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Synthesis, Spectroscopic, Characterization and Biological Activities of Schiff Base Ligand and Metal Complexes of Some Metal (II) Salts with Anthranilic Acid.

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ABSTRACT

Schiff base N,N'-Bis-(4-dimethylamino-benzylidene)-benzene-1,4-diamine has been synthesized from 4-dimethylaminobenzaldehyde and benzene-1,4-diamine. The structure of Schiff base was obtained by (C.H.N.) microanalysis, Mass, ¹HNMR, FT-IR and UV-Vis spectral methods and thermal analysis. Metal mixed ligand complexes of some metal(II) salts with Schiff base ligand and anthranilic acid were prepared in the molar ratio (1:2:2), (Metal):(SBL)₂:(Anthra)₂, (SBL)= Schiff base ligand, (Anthra) =anthranilic acid and Metal= Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II). The thermal behaviour (TGA) of the complexes was studied. The prepared complexes identified by using mass, thermal analysis, FT.IR and UV-Vis spectrum methods, on otherwise flame atomic absorption, magnetic properties and conductivity measurements. According, the characterization of the complexes from the mixture of anthranilic acid and the ligand prepared according to Schiff base ligand exhibited that the anthranilic acid make the coordination with metals (II) without existence of the Schiff base ligand. The coordination became Metal:(Anthra)₂, from The physico-chemical data suggested octahedral geometry for the all complexes. The Schiff base ligand, anthranilic acid and metal(II)- complexes were screened for antibacterial activity against *Staphylococcus epidermidies* and *Staphylococcus aureus* (Gram Positive Bacteria) as well as *Klebsiella* and *Escherichia coli* (Gram Negative Bacteria) by the agar well diffusion method.

Keywords: Anthranilic acid; transition metal complexes; mass spectra; thermal analysis and Bacteria-activities.

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INTRODUCTION

Schiff bases have received a great deal of attention in a wide variety of fields due to their simple synthesis and various applications. They can be readily synthesised by simple one-pot condensation of aldehydes and primary amines in an alcoholic solvent under anhydrous conditions. In azomethine derivatives, the Carbon and Nitrogen linkage is essential for biological activity, they are useful in catalysis inorganic synthesis and in medicine as antibiotics, antiallergic and antitumor agents. Formation of Schiff base generally takes place under acid or base catalysis or with heat. [1-5]. Over the past few years, there were numerous reports in their applications at biology including antibacterial, antifungal, anticancer, antioxidant, anti-inflammatory, antimalarial, antiviral efficacy as well also as catalyst by various reactions [6-8]. A 2-aminobenzoic acid (anthranilic acid), (Anthra) is very beneficial by synthesis from heterocyclic systems as well another molecules. It serves like a stellar biochemical precedent into aromatic amino acids as well it also forms a significant part from diversified alkaloids [9]. The acid and its derivatives are beneficial at unlike applications like produce sunscreen [10], perfumery [11] as well as monitoring of glycosylation of proteins [12]. Anti-convulsant [13] anti-inflammatory activity [14] of (Anthra) and its derivatives were reported. Some transition metal anthranilates have confirmed capacity with hydrogenation [13]. This research work reports the preparation of Schiff base ligand (SBL) was prepared and then attended the mixed ligand complexes of the (SBL), and (Anthra) in an aqueous alkaline with metal salts of the Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II). It was found, when the complexes were prepared, that the coordinated with the metals by only the (Anthra), but not associated with the (SBL). The resulting complexes have been described as well their biological activity has been scrutinized.

EXPERIMENTAL

Chemical and Instrumental

All the chemicals used in the work were of Analar grade (BDH / Aldrich) including 4-dimethylaminobenzaldehyde, benzene-1,4-diamine, anthranilic acid, metal salt such as Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) chloride as well solvents like ethanol, methanol, acetone, diethylether, calcium chloride, chloroform, benzene, carbontetrachloride, dimethylsulfoxide, N,N-dimethylformamide and distilled water were used.

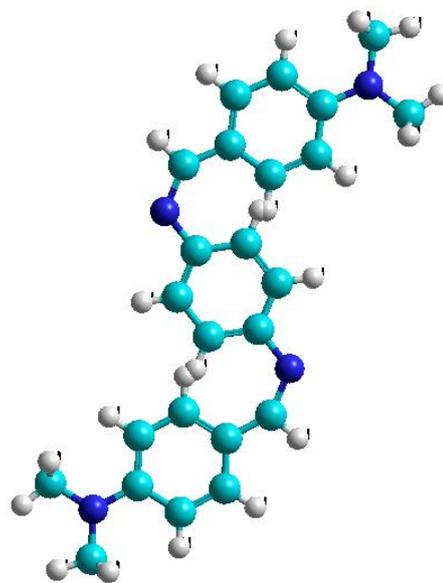
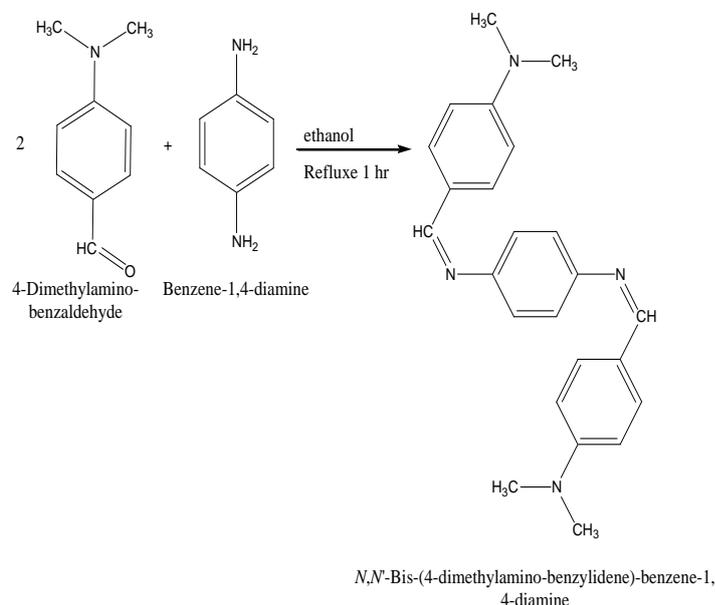
The FT-IR. for ligand [(SBL) and (Anthra)] and metal (II)- complexes were recorded in the range 4000-400 cm^{-1} as a (KBr) disc on FT-IR-600 FT-IR Spectrophotometer. UV-Visible spectra were measured by using Shimadzu-U.V-160 of the (SBL), (Anthra) and metal complexes. Ultraviolet spectrometer at 1.000 \pm 0.001 cm matched quartz cell in the range 200-1100 nm. The magnetic susceptibility values of the prepared complexes were estimated at room temperature using AutoMagnetic Susceptibility Balance Sherwood Scientific. The ^1H NMR spectrum for (SBL) was recorded by Nmr bruker400mhz in DMSO- d_6 with TMS as the internal standard. Mass spectra was recorded for (SBL) and metal complexes base by MS Model 5973 Network Mass Selection Technology (HP) with Triple -Axis Detector by the analyzer Quadrupole at 230 $^\circ\text{C}$. The measured molar conduct values (Λ_m) at DMSO solution to the (SBL), (Anthra) and metal(II)- complexes were measured at 25 $^\circ\text{C}$ with (0.001M) solution of the samples which uses CON 510 Conductivity. Elemental C.H.N microanalysis have been accomplished on (SBL) was nominated through the micro analytical unit at Euro EA Elemental Analyzer. When metal (II) contents of the complexes have been identified from before Atomic Absorption (A.A) Technique / Flame Emission Spectrophotometer using AA - 680 Shimadzu. The melting point of the compounds measured by using Stuart Melting Point Apparatus. Thermal analysis was Differential Scanning Calorimetry carried out on a STAPT- 1000 Lineseis (TGA) with a heating rate of 10 $^\circ\text{C}/\text{min}$ using Ar atmosphere for the (SBL) and metal(II)- complexes.

Synthesis of Schiff Base N,N'-Bis-(4-dimethylamino-benzylidene)-benzene-1,4-diamine (SBL)

The Schiff base of was synthesized of (1mmole) of benzene-1,4-diamine (0.108g) with (2mmol) of 4-dimethylaminobenzaldehyde (0.298g) of the addition of 5 drops of glacial acetic acid by the method of the Schiff base. The reaction mixture was refluxed for one hour, then the formed precipitate as orange solid has been filtrated, washed several times by ether and dried at a desiccator over calcium chloride. The yield from the reaction was 87%, m.p.=300 $^\circ\text{C}$, $\Lambda_m(\text{S.cm}^2.\text{mol}^{-1})$ in DMSO = 1.58. The following structure represents the formation of the Schiff base ligand (SBL) according to the Scheme (1). The (SBL) dissolved in ethanol, methanol, acetone, chloroform, DMSO and DMF, while non dissolve in carbontetracarbon, benzene and ether.

Synthesized Schiff base (SBL) by condensation of 4-dimethylaminobenzaldehyde and benzene-1,4-diamine. The ligand was identified by:

(C.H.N) microanalysis: The elemental microanalyses were carried out which includes C:H:N, as following : calculated for the ligand (SBL): C=77.79%, H= 7.09%, N= 15.12 % , Found: C= 78.92%, H = 8.67%, N = 15.78%. proposed model from the kinds has been built for chemical - 3D show at (Fig.1).



Scheme(1): Preparation of Schiff Base (SBL) of (SBL)

Figure (1) : 3D-Geometrical Structure

¹HNMR Spectrum of the (SBL) : The ¹HNMR spectrum of (SBL) in DMSO-d₆ solvent, appears chemical shift of CH proton of the azomethine [15] group was assigned at $\delta=8.40$ ppm. The spectrum displays various signals in $\delta=6.58-8.31$ ppm assigned into aromatic protons [16], the resonance in $\delta=1.11$ and 1.25 ppm due to methyl groups of (N-(CH₃)₂), the signals at $\delta=2.50$ ppm and $\delta=3.50$ indicated into DMSO-d₆ and water (H₂O) respectively, the ¹HNMR data clarified in the following (Fig. 2).

Thermal Analysis of the Ligand: The results of thermo gravimetric analyses of ligand. The thermograms have been carried out in the range of 25–600 °C at a heating rate of 10 °C/min in nitrogen atmosphere. They show an agreement in weight loss between their results obtained from the thermal decomposition and the calculated values, which supports the results of elemental analysis and confirms the suggested formulae. Thus, the ligand show in (Fig. 3) showed general behavior as the first step (C₁₅H₈N₃), was loss of C₉H₁₈N moiety followed by the other parts of the ligand. (L) = C₂₄H₂₆N₄ [95.6% Found (99.867% Cal)] (267– 326 °C) → C₁₅H₈N₃ [60.45% Found (62.080% Cal)] (406-596 °C) → C₉H₁₈N [35.15% Found (37.787%Cal)] [17].

Mass Spectrum of the (SBL): The prepared (SBL) has been measured by mass spectroscopy to provide the molecular weight from the Schiff base ligand (SBL). The peak in $m/e^+ = 370.3$ analogous to C₂₄H₂₂N₄⁺. The mass spectra of (SBL) according in (Fig. 4).

FT.IR Spectra from the (SBL) : Show FT.IR spectrum of Schiff base (SBL) in (Fig. 5). In the IR spectrum of (SBL) the stretching vibration of the $\nu(C=N)$ in the range 1685cm^{-1} [16]. Bands corresponding to (C–H) aromatic stretching in the range of 3075cm^{-1} , (C–H)aliphatic stretching in the range of 2983cm^{-1} , $\nu(C=C)$ aromatic in the range of 1595cm^{-1} [18-20].

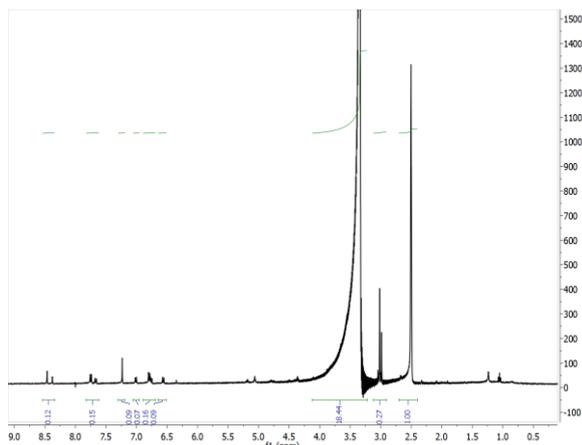


Figure (2): ¹H NMR Spectrum of (SBL) of (SBL)

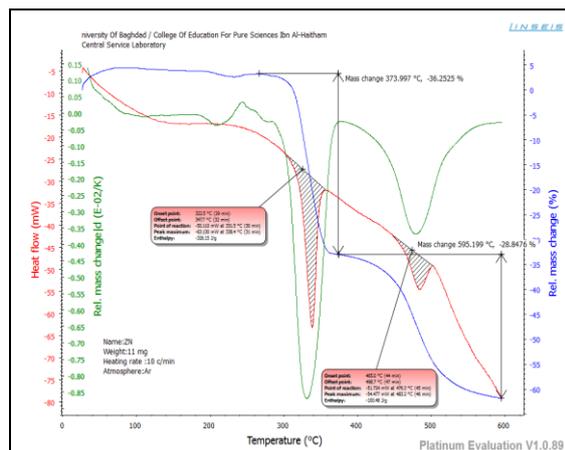


Figure (3): Thermal Gravimetric Analysis (TGA)

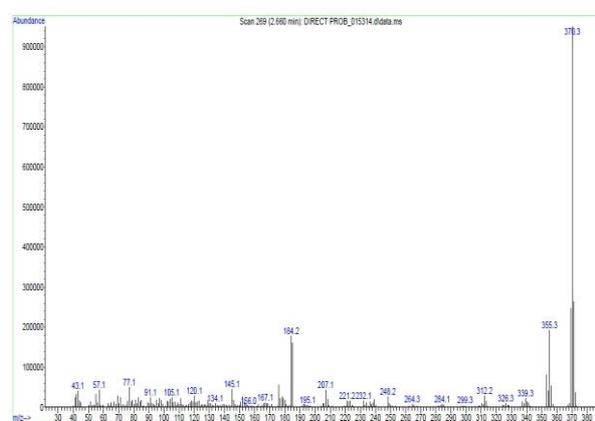


Figure (4): Mass Spectrum of the (SBL)

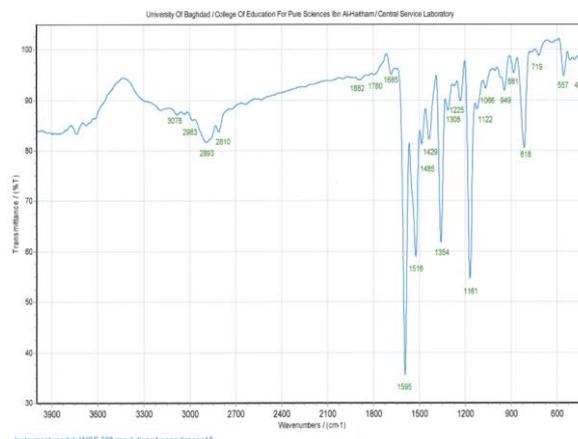


Figure (5): FT-IR spectrum of the (SBL)

UV.Spectra of the (SBL): The electronic absorption spectra of (SBL) recorded in DMSO in the range of 200-1100 nm. The electronic spectrum of free (SBL) three bands at 262 nm (38168 cm^{-1}), 323 nm (30959 cm^{-1}) and 401nm (24938 cm^{-1}) suggesting the presence of $\pi-\pi^*$ and $n \rightarrow \pi^*$ transition respectively, connected for the azomethine chromophore ($\text{HC}=\text{N}$) [3].

Synthesis of Metal (II)- Complexes :

To ethanolic solution of (80 cm^3) contains of (2 mmol) of the N,N'-Bis-(4-dimethylamino-benzylidene)-benzene-1,4-diamine (SBL) (0.740 g) and (40 cm^3) of ethanolic solution consisting of (2mmol) of the anthranilic acid (0.274g) with adding (2mmol) of sodium hydroxide (0.08gm) with (10 cm^3) of distilled water from a metal chloride (1.0 mmol) of the (0.238g) $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$, (0.238g) $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$, (0.170g) $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$, (0.136g) ZnCl_2 , (0.201g) $\text{CdCl}_2 \cdot \text{H}_2\text{O}$ and (0.271g) HgCl_2 were added under constant stirring. The precipitated colored solid metal complexes were filtered off under normal conditions and washed with distilled water dried over anhydrous calcium chloride in a vacuum desiccator.

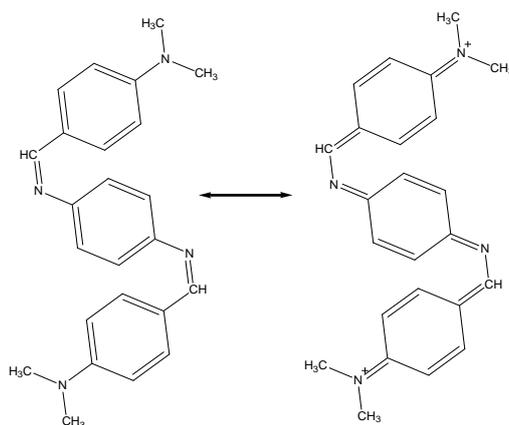
Biological Activity

The Schiff base (SBL), (Antra) and metal(II) complexes have been screened up against two Gram-positive (*Staphylococcus epidermidies* and *Staphylococcus aureus*) as well as two Gram-negative (*Klebsiella* and *Escherichia coli*) through well diffusion method [21] employing agar nutrient. The suspension from each a microscopic organism was added into a sterilized agar medium, thereafter poured into sterile Petri dishes as well left into solidification. The well has been dug within agar media utilizing sterilized metallic pricket during each dish. The test solution has been prepared through dissolving the compounds at DMSO and the well has been filled for the test solution employing micropipette. The dishes have been brood for (24h.) at the case for bacteria in 35°C . The extracts have been submitted into further check for a series through time based (24h.).

During this time the check solution has been prevalent as well influenced the growth from the vaccinated microorganisms. Activity has been determined through measuring the diameter for the zone showing whole inhibition (mm). Growth from inhibition has been likened for the control.

RESULTS AND DESCUTION

The solid complexes have been prepared through reaction from alcoholic solution for the ligands (SBL), (Anthra) for the alcoholic solution of the metal ions such as Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II). In a (M:SBL:Anthra) of (1:2:2). But after characterized of the complexes formed by physical methods and analysis of mass, thermal analysis, FT-IR, UV-Visible spectral as well magnetic measurements. Characterization of the complexes of mixture from a ligand (Anthra) and the ligand prepared according to Schiff base ligand (SBL) with metal(II) salts exhibited that the (Anthra) make the coordination with metal (II) without existence of the ligand (SBL). That could be attributed to the long range resonance of the ligand (SBL) as depicted in Scheme (2).



Scheme (2): The Shape Shows the Resonance State of the Ligand (SBL)

Isolated solid complexes were coloured powders, steady at air, non-hygroscopic within nature as well as insoluble on water, non-soluble on other common solvents, however easily soluble at N,N-dimethylformamide and dimethylsulfoxide. The melting points show that mostly complexes decomposed before melting except nickel and mercury complexes. The analytical datum in (Table 1) point such the metal to ligand ratio is (1:2) of (M:Anthra) for all the complex systems and the metal contents for these complexes have been at good agreements for the deliberated values (Table 1) contains the physical properties. Atomic absorption measurements content in (Table 1) with all complexes gave approximated values with theoretic values. Metal chelate solution at DMSO with 10^{-3} M the appearance molar conductance for the complexes, ranging of 6.21–25.70 $S\ cm^2\ mol^{-1}$ as well this supports the non-electrolyte nature of the complexes within the room temperature [22].

Table 1: Physical Properties of the Ligand and their Complexes

Compounds	Empirical Formula	Molecular weight (g/mol)	Color	M.P°C	Λ_m ($S\ cm^2\ mol^{-1}$) in DMSO	Elemental analysis Metal%	
						Calc.	Foun.
(Anthra)	$C_7H_7NO_2$	137.14	Pale-yellow	146-148	2.77	-	-
$[Co(Anthra)_2(OH_2)_2].5H_2O$	$[CoC_{14}H_{16}N_2O_6].5H_2O$	457.301	Pale-rose	320 Dec.	24.70	12.89	11.64
$Ni(Anthra)_2(OH_2)_2$	$NiC_{14}H_{16}N_2O_6$	367.19	Deep-rose	300 Dec.	27.10	16.04	15.17
$[Cu(Anthra)_2(OH_2)_2].2H_2O$	$[CuC_{14}H_{16}N_2O_6].2H_2O$	407.87	Pale-green	293-295	10.77	15.56	14.69
$Zn(Anthra)_2(OH_2)_2$	$ZnC_{14}H_{16}N_2O_6$	373.67	Pale-	300	6.21	17.50	16.46

			brown	Dec.			
[Cd(Anthra) ₂ (OH ₂) ₂].4H ₂ O	[CdC ₁₄ H ₁₆ N ₂ O ₆].4H ₂ O	492.76	Brown	300 Dec.	16.55	22.81	21.09
[Hg(Anthra) ₂ (OH ₂) ₂].2H ₂ O	[HgC ₁₄ H ₁₆ N ₂ O ₆].2H ₂ O	544.91	Deep- brown	250- 253	25.70	36.81	35.68

Dec= decompose

Thermal analysis of the Zn (II) complex: The results of thermo gravimetric analyses of Zn(II) complex. The thermograms have been carried out in the range of 25–600 °C at a heating rate of 10 °C/min in nitrogen atmosphere. They show an agreement in weight loss between their results obtained from the thermal decomposition and the calculated values. The Zn(II) complex show in (Fig.) Showed a common behavior as the first step (2H₂O +C₇H₈O₂) was loss of C₇H₈N₂O₃ and ZnO moiety followed by the other parts of the complex. Furthermore, the final step of the thermofly reactions of the complexes was found to give the metal oxide (complex) = C₁₄H₁₆N₂O₆Zn [86.728% Found (87.777% Cal) (91.5-293 °C) → 2H₂O +C₇H₈O₂ [44.75% Found (42.818% Cal)]. (317.6 - 596 °C) → C₇H₈N₂O₃ [41.978% Found (44.959%Cal) and faina (ZnO) [13.272% Found (12.223% Cal)]. [17].

Mass Spectra of Metal(II)- Complexes: The mass spectra of (Fig. 7) of the some metal(II)- complexes . Displayed peaks refered in the molecular ions m/z at 457.30, 367.19, 407.87, 373.67, 492.76 and 544.91 M⁺ into Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) complexes, Consecutively. That datum is at good convention for suggesting molecular formulation into the complexes. The mass spectral data backing the structures of transition metal complexes. The suggested molecular formula of these complexes was provened through resembling their molecular formula weights with m/z values. Structural probability models with the types have been built on chem.3D of complexes according of (Fig. 8).

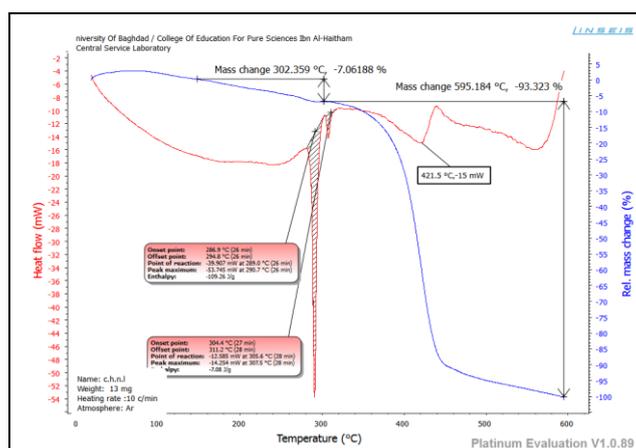
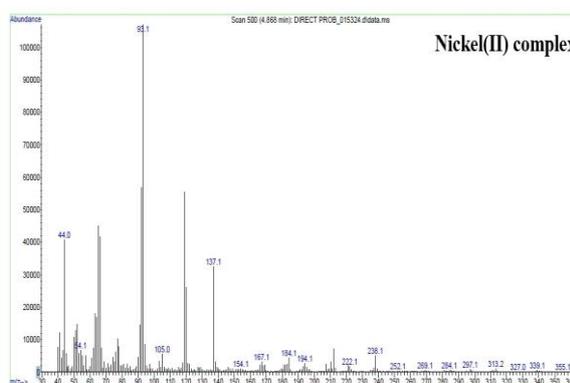
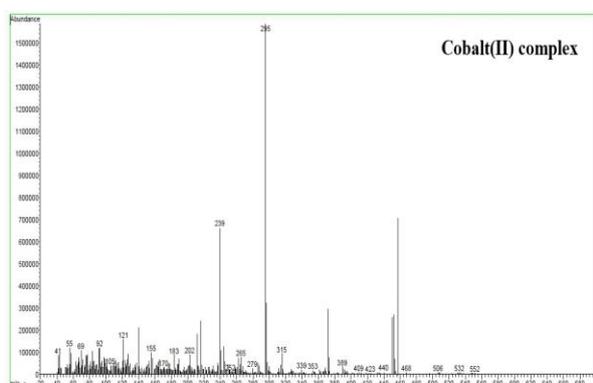


Figure (6): Curve (TGA) of the Zn(II) Complex



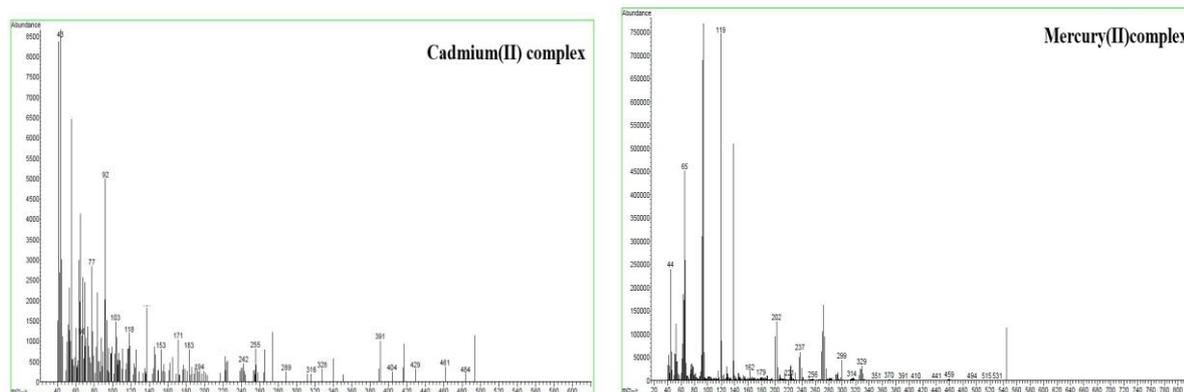


Figure (7): Mass Spectra of some metal Complexes

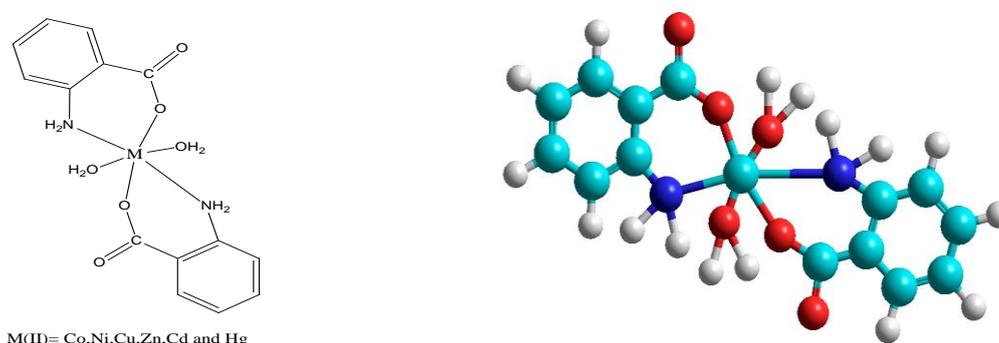


Figure (8): The Proposed Structure and 3D- Geometrical Structure to the Complexes

IR Spectral Studies: FT-IR spectral for the ligand (Anthra) as well the prepared complexes were compared, and the datum was tabulated at (Table 2) and [(Anthra) and Ni(II)- complex] in (Fig. 9, 10) , respectively. The FT-IR spectra of ligand (Anthra) displayed broad band in 3581 cm^{-1} , whom has been assigned into the stretching vibration for $\nu(\text{OH})$ group, that band disappear at the all spectral for complexes lead to coordinated of this group in coordination [23]. Bands at 3373 and 3064 cm^{-1} which were attributed to $\nu(\text{NH}_2)$ group, suffered a great change for less frequency has been observed during complexation for metal ion, lead to coordinated of this group in coordination [24]. The bands at 1568 cm^{-1} and 1308 cm^{-1} have been appointed into stretching vibration of $\nu(\text{COO}^-)$ asymmetric and symmetric respectively, By complexation these bands were shifted into lower as well higher frequencies [25]. The presence of water in the spectra for all complexes have been suggested by the very broad absorption bands around $3294\text{-}3597\text{ cm}^{-1}$ and show peaks at $(748\text{-}756)\text{ cm}^{-1}$ due to stretching, rocking and wagging modes of coordination water molecules [26]. A few new bands have weak density observed at the areas about $(515\text{-}577)\text{ cm}^{-1}$ and $(420\text{-}517)\text{ cm}^{-1}$ may be ascribed to $\nu(\text{M-N})$ and $\nu(\text{M-O})$ vibration respectively [27-28]. The results showed that the ligand (Anthra) coordinated with metal ions like bidentate ligand by the oxygen atom for the carboxylate acid ($-\text{COO}^-$) as well the nitrogen atom for the amine group ($-\text{NH}_2$).

Table 2: FT-IR Spectral Data for the Ligand (Anthra) as well its Metal Complexes(cm^{-1})

Compounds	$\nu(\text{OH})$ (COOH)	$\nu(\text{H}_2\text{O}) +$ $\nu(\text{NH}_2)$	$\nu_{\text{asym}}(\text{COO})$ and $\nu_{\text{sym}}(\text{COO})$	$\delta(\text{H}_2\text{O})$	$\nu(\text{M-N})$	$\nu(\text{M-O})$
(Anthra)	3581 br.	-	1568 s. 1308 sh.	-	-	-
[Co(Anthra) ₂ (OH ₂) ₂].5H ₂ O	-	3425 br. 3311 sh. 3145 s.	1535 sh. 1336 s.	752 w.	517 w.	474 w.

Ni(Anthra)₂(OH₂)₂	-	3298 sh. 3219 br. 3128 sh.	1541 sh. 1323 s.	748 w.	525 w.	471 w.
[Cu(Anthra)₂(OH₂)₂].2H₂O	-	3448 br. 3282 sh. 3120 sh.	1556 sh. 1377 sh.	752 w.	517 w.	482 w.
Zn(Anthra)₂(OH₂)₂	-	3294 sh. 3226br 3172 sh.	1539 sh. 1331 s.	750 w.	515 w.	420 w.
[Cd(Anthra)₂(OH₂)₂].4H₂O	-	3448 br. 3290 sh. 3132 sh.	1547 sh. 1321 s.	748 w.	577 w.	517 w.
[Hg(Anthra)₂(OH₂)₂].2H₂O	-	3597 br. 3261 sh. 3064 s.	1512 sh. 1375 sh.	756 w.	542 w.	459 w.

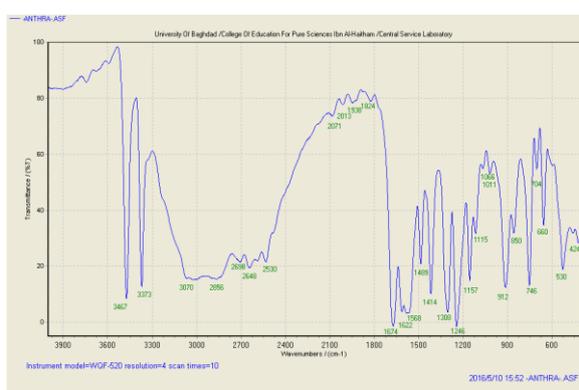


Figure (9): FT-IR Spectra for the Ligand (Anthra)

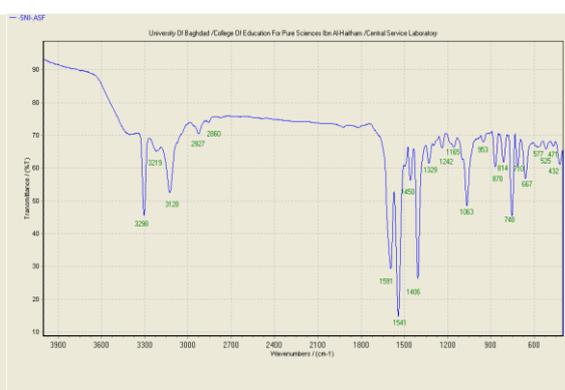


Figure (10): FT-IR Spectra for the Ni-Complex

Absorption Spectral Studies and the Magnetic Moment: The UV-Vis spectra of the (Anthra) and metal(II) complexes resolved in DMSO (10^{-3} M) were deliberated and the datum comprised at (Table3). Spectral for (Anthra) shows peaks in 261 and 347 nm due into (π - π^*) and (n - π^*) electronic transition [29].

Spectrum for Co(II) complex display three peaks in 261,348 as well 397 nm due into ligand field and charge transfer (C.T.), respectively, other peak in 815 nm assigned into electronic transition type ${}^4T_1g(F) \rightarrow {}^4T_2g(F)$ suggesting an octahedral environment around the cobalt ion [23, 26] . The Ni(II) complex exhibited two proposing absorption peaks in 279 as well 347 nm due into ligand field. Other two peaks in 769 and 818 nm have been assigned into electronic transition type ${}^3A_{2g} \rightarrow {}^3T_{1g}(F)$ and ${}^3A_{2g} \rightarrow {}^3T_{2g}(F)$ respectively into octahedral geometry [30]. Cu(II) complex appears three peaks at 288,324 and 345 nm due into ligand field, while third peak at 750 nm described into electronic transition type [31] ${}^2E_g \rightarrow {}^2T_{2g}$. Magnetic estates to the compounds were occurred into a paramagnetic that has been accounted to octahedral structure, paramagnetic compounds will be attracted whilst diamagnetic compounds repulsed at a magnetic field. Subsequently, paramagnetic materials will have positive sensitivities. So, magnetic susceptibility measures locate geometry to the complexes. Magnetic susceptibility measurements displayed that Co(II), Ni(II) and Cu(II) complexes have paramagnetic characters and have octahedral and the complexes are further supported by the observed magnetic moment value from the Co(II) complex is the magnetic moment of 5.12 BM corresponds to this high spin geometry[32]. The magnetic moment value with the Ni(II) complex from the ligand has been found to be (2.92 B.M)[33]. The Cu(II) complex acquired value for the efficient magnetic moment (1.9 B.M.) is model the octahedral Cu(II) chelates [34]. But the magnetic susceptibility of Zn(II), Cd(II) and Hg(II) complexes offers that three complexes have diamagnetic moments, because complexes could not exhibit any d-d. The electronic transitions due to its completely filled d^{10} electronic configuration. The three the complexes from six coordination have been suggested the octahedral structures [35-36].

Table 3: Electronic Spectral and Magnetic Susceptibility Measurements Datum

Compounds	λ (nm)	ABS	Wave number (cm ⁻¹)	ϵ_{\max} (L.mol ⁻¹ .cm ⁻¹)	μ_{eff} (B.M)	Suggested Molecular formula
(Anthra)	261 347	0.520 1.165	38314 28818	520 1165	-	-
[Co(Anthra) ₂ (OH ₂) ₂].5H ₂ O	261 348 397 815	0.549 0.909 0.638 0.034	38314 28735 25188 12269	549 909 638 34	5.12	Octahedral
Ni(Anthra) ₂ (OH ₂) ₂	279 347 769 818	2.393 1.218 0.067 0.057	35842 28818 13003 12249	2393 1218 67 57	2.92	Octahedral
[Cu(Anthra) ₂ (OH ₂) ₂].2H ₂ O	288 324 345 750	1.525 1.513 1.722 0.237	34722 30864 28985 13333	1525 1513 1722 237	1.90	Octahedral
Zn(Anthra) ₂ (OH ₂) ₂	262 326	0.889 1.834	38167 30674	889 1834	Dia	Octahedral
[Cd(Anthra) ₂ (OH ₂) ₂].4H ₂ O	263 320	1.014 2.025	38022 31250	1014 2025	Dia	Octahedral
[Hg(Anthra) ₂ (OH ₂) ₂].2H ₂ O	263 323	0.941 1.130	38022 30959	941 1130	Dia	Octahedral

Biological Activities: In this research antibacterial bio effects of the ligand (SBL), (Anthra) and metal(II)-complexes were tested against four bacterial samples namely: *Staphylococcus epidermidis* and *Staphylococcus aureus* (Gram Positive Bacteria) as well as *Klebsiella* and *Escherichia coli* (Gram negative Bacteria) by agar well diffusion method using Mueller Hinton agar medium for antibacterial activity. The diameter for inhibition zones have been measured and expressed at millimeters (mm). Metal complexes of Cd(II) and Hg(II) complexes were showed higher antibacterial activity than (SBL), (Anthra) and the rest of other complexes [37]. The biological efficacy of ligand as well its metal complexes were showed in the (Table 4) and (Fig.11).

 Table 4: Zone for Inhibition Zone at (mm) by Ligands and Metal(II) Complexes at Concentration of (1x10⁻³)

Compounds	<i>Staphylococcus epidermidis</i> (G+ev)	<i>Staphylococcus Aureus</i> (G+ev)	<i>Klebsiella</i> (G-ev)	<i>Escherichia. Coli</i> (G-ev)
(SBL)	10	12	-	-
(Anthra)	10	-	-	11
Co.comp.	13	-	10	12
Ni.comp.	12	11	10	-
Cu.comp.	-	12	-	-
Zn- comp.	15	12	-	-
Cd.comp.	25	20	20	20
Hg.comp.	30	30	21	26

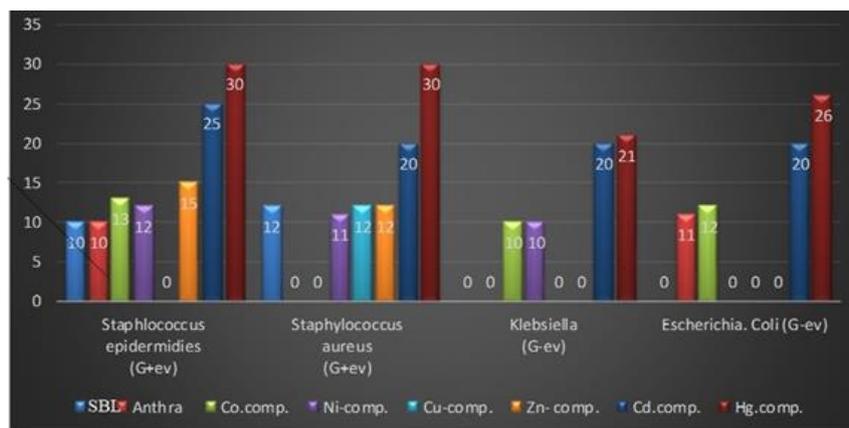


Figure (11): Biological efficacy for the Ligands (SBL), (Anthra) as well Metal(II) Complexes

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