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## Synthesis and Spectral Analysis of Some Metal Ions Complexes with Mixed Ligands of Schiff Base and 1, 10-Phenanthroline

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### Abstract:

The free Schiff base ligand ( $HL_1$ ) is prepared by being mixed with the co-ligand 1, 10-phenanthroline ( $L_2$ ). The product then is reacted with metal ions: ( $Cr^{+3}$ ,  $Fe^{+3}$ ,  $Co^{+2}$ ,  $Ni^{+2}$ ,  $Cu^{+2}$  and  $Cd^{+2}$ ) to get new metal ion complexes. The ligand is prepared and its metal ion complexes are characterized by physic-chemical spectroscopic techniques such as: FT-IR, UV-Vis, spectra, mass spectrometer, molar conductivity, magnetic moment, metal content, chloride content and microanalysis (C.H.N) techniques. The results show the formation of the free Schiff base ligand ( $HL_1$ ). The fragments of the prepared free Schiff base ligand are identified by the mass spectrometer technique. All the analysis of ligand and its metal complexes are in good agreement with the theoretical values indicating the purity of Schiff base ligand and the metal complexes. From the above data, the molecular structures for all the metal complexes are proposed to be octahedral.

**Key words:** Metal Ion Complexes, Mixed Ligands, Schiff Base, 1, 10-Phenanthroline.

### Introduction:

Mixed ligands are either bidentate or polydentate ligands which contain at least two different types of chemical functional groups capable of binding to metal atom. At this time the development of these ligands is an increasing interest, as the different features associated with each donor atom confer unique reactivity to their metal complexes [1].

Depending on the number of ligands, attached to the metal ion, the mixed

ligand complexes can be diligand, triligand, tetraligand or multiligand complexes. The formation of the mixed ligand complexes and their properties can be crucial from the point of view of the kinetic effect[2]. The coordination chemistry of transition metal complexes with mixed ligands are of current interest because they can provide new materials with useful properties such as magnetic exchange[3], electrical conductivity[4], photoluminescence[5],

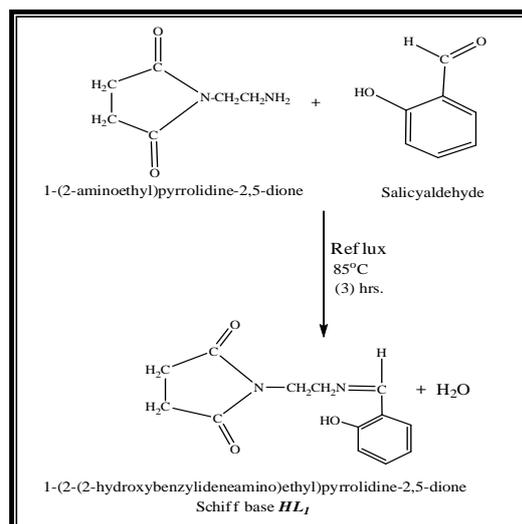
nonlinear optical property[6] and antimicrobial activity[7]. The biological importance of mixed ligand complexes is that they are sometimes more effective than the free ligands [8]. The stabilities of mixed chelates are of great importance in biological systems as many metabolic and toxicological functions are dependent upon this stability. Many attempts have been made to correlate the stability of the metal-ligand complexes with their antimicrobial activity [9, 10]. Antitumor activity of some mixed ligand complexes have also been reported [11]. Mixed ligand complexes containing nitrogen and oxygen donors are important owing to their antifungal, antibacterial, and anticancer activities [12].

### Materials and Methods:

All the chemicals used in this work are of the highest purity available and their supplier without further purification. Solvents: Acetic acid glacial ethanol, dimethyl Sulfoxide (DMSO).

### Preparation of Schiff Base Ligand (HL<sub>1</sub>): [13]

1-(2-aminoethyl) pyrrolidione-2,5-dione ligand (0.230 g, 0.001 mole) is dissolved in absolute ethanol (17ml) with stirring. Salicylaldehyde (0.198 g, 0.001 mole) is dissolved in absolute ethanol (7ml), and added to 1-(2-aminoethyl) pyrrolidione-2,5-dione solution were mixed in 1:1 mole ratio, and then three drops of glacial acetic acid are added. The mixture is heated with stirring under reflux at temperature (85°C) for (3) hrs. During this period, the colorless solution turned to the yellow solid. The yellow solid is collected by filtration and recrystallized from absolute ethanol and then dried. Weight (0.298g) m. p (106-108 °C) and yield (75%). Synthesis can be shown according to the following **Scheme (1)**.



**Scheme (1): Synthesis of Schiff Base Ligand 1-[2-(2-hydroxybenzylideneamino) ethyl] pyrrolidine-2,5-dione (HL<sub>1</sub>).**

### Preparation of Mixed Ligands Complexes:

**Synthesis of the Metal Ion Complexes [Cr<sup>3+</sup>, Fe<sup>3+</sup>, Co<sup>2+</sup>, Ni<sup>2+</sup>, Cu<sup>2+</sup> and Cd<sup>2+</sup>] from the mixed Ligands of 1-[2-(2-hydroxybenzylideneamino) ethyl] pyrrolidine-2,5-dione (HL<sub>1</sub>) and Ligand 1,10-Phenanthroline (L<sub>2</sub>).**

Schiff base ligand (HL<sub>1</sub>) (0.06g, 0.0002 mole) is dissolved in (10ml) absolute ethanol. Ethanolic solution of 1,10-phenanthroline L<sub>2</sub> (0.169g, 0.0002mole) is added to the above solution. This is followed by adding (2 mole) of triethylamine and then ethanolic of: [Copper(II) chloride (0.04g, 0.0002 mole); Cobalt(II) chloride (0.06g, 0.0002 mole); Nickel(II) chloride (0.04g, 0.0002 mole); Chromium(III) chloride (0.06g, 0.0002 mole); cadmium(II) chloride (0.04g, 0.0002 mole) and Iron(III) chloride (0.06g, 0.0002 mole)] is added to the mixed ligands solution at the mole ratio 1:1:1 and then heated under reflux at temperature at (80-85) °C for (3) hours. During this period, the color changes for all complexes. The precipitate is collected by filtration, washed with absolute ethanol and then recrystallized from absolute ethanol. The powder is collected by filtration and

then dried at temperature (85°C) for three hours and then kept in desiccators. Some analytical and physical properties can be shown in **Table (2)**. The general equation of preparation is:



Where:

**HL<sub>1</sub>**: 1-[2-(2-hydroxybenzylideneamino) ethyl] pyrrolidine -2,5-dione.

**L<sub>2</sub>**: 1,10-Phenanthroline.

**M**: Metal ions of (Cr(III), Fe(III), Co(II), Ni(II), Cu(II), Cd(II)).

#### Statistical Analysis:

The FTIR spectra of the ligand and its metal ion complexes are recorded by using Shimadzu FTIR (8000) with KBr disc in the range of wave number (4000-400)cm<sup>-1</sup>. The electronic spectra of the compounds are obtained by using UV-VIS Spectrophotometer, UV-160A Shimadzu using (1.0) quartz cell in the range of wavelength (200-900)nm., using DMSO as a solvent. The metal percentages in the complexes are determined by using flame atomic absorption spectrophotometer (Nov AA 350, Germany). The molar conductivity measurements are obtained by using conduct meter WTW at (25°C) with a concentration of 1 x 10<sup>-3</sup>M (DMSO). The Digimelt (MSRS) apparatus is used to measure the melting point of the compounds. Microanalyses (C.H.N) of compounds are recorded by Euro Vector model EA3000, Italy. The percentages of chloride ion in the complexes are obtained by using on titro processor (Metrohm 686), UV-160A Shimadzu and turbidity (Hach) respectively. The

magnetic susceptibility of the prepared complexes is determined at room temperature by Balance Magnetic Susceptibility, Model (MSB-MKI). The mass spectrometer of the Schiff base ligand is carried out by using (QP 2010 Ultra Shimadzu).

#### Results:

##### Mass Spectrometer:

The main high resolution mass spectrometer of the prepared Schiff base ligand 1-[2-(2-hydroxybenzylideneamino) ethyl] pyrrolidine-2,5-dione (HL<sub>1</sub>) is summarized in Scheme (3.1) and Table (3.4). The molecular ion peak for protonation of the free Schiff base ligand, C<sub>13</sub>H<sub>15</sub>N<sub>2</sub>O<sub>3</sub> appears at m/z = 247(M) which is in good agreement with the theoretical value. The other peaks are detected at m/z =202, 174, 161, 134, and 120 corresponding to [M(246)+(C<sub>13</sub>H<sub>14</sub>N<sub>2</sub>O<sub>3</sub>)], [M(247)+(C<sub>13</sub>H<sub>15</sub>N<sub>2</sub>O<sub>3</sub>)], [M(202)-(C<sub>11</sub>H<sub>10</sub>N<sub>2</sub>O<sub>2</sub>)], [M(174)-(C<sub>10</sub>H<sub>10</sub>N<sub>2</sub>O)], [M(161)(C<sub>9</sub>H<sub>9</sub>N<sub>2</sub>O)], [M(134)(C<sub>8</sub>H<sub>8</sub>NO)] and [M(120)-(C<sub>8</sub>H<sub>8</sub>O)] respectively. All these fragmentations can be shown in Table (1), Scheme (2).

**Table (1): The Fragmentation Pattern Data for the Free Schiff Base Ligand (HL<sub>1</sub>)**

Peak m/z	Assignment
247	C <sub>13</sub> H <sub>15</sub> N <sub>2</sub> O <sub>3</sub>
202	[C <sub>11</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub> ]
174	[C <sub>10</sub> H <sub>10</sub> N <sub>2</sub> O]
161	[C <sub>9</sub> H <sub>9</sub> N <sub>2</sub> O]
134	[C <sub>8</sub> H <sub>8</sub> NO]
120	[C <sub>8</sub> H <sub>8</sub> O]

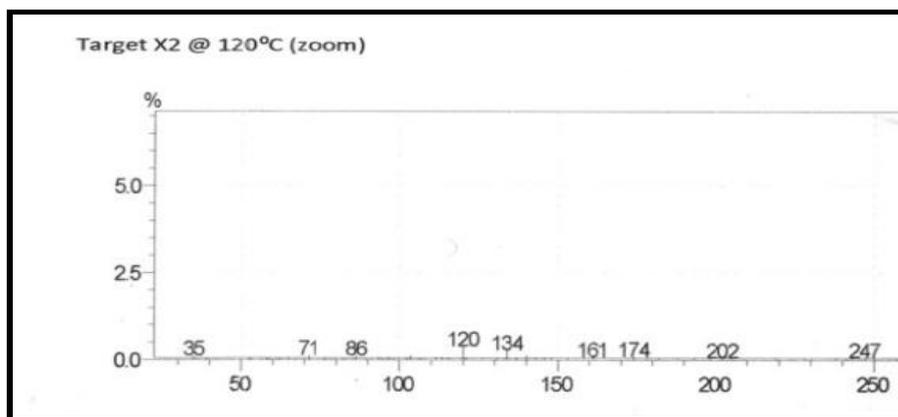


Fig. (1): Mass Spectrum of Schiff Base ( $HL_1$ )

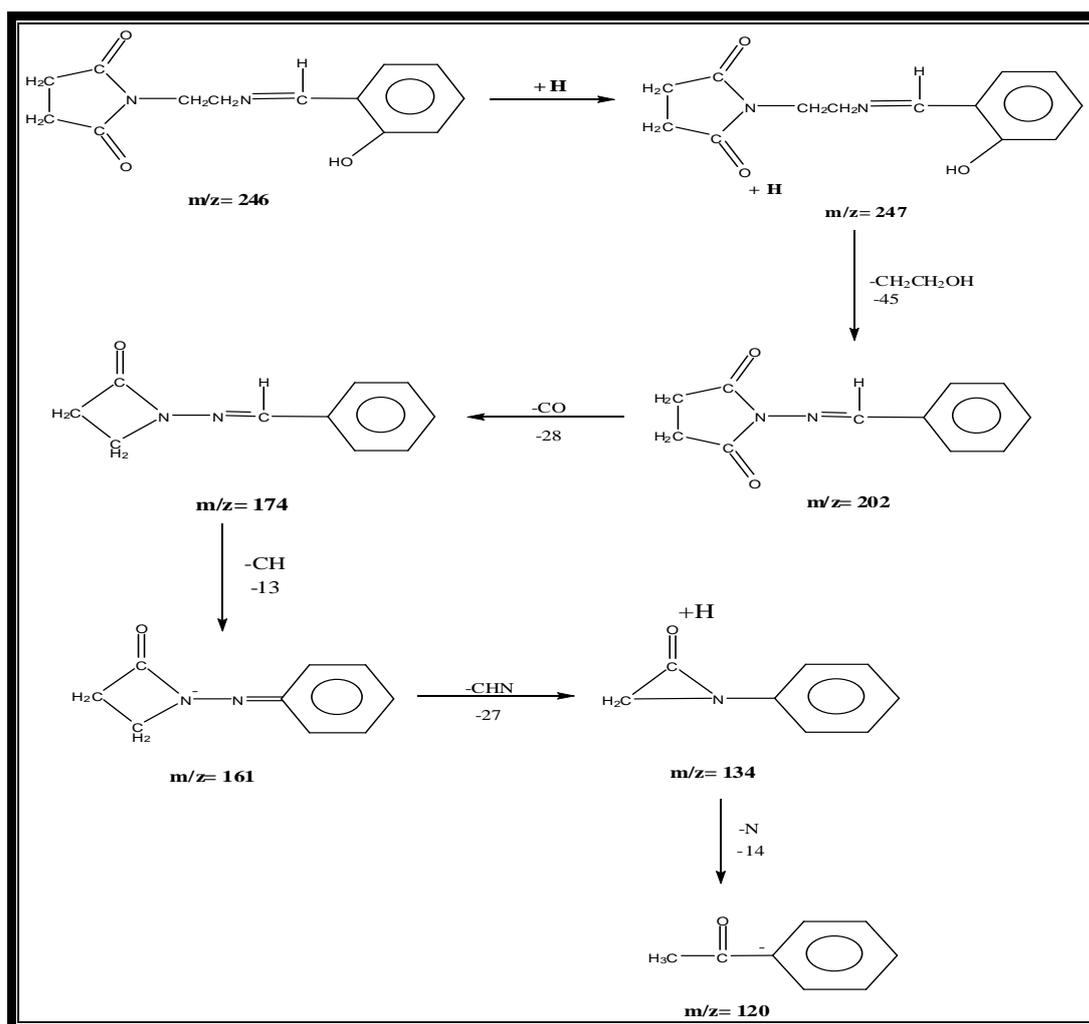
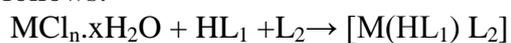


Fig. (2): The Fragmentation Pattern of the Free Schiff Base ( $HL_1$ )

### Characterization of Metal Complexes

The synthesis of mixed ligand complexes may be represented as follows:



1: 1: 1 mixed ligand complexes

Where:  $HL_1$  is 1-[2-(2-hydroxybenzylideneamino)ethyl]pyrrolidine-2,5-dione and  $L_2$  is the other ligand). All of the complexes are colored and thermally stable, indicating a strong metal-ligand bond. The elemental analysis data are illustrated in

**Table (2)** of the metal complexes consistent with their general formulation as mixed ligand complexes.

### Molar Conductivity

The molar conductance values of the complexes in dimethyl Sulfoxide (DMSO) at  $10^{-3}$ M indicating that all these complexes are of a non-electrolytic nature.

All the complexes are neutralized by the chloride ion inside the coordination sphere for all the above complexes except the Iron(III) complex

neutralized by the chloride ion inside and outside the coordination sphere.

### Magnetic Susceptibility

The values of magnetic moments for the complexes:

[Co(HL)(L<sub>3</sub>)(H<sub>2</sub>O)Cl],  
[Cu(HL)(L<sub>3</sub>)(H<sub>2</sub>O)Cl],  
[Fe(HL<sub>1</sub>)(L<sub>3</sub>)(H<sub>2</sub>O)Cl]Cl,  
[Ni(HL<sub>1</sub>)(L<sub>3</sub>)(H<sub>2</sub>O)Cl],  
[Cr(HL)(L<sub>3</sub>)Cl<sub>2</sub>]H<sub>2</sub>O,  
[Cd(HL<sub>1</sub>)(L<sub>3</sub>)(H<sub>2</sub>O)Cl] are found to be 4.01, 1.67, 4.89, 2.93, 3.76 and 0.0 B.M. respectively within the expected values of

**Table (2): Some Analytical and Physical Data of the Ligand (HL<sub>1</sub>) and its Metal Ion Complexes.**

Compound and color	M. wt. gm/mol	Molecular formula	Yield %	m. p. °C	Microanalysis (Calc.) Exp.			M % (Calc.) Exp.	Cl %	Molar Conductance (μs/cm <sup>1</sup> )	μeff. (B.M)
					C%	H%	N%				
Schiff base(HL <sub>1</sub> ) Shiny-Yellow	246	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	75	106-108	(61.86) 62.87	(5.93) 6.05	(11.8) 12.07	-	-	-	-
[Cu(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl] Dark-olive	541	C <sub>25</sub> H <sub>23</sub> ClCuN <sub>4</sub> O <sub>4</sub>	78	200-202	(55.86) 56.06	(4.0) 3.93	(10.35) 11.06	(11.64) 12.00	(6.47) 7.07	20	1.67
[Co(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl] Yellowish-olive	537	C <sub>25</sub> H <sub>23</sub> ClCoN <sub>4</sub> O <sub>4</sub>	60	80-82	(55.86) 56.06	(4.28) 3.97	(10.43) 11.00	(10.98) 11.09	(6.74) 7.02	22	4.01
[Ni(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl] Yellowish-brown	533.57	C <sub>25</sub> H <sub>23</sub> ClNiN <sub>4</sub> O <sub>4</sub>	80	212-214	(56.00) 57.00	(4.3) 4.43	(10.45) 11.05	(10.96) 11.13	(6.53) 7.03	21	2.93
[Cr(HL <sub>1</sub> )(L <sub>2</sub> )Cl <sub>2</sub> ]H <sub>2</sub> O Yellowish-green	565	C <sub>25</sub> H <sub>23</sub> Cl <sub>2</sub> CrN <sub>4</sub> O <sub>4</sub>	63	264-266	(53.1) 54.00	(4.07) 4.15	(9.91) 10.02	(9.20) 9.04	(12.4) 12.5	25	3.76
[Cd(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl] Off-white	591.34	C <sub>25</sub> H <sub>23</sub> ClCdN <sub>4</sub> O <sub>4</sub>	70	Dec. >300	(50.78) 51.00	(3.92) 4.04	(9.47) 10.13	(19.01) 19.12	(6.00) 6.10	8.8	0.0 dia
[Fe(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl] Dark-Reddish brown	570.23	C <sub>25</sub> H <sub>23</sub> Cl <sub>2</sub> FeN <sub>4</sub> O <sub>4</sub>	78	145-147	(52.5) 52.31	(4.7) 3.96	(9.83) 10.06	(9.79) 10.00	(12.43) 12.12	21	4.89

the theoretical values. All the above complexes are paramagnetic except the cadmium(II) complex is diamagnetic.

### Elemental Analyses (C.H.N.)

The microanalysis (C.H.N) for the prepared metal complexes and the Schiff base ligand results are in good agreement with the theoretical values, indicating the identities and purities of all compounds (Schiff base ligand and its metal complexes). Also, the metal and chlorides content in complexes are determined and the obtained data are in good agreement with the theoretical values. All the results are summarized in Table (2).

### Infra-Red Spectra

The FT-IR spectra analyses give useful information about the mode of coordination of the ligands to the central metallic ions. The vibrational

bands of the ligands and their metal complexes as well as their assignments are listed on **Table (3)**. **The measurements are carried out for each compound in solid state using KBr in the range (4000-400)cm<sup>-1</sup>.**

The infrared spectra of 1-[2-(2-hydroxybenzylideneamino)ethyl]pyrrolidine-2,5-dione (Schiff base ligand) (HL<sub>1</sub>) show a characteristic of the stretching vibration of (OH) of phenolic group at (3437)cm<sup>-1</sup> [13], the band at (3055)cm<sup>-1</sup> and (3008)cm<sup>-1</sup> can be assigned to (C-H) aromatic stretching vibrations of asymmetrical and symmetrical respectively [14]. The infrared spectrum of free Schiff base ligand (HL<sub>1</sub>) shows strong sharp bands at (1635)cm<sup>-1</sup> and (1577)cm<sup>-1</sup> which are due to the stretching vibration of (C=O) and (C=N) respectively. The other strong sharp band at (1496)cm<sup>-1</sup>

is due to the stretching vibration of (C=C) of benzene ring[14,15].

The infrared spectra of 1,10-phenanthroline ( $L_2$ ) and 1-[2-(2-hydroxybenzylideneamino)ethyl]pyrrolidine-2,5-dione ( $HL_1$ ) and their metal complexes are carried out with potassium bromide pellets in the range (4000-400) $\text{cm}^{-1}$  were recorded a Shimadzu IR-Prestige-21 FTIR 84005, 2006) Fourier transform infrared spectrophotometer.

The stretching vibration of (OH) phenolic group of the free Schiff base ligand ( $HL_1$ ) disappears in all the

metal complexes, which indicates that oxygen atom is coordinated with the metal ions center of the complexes.

The strong bands show at (1577) $\text{cm}^{-1}$  for (C=N) in the free Schiff base ligand [16] which is shifted to a lower stretching vibration (34-59) $\text{cm}^{-1}$ , that band indicates the participation of the nitrogen atom of azomethine group in coordination.

This change can be explained by the transfer of all the electrons from the nitrogen to the central metal atom due to the coordination.

**Table (3): The Infrared Spectra Data of the Metal Ion Complexes**

Compound	$\nu(\text{H}_2\text{O})$ intra	$\nu(\text{C-H})$		$\nu(\text{C=O})$	$\nu(\text{C=N})$	$\nu(\text{C-O})$	$\nu(\text{C-N})$	$\rho(\text{OH})$ aqua	$\nu(\text{M-N})$	$\nu(\text{M-O})$
		arom.	aliph. as, s							
Schiff base( $HL_1$ )	3437	3055 3008	2900 2866	1635	1577	1199	1111 1041	-	-	-
[Cu( $HL_1$ )( $L_2$ )( $\text{H}_2\text{O}$ )Cl]	3414	3005	2912 2804	1631 1600	1518	1145	1033	902	574 613	489
[Co( $HL_1$ )( $L_2$ )( $\text{H}_2\text{O}$ )Cl]	3394	3055	2931 2866	1635 1600	1519	1149	1037	848	563	424
[Ni( $HL_1$ )( $L_2$ )( $\text{H}_2\text{O}$ )Cl]	3410	3051	2981 2900 2804	1624 1600	1535 1516	1103	1041	902	532 601	424
[Cr( $HL_1$ )( $L_2$ )Cl <sub>2</sub> ] $\text{H}_2\text{O}$	3390	3051 3012	2920 2804	1612	1519	1149	1026	902	532	439
[Fe( $HL_1$ )( $L_2$ )( $\text{H}_2\text{O}$ )Cl]Cl	3394	2978	2904 2800	1624 1600	1543	1103	1033	902	586 617	424
[Cd( $HL_1$ )( $L_2$ )( $\text{H}_2\text{O}$ )Cl]	3429	3047 3008	2927 2870	1616	1577	1199	1145	937	509 470	428

ar. = aromatic aliph. = aliphatic phen. = phenolic as. = asymmetrical s. = symmetrical

Also, the shift to a lower stretching vibration of (C=N) band at (1647) $\text{cm}^{-1}$  of 1,10-phenanthroline is shifted to lower frequency (104-129) $\text{cm}^{-1}$  because of the ligand coordination of the nitrogen atom of the ligand 1,10-phenanthroline in all the spectra of all the metal complexes.

Frequency may be due to delocalization of metal electron density into the ligand  $\pi$ -system (HOMO $\rightarrow$ LOMO), where:

HOMO: Highest occupied molecular orbital.

LOMO: Lowest unoccupied molecular orbital [17].

The medium broad band's (3390-3414) $\text{cm}^{-1}$  can be attributed to the stretching vibration of (OH) of water molecule, all the prepared complexes

have bands at (902) $\text{cm}^{-1}$  for Cu(II), Fe(III), Ni(II) and Cr(III) complexes and the bands at (848) $\text{cm}^{-1}$  and (937) $\text{cm}^{-1}$  for Co(II) and Cd(II) complexes attributed to the rocking vibration of (OH) of water molecules (aqua) indicating the presence of coordinated water molecules with the above metal ions in the complexes (water molecules inside the coordination sphere)[18].

The new medium intensity bands shown around (424-489) $\text{cm}^{-1}$  and (470-617) $\text{cm}^{-1}$  can be assigned to the frequency at (metal-nitrogen) and (metal-oxygen) respectively [16]. All the spectra of ligand and its metal complexes are demonstrated in **Table (3)**.

### Electronic Spectra

The electronic absorption Spectrum of the yellow 1-[2-(2-hydroxybenzylideneamino) ethyl] pyrrolidine-2,5-dione ( $HL_1$ ), **Figure(2)** in dimethylsulphoxide (DMSO) showing two sharp and high intensity absorption band at (269nm,  $37174\text{ cm}^{-1}$ ) and (282nm,  $35460\text{ cm}^{-1}$ ) are assigned to ( $\pi \rightarrow \pi^*$ ) and ( $n \rightarrow \pi^*$ ) electronic transition of benzene ring and azomethine group respectively [19-21]. The weak intensity absorption band at (236nm,  $42372\text{ cm}^{-1}$ ) electronic transition of Schiff base azomethine group [22, 23].

The U.V- Vis Spectrum of the white 1,10-phenanthroline ( $L_2$ ), **Figure (2)** in dimethylsulfoxide (DMSO) exhibits strong sharp and high intensity absorption band at (281nm,  $35587\text{ cm}^{-1}$ ) which can be assigned to ( $\pi \rightarrow \pi^*$ ) electronic transition of azomethine group[24].

The Schiff base ligands with metal ion cause either bathochromic hypochromic shifts of ligand band [19]. The appearing of new bands has different positions and intensity in the spectra of metal complexes related to charge transfer (C.T.) and (d-d) transitions and these depend on the oxidation states and the position of metal in periodic table, stereochemistry of the complexes and the ligand field strength. The electronic spectra for all the prepared metal complexes are performed in the ranges (200-900)nm and (200-1100)nm in dimethyl sulphoxide (DMSO) as solvent in room temperature.

The absorption bands for all the prepared metal ion complexes are classified into two distinct groups, these belong to ligand transitions showed in absorptivity attributed to charge transfer (C.T.) electronic transition, the second band also with higher intensity can be assigned to ligand field (L.F.) electronic transition. The third absorption band gives low intensity

the ultraviolet region, while the transitions of (d-d) appears in the visible region, and these are assigned in the relevance to the structure of the complexes. The electronic spectrum of Cobalt (II) complex appears four absorption bands, the first band appears at (295nm,  $33898\text{ cm}^{-1}$ ) can be assigned to ( $\pi \rightarrow \pi^*$ ) electronic transition, the other bands at (400nm,  $25000\text{ cm}^{-1}$ ) attributed to d-d[25], the band at (490nm,  $20408\text{ cm}^{-1}$ ) corresponding to (d-d) electronic transition type ( ${}^4T_{1g(F)} \rightarrow {}^4T_{2g(P)}(v_3)$ ) electronic transition, and the band at (634nm,  $15773\text{ cm}^{-1}$ ) attributed to ( ${}^4T_{1g(F)} \rightarrow {}^4A_{2g(F)}(v_2)$ ) electronic transition. This appears in octahedral complex geometry around the Cobalt ion,[26].

The UV-Vis spectrum of Nickel (II) complex exhibiting five peaks which were compared with those of related ligands. The first peak observed at (296nm,  $33898\text{ cm}^{-1}$ ) is of a higher intensity attributed to ligand field (L.F.), the second peak at (372nm,  $26881\text{ cm}^{-1}$ ) can be assigned to charge transfer (C.T.) [25], the other three peaks have lower intensity appearing at (408nm,  $24509\text{ cm}^{-1}$ ), (480nm,  $20833\text{ cm}^{-1}$ ) and (626nm,  $15974\text{ cm}^{-1}$ ) attributed to (d-d) electronic transition type ( ${}^3A_{2g(F)} \rightarrow {}^3T_{1g(P)}$ ), ( ${}^3A_{2g(F)} \rightarrow {}^3T_{1g(F)}$ ) and ( ${}^3A_{2g(F)} \rightarrow {}^3T_{2g(F)}$ ) electronic transition respectively. The observed electronic spectrum suggests that complex as octahedral geometry around the Nickel ion[27].

The electronic spectrum of Copper (II) complex shows three absorption bands in the ultraviolet and visible regions, the following absorption bands are found at (362nm,  $27624\text{ cm}^{-1}$ ) with higher intensity and molar absorption and low molar extinction coefficient at (597nm,  $16750\text{ cm}^{-1}$ ) due to (d-d) electronic transition type ( ${}^2E_g \rightarrow {}^2T_{1g(D)}$ ), These electronic transition are characterized by

octahedral complex geometry around the Copper ion[27].

The spectrum of Chromium(III) complex, shows four absorption bands, the first band with higher intensity absorption and molar absorptivity at (277nm,  $36101\text{cm}^{-1}$ ) with ultraviolet and visible regions, the following absorption bands found at (362nm,  $27624\text{cm}^{-1}$ ) corresponding to ( $\pi \rightarrow \pi^*$ ) electronic transition, the second absorption band at (372nm,  $26881\text{cm}^{-1}$ ) due to (d-d) electronic transition, the third band with medium absorption intensity and molar extinction coefficient attributed to ( ${}^4\text{A}_{2g(\text{F})} \rightarrow {}^4\text{T}_{2g(\text{P})}$ ) and the fourth absorption band with low absorption intensity and molar extinction coefficient due to ( ${}^4\text{A}_{2g(\text{F})} \rightarrow {}^4\text{T}_{1g(\text{F})}$ ) electronic transition. According to these transitions, we can suggest that this complex is an octahedral complex geometry around the Chromium ion [28].

The UV-Vis spectrum of the Iron(III) complex exhibits five absorption bands, the first and second bands are strong and of higher intensities and molar extinction coefficient, the first band releasing at (272nm,  $36764\text{cm}^{-1}$ ) is assigned to ( $\pi \rightarrow \pi^*$ ) electronic transition [29], while the second is observed at (293nm,  $34129\text{cm}^{-1}$ ) is attributed to ( $n \rightarrow \pi^*$ ) electronic transition of azomethine group[30] is shifted and is changed in

the shape and the position in the spectrum of the ferric complex. The third band is medium at (426nm,  $23474\text{cm}^{-1}$ ) is attributed to ( ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{2g}$ ) electronic transition [31]. While the absorption band is low intensity observed at (480nm,  $20833\text{cm}^{-1}$ ) which can be assigned to ( ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{2g(\text{D})}$ ) electronic transition, the last absorption band at (806nm,  $12406\text{cm}^{-1}$ ) is attributed to ( ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{1g(\text{G})}$ ) electronic transition.

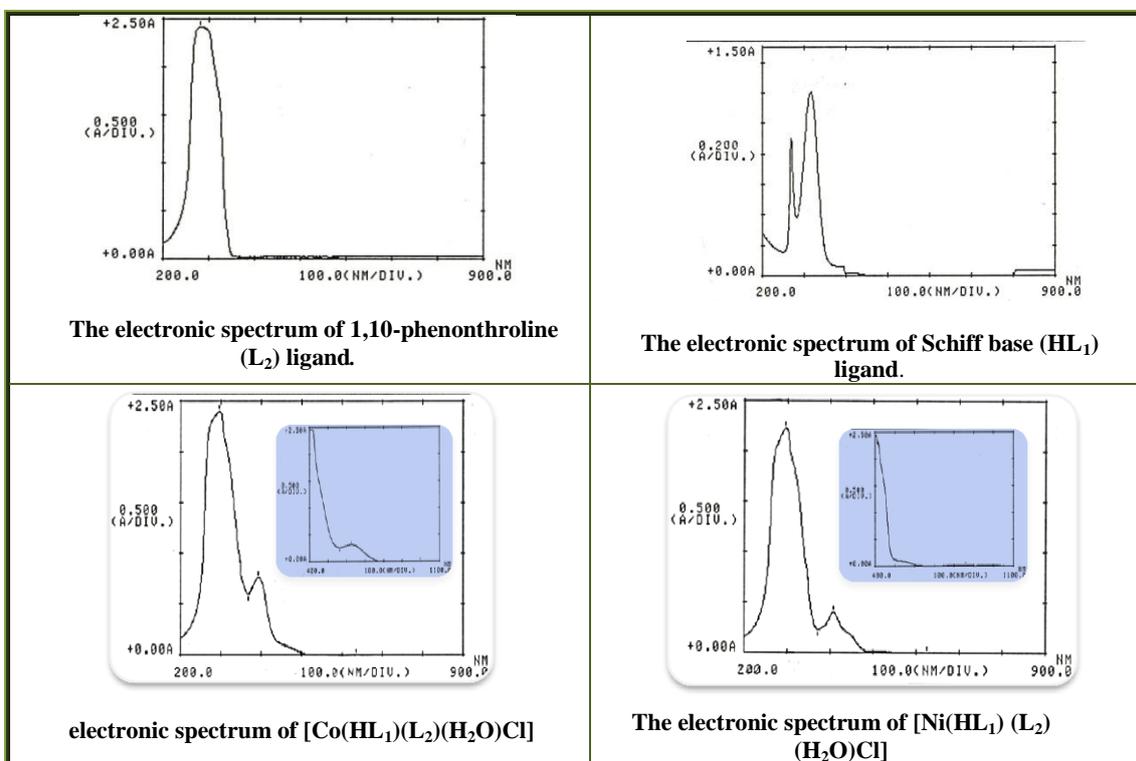
These transitions are indicate that the complex is octahedral geometry around the Iron (III) ion.

The electronic spectrum of Cadmium(II) complex shows three absorption bands, the first absorption band intensity appears at (295nm,  $33783\text{cm}^{-1}$ ) corresponding to ( $\pi \rightarrow \pi^*$ ) electronic transition, while the second absorption band is sharpe and of a high intensity and high molar absorptivity at (351nm,  $28490\text{cm}^{-1}$ ) attributed to ligand field (L.F.), the third band is a weak band and of a low absorption intensity with low molar absorptivity at (403nm,  $24813\text{cm}^{-1}$ ) due to the charge transfer (C.T.). According to these transitions, in addition to the results of microanalysis (C.H.N) and metal

Contain, we can suggest that an octahedral complex geometry around the Cadmium ion[19].All the spectra of the ligands are illustrated in **Figure(2)** and listed on **Table(4)**.

**Table (4): Electronic Absorption Spectra Data of Schiff Base Ligand (HL<sub>1</sub>), 1,10-phenanthroline (L<sub>2</sub>) and their Metal Complexes.**

Compounds	$\lambda_{max}$ (nm)	$\nu$ (cm <sup>-1</sup> )	$\epsilon_{max}$ Mole <sup>-1</sup> . l.cm <sup>-1</sup>	ABS.	Assignment	Suggested structure
1,10-phenanthroline (L <sub>2</sub> )	281	35587	2420	2.420	$\pi \rightarrow \pi^*$	-
C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub> (HL <sub>1</sub> )	269	37174	869	0.869	$\pi \rightarrow \pi^*$	-
	316	31645	1135	1.135	$n \rightarrow \pi^*$	-
[Co(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl]	295	33898	2393	2.393	$\pi \rightarrow \pi^*$	Octahedral
	400	25000	770	0.77	d-d	
	490	20408	100	0.1	${}^4T_{1g(F)} \rightarrow {}^4T_{1g(P)} (v_3)$	
	634	15773	21	0.021	${}^4T_{1g(F)} \rightarrow {}^4A_{2g(F)} (v_2)$	
	296	33783	2223	2.223	$\pi \rightarrow \pi^*$	
[Ni(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl]	372	26881	223	0.223	C.T	Octahedral
	408	24509	398	0.398	${}^3A_{2g(F)} \rightarrow {}^3T_{1g(P)}$	
	480	20833	251	0.251	${}^3A_{2g(F)} \rightarrow {}^3T_{1g(F)}$	
	626	15974	3	0.003	${}^3A_{2g(F)} \rightarrow {}^3T_{2g(F)}$	
	362	27624	1615	1.615	C.T	
[Cu(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl]	486	20576	10	0.10	L. F.	Octahedral
	597	16750	49	0.049	${}^2E_g \rightarrow {}^2T_{2g(D)}$	
	277	36101	2262	2.262	$\pi \rightarrow \pi^*$	
[Cr(HL <sub>1</sub> )(L <sub>2</sub> )Cl <sub>2</sub> H <sub>2</sub> O]	372	26881	265	0.265	$n \rightarrow \pi^*$	Octahedral
	408	24509	318	0.318	${}^4A_{2g(F)} \rightarrow {}^4T_{1g(P)}$	
	612	16339	11	0.011	${}^4A_{2g(F)} \rightarrow {}^4T_{2g(F)}$	
	272	36764	1736	1.736	$\pi \rightarrow \pi^*$	
[Fe(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl]Cl	293	34129	1743	1.743	$n \rightarrow \pi^*$	Octahedral
	426	23474	339	0.339	${}^6A_{1g} \rightarrow {}^4T_{1g}$	
	480	20833	361	0.361	${}^6A_{1g} \rightarrow {}^4T_{2g(D)}$	
	806	12406	24	0.24	${}^6A_{1g} \rightarrow {}^4T_{1g(G)}$	
	295	33783	2950	2.950	$\pi \rightarrow \pi^*$	
[Cd(HL <sub>1</sub> )(L <sub>2</sub> )(H <sub>2</sub> O)Cl]	295	33783	2950	2.950	$\pi \rightarrow \pi^*$	Octahedral



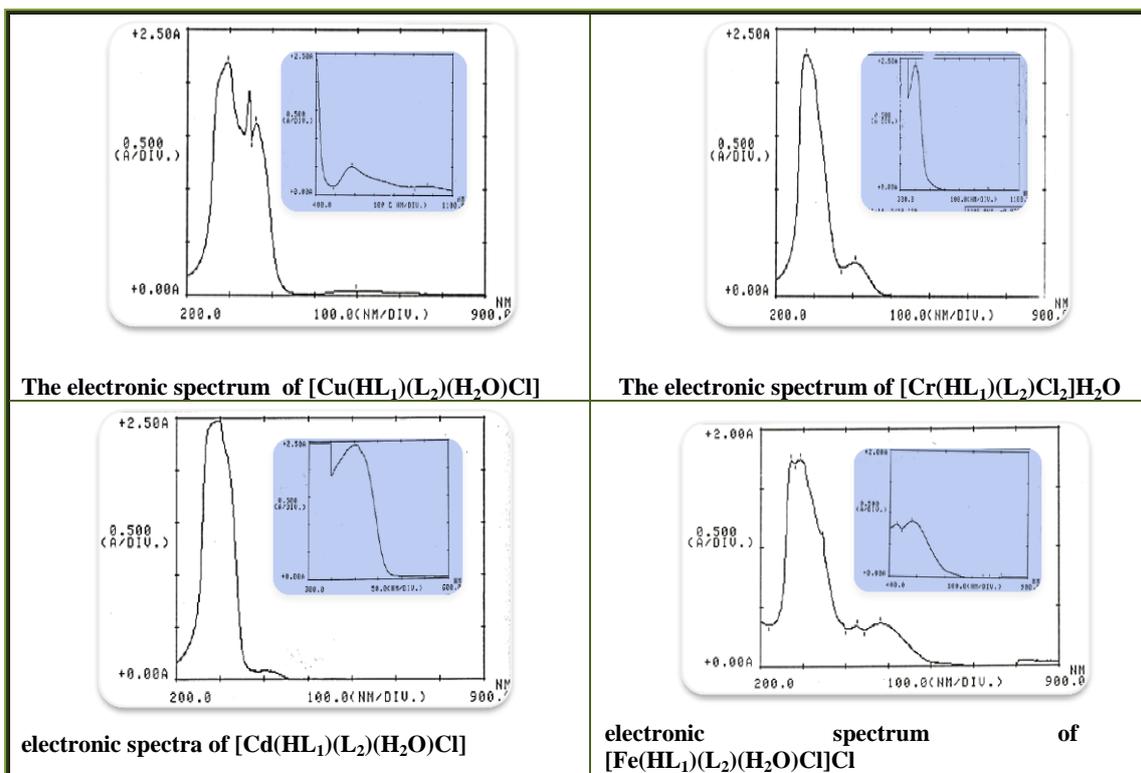


Fig. (2): The Electronic Spectrum for  $(HL_1)$ ,  $(L_2)$  and their Metal Ion Complexes.

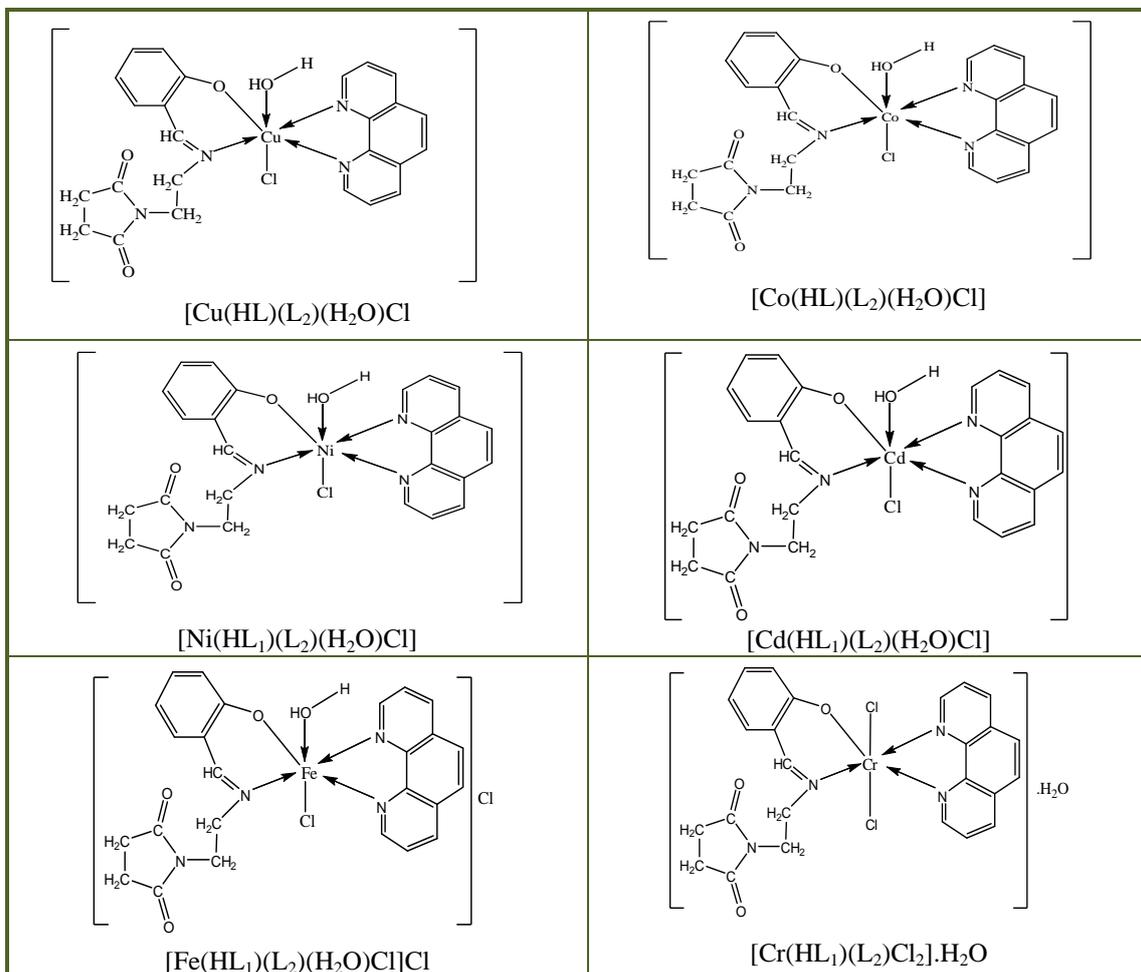


Fig. (3): The Suggested Structures for the Newly Prepared  $HL_1$ , Co-Ligand  $L_2$  and their Metal Ion Complexes.

**Conclusions:**

1. All the data of the infrared spectra of the metal complexes suggest that the metal ion is coordinated with the Schiff base ligand through the oxygen atom of phenol and the nitrogen atom of the azomethine groups.
2. According to the results, characterization of the metal complexes by using different techniques FT-IR, UV-Vis, C.H.N., magnetic moment and molar conductivity proposes an octahedral geometry for all the above prepared complexes.
3. The molar conductivity measurements of all the complexes indicate that these complexes are non-electrolytic nature.
4. The metal content and the (Chlorides %) ions in complexes determined and primary valences are neutralized by the chloride ion inside the coordination sphere for all the above complexes except the iron(III) complex neutralized by the chloride ion inside and outside the coordination sphere.
5. The magnetic measurements indicated that all the above metal complexes are paramagnetic, except the Cd(II) complex which is diamagnetic.

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## تحضير وتحليل طيفي لبعض معقدات ايونات الفلزات مع مزيج من الليكاندات ل-10,1- فينانثرولين وقاعدة شيف

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### الخلاصة:

تم خلط ليكاند قاعدة شيف الحر ( $HL_1$ ) الذي تم تحضيره مع الليكاند المشارك (10,1-فينونثرولين) ( $L_2$ ). بعد ذلك تم مفاعلة الناتج مع بعض املاح فلزات العناصر: ( $Cu^{+2}$ ,  $Ni^{+2}$ ,  $Cr^{+3}$ ,  $Co^{+2}$ ,  $Fe^{+3}$ ,  $Cd^{+2}$ ) للحصول على معقدات فلزات جديدة. شخخص الليكاند المحضر ومعقداته الفلزية بعدة تقنيات: مطيافية الاشعة تحت الحمراء ، اطياف (UV-Vis.) ، طيف الكتلة ، التوصيلية المولارية ، الحساسية المغناطيسية ، المحتوى الفلزي ، محتوى الكلورايد والتحليل الدقيقة (C.H.N). اظهرت النتائج تكوين ليكاند قاعدة شيف ومعقداته الفلزية. طبقت الانشطارات في ليكاند قاعدة شيف المحضر بواسطة تقنية طيف الكتلة. تتفق جميع التحاليل لليكاندات ومعقداتها الفلزية المحضرة بصورة جيدة مع قيم الحسابات النظرية والتي تظهر نقاوة قاعدة شيف ومعقداتها الفلزية. اظهرت البيانات اعلاه ان الشكل الهندسي المقترح لجميع المعقدات ثمانية السطوح.

الكلمات المفتاحية: معقدات ايونات الفلزات، تشخيص، مزيج ليكاندي، 10,1- فينانثرولين وقاعدة شيف.