ppm	500 ppm	250 ppm	500 ppm	250 ppm	500 ppm	250 ppm	500 ppm
$C_{14}H_{13}NO_2(L^1)$	nil	14	nil	16	nill	11	16	19
$C_{15}H_{15}NO_3(L^2)$	nil	16	nil	17	16	16	15	18
$[Mn(L^1\&L^2)(H_2O)_2]$	15	15	16	13	21	19	21	nil
$[Fe(L^1\&L^2)(H_2O)_2]$	13	16	13	14	20	17	20	15
$[Co(L^1\&L^2)(H_2O)_2]$	13	16	14	13	19	22	21	nil
$[Ni(L^1\&L^2)(H_2O)_2]$	11	15	14	12	23	13	21	nil
$[Cu(L^1\&L^2)(H_2O)_2]$	14	18	16	19	19	20	22	16
$[Zn(L^1\&L^2)(H_2O)_2]$	13	17	20	19	20	19	20	23

4. Results and Discussion

Powder X-ray Diffraction Study

The powder x-ray diffraction of Mn(II), Fe(III), Co(II), Ni(II), Cu(II), Zn(II) complexes was mixed Ligands scanned in the range of 5-65^{0}at wavelength 1.540598Å. The diffractogram and associated data depict the 2θ value each peak ,relative intensity and inter-planar spacing (d-values). The diffractogram of Mn(II) complex of mixed ligands had 9 reflections with maxima at 2θ =26.114 corresponding to d value 3.409Å The diffractogram of Fe(III) complex of mixed ligands had 14 reflactions with maxima at 2θ=8.724 corresponding to d value 10.123ÅThe diffractogram of Co(II) complex of mixed ligands had 11 reflections with maxima at 2θ=12.136 corresponding to d value 7.287Å.The diffractogram of Ni(II) complex of mixed ligands had 11 reflactions with maxima at 2θ=16.948 corresponding to d value 5.684Å.The diffractogram of Cu(II) complex of mixed ligands had 15 reflactions with maxima at 2θ=13.634 corresponding to d value 6.489Å.The diffractogram of Zn(II) complex of mixed ligands had 12 reflaction with maxima at 2θ=14.609 corresponding to d value 6.058Å. The X-ray diffraction pattern of these complexes with respect to major peak having relative intensity greater than 10% has been indexed by computer programme (Shoemaker & Garland,1989). The above indexing method also yields Miller indices (hkl), unit cell parameters & unit cell volume.

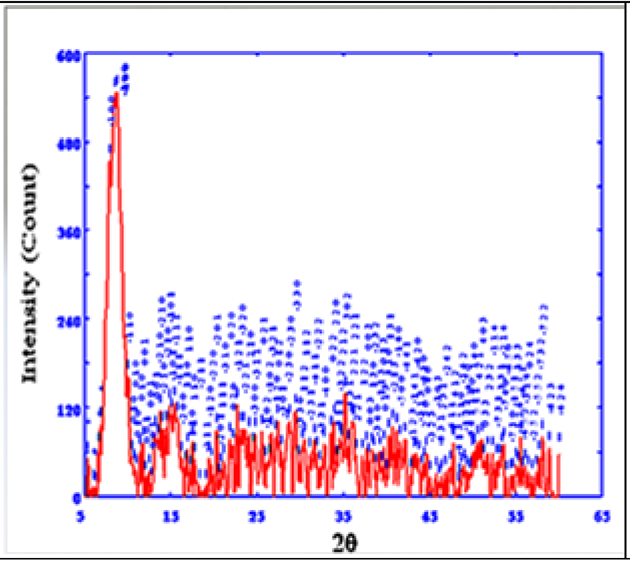
The unit cell of Mn(II) complex yielded values of lattice constants, a= 14.243Å,b=9.511Å,c=9.325Å and unit cell volume V=733.4354(Å)^3.The unit cell of Fe(III) complex yielded values of lattice constant, a=12.536Å,b=9.235Å,c=7.125Å and unit cell volume V=478.9815(Å)^3. In concurrence with these cell parameters, the condition such as a≠b≠c and α=γ=90^{0}β=120^0 require for the compounds to be monoclinic were tested & found to be satisfactory. The unit cell of Co(II)complex yielded values of lattice constants, a=12.542Å,b=10.356Å,c=7.421Å and unit cell volume V=559.645(Å)^3 The unit cell of Ni (II) complex yielded values of lattice constants, a=14.235Å,b=9.235Å,c=7.254Å and unit cell volume V=553.678(Å)^3. The unit volume of Cu (II) complex yielded values of lattice constants, a=14.478Å, b=11.542Å,C=9.257Å and unit cell volume V=898.235(Å)^3. The unit cell of Zn (II) complex yielded values of lattice constants, a=11.254Å, b=9.257Å,c=6.325Å and unit cell volume V=382.5807(Å)^3. Hence it is concluded that Mn(II), Fe(III), Co(II), Ni(II), Cu(II), Zn(II). Complexes have monoclinic crystal system .In concurrence with these cell parameters, the condition such as a≠b≠c and α=γ=90^{0}β=120^0 required for sample to be monoclinic were tested and found to be satisfactory.



Millar indices and interplanar distances of Mn$^{(II)}$ complex

h	k	l	2θ (Obs)	2θ (Cal)	d (Obs)	d (Cal)	Relative intensity
-1	0	0	6.56	7.16	13.46	12.33	0.56
-1	0	0	7.17	7.16	12.30	12.33	0.54
-1	0	0	7.54	7.16	11.71	12.33	0.53
-1	0	0	7.94	7.16	11.12	12.33	0.68
0	0	1	9.62	9.47	9.18	9.32	22.27

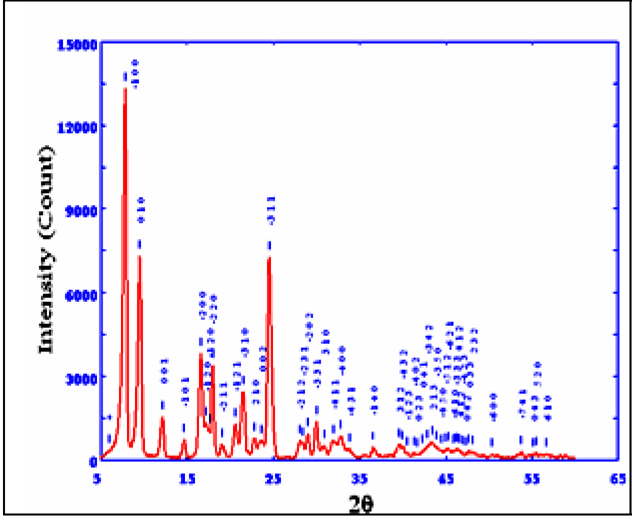
Figure 1:.X-ray diffraction data of [MnL^{1}and L^2(H$_2$O)$_2$] complex:
Crystal system: Lattic Type: Monoclinic, Lattic Parameter: a=14.243, b=9.511, c=9.325, Å
Volume of unit cell V=733.4354(Å)^3 Lattic Parameter .π=γ=90^0 β=120^0



Millar indices and interplanar distances of Fe$^{(III)}$ complex

h	k	l	2θ (Obs)	2θ (Cal)	d (Obs)	d (Cal)	Relative intensity
-1	0	0	7.89	8.13	11.18	10.85	4.53
-1	0	0	8.52	8.13	10.36	10.85	5.42
-1	0	0	8.72	8.13	10.12	10.85	5.46
-1	1	0	10.09	9.84	8.75	8.97	1.60
0	1	0	10.50	10.94	8.41	8.07	0.52
0	1	0	10.76	10.94	8.21	8.07	0.40

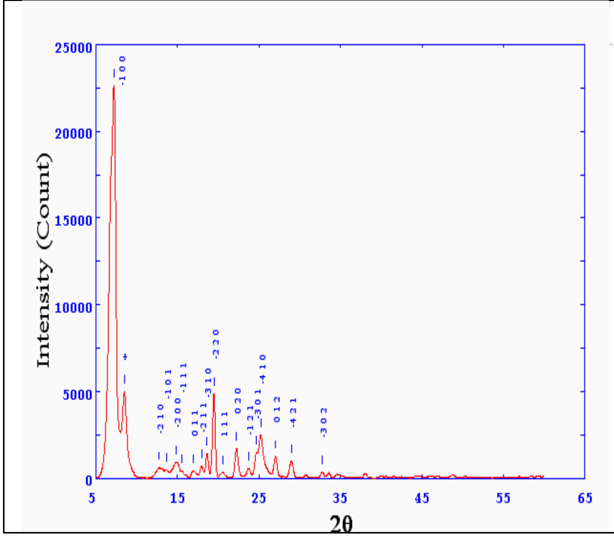
Figure 2: X-ray diffraction data of [FeL^{1}and L^2 (H$_2$O)$_2$] Complex :
Crystal system: Lattic Type:Monoclinic, Lattic Parameter: a=12.536, b=9.325, c=7.125,Å
Volume of unit cell V=478.9815(Å) ^{3} Lattic Parameter.π=γ=90^0β=120^0



Millar indices and interplanar distances of Co$^{(II)}$ complex

h	k	l	2θ (Obs)	2θ (Cal)	d (Obs)	d (Cal)	Relative intensity
-1	0	0	7.81	8.13	11.30	10.86	133.33
0	1	0	9.51	9.85	9.28	8.96	73.08
0	0	1	12.13	11.91	7.28	7.42	15.52
-1	0	1	14.66	14.44	6.03	6.12	7.25
-2	0	0	16.61	16.30	5.33	5.43	38.2
-1	2	0	17.21	17.19	5.14	5.15	13.00

Figure 3: X-ray diffraction data of [CoL^{1}and L^2 (H$_2$O) $_2$] Complex:
Crystal system: Lattic Type:Monoclinic, Lattic Parameter: a=12.542, b=10.356, c=7.421,Å
Volume of unit cell V=559.651(Å)^3 Lattic Parameter .π=γ=90^0β=120^0

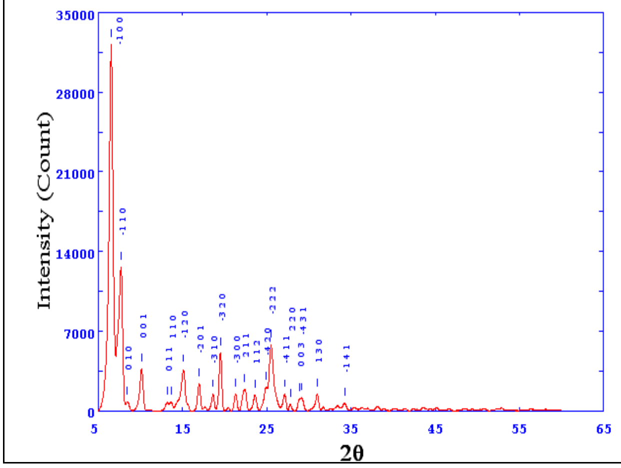


Millar indices and interplanar distances of Ni$^{(II)}$ complex :

h	k	l	2θ (Obs)	2θ (Cal)	d (Obs)	d (Cal)	Relative intensity
-1	0	0	7.213	7.16	12.24	12.32	226.31
-2	1	0	12.76	13.02	6.92	6.79	58.94
-1	0	1	13.63	14.15	6.48	6.25	47.25
-2	0	0	14.88	14.35	5.94	6.16	93.15
-1	1	1	15.56	15.60	5.69	5.67	40.26
0	1	1	16.97	16.48	5.21	5.37	42.50

Figure 4: X-ray diffraction data of [NiL^1&L^2 (H$_2$O) $_2$]:
Crystal system: Lattic Type:Monoclinic, Lattic Parameter: a=14.235, b=9.235, c=7.254,Å

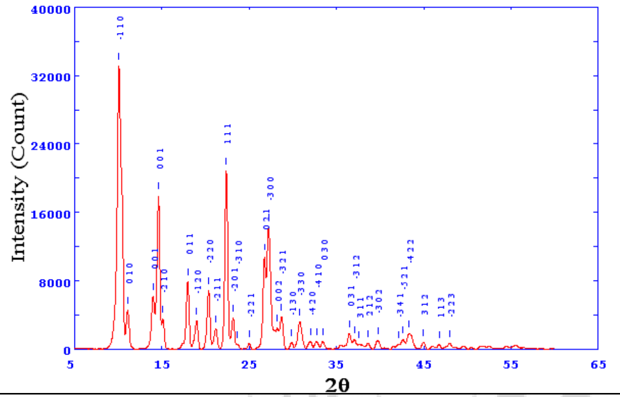
Volume of unit cell V=553.778(Å)^{33}Lattic Parameter .π=γ=90^0β=120^0



Millar indices and interplanar distances of Cu$^{(II)}$ complex:

h	k	l	2θ (Obs)	2θ (Cal)	d (Obs)	d (Cal)	Relative intensity
-1	0	0	6.51	7.04	13.55	12.53	322.18
-1	1	0	7.70	8.09	11.47	10.91	126.26
0	1	0	8.46	8.83	10.43	9.99	78.54
0	0	1	10.14	9.54	8.71	9.25	36.58
0	1	1	13.17	13.02	6.71	6.79	72.74
1	1	0	13.63	13.80	6.4	6.40	74.35

Figure 5:X-ray diffraction data of [CuL^{1}and L^2(H$_2$O)$_2$]
Crystal system: Lattic Type: Monoclinic, Lattic Parameter: a=14.474, b=11.542, c=9.257Å
Volume of unit cell V=898.235 (Å)^3 Lattic Parameter .π=γ=90^0β=120^0



Millar indices and interplanar distances of Zn$^{(II)}$ complex

h	k	l	2θ (Obs)	2θ (Cal)	d (Obs)	d (Cal)	Relative intensity
-1	1	0	10.09	10.18	8.75	8.67	330.91
0	1	0	11.09	11.02	7.96	8.01	450.35
0	0	1	14.00	13.99	6.31	6.32	620.46
0	0	1	14.60	13.99	6.05	6.32	179.54
-2	1	0	15.12	15.85	5.85	5.58	34.80
0	1	1	17.96	17.84	4.93	4.96	79.11

Figure 6: X-ray diffraction data of [ZnL^1&L^2 (H$_2$O)$_{2]}$
Crystal system: Lattic Type:Monoclinic, Lattic Parameter: a=11.255, b=9.257, c=6.352Å
Volume of unit cell V= 382.5807 (Å)^3 Lattic Parameter .π=γ=90^0β=120^0

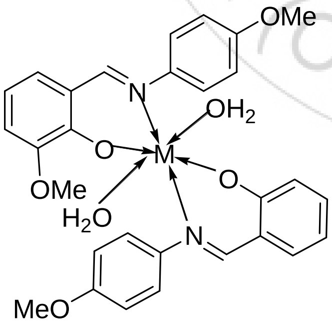


Figure 7: Synthesis of mixed ligand complexes.

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

5. Conclusions

The synthesis of mixed ligand and its transition metal complexes like Mn(II),Fe(III),Co(II),Ni(II),Cu(II),Zn(II) complexes with N and O donor Schiff base ligand derived from 4-methoxyphenylanaline,Salicylaldehyde and O-vanilline were synthesized. A comparative study of crystal system, miller indices of powder XRD. The powder XRD study suggested that monoclinic crystal system for Mn(II), Fe(III), Co(II), Ni(II), Cu(II), Zn(II) complexes .

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