

ARTICLE / INVESTIGACIÓN

Synergism antibacterial activity for novel synthesized Schiff base ligands and semi-thiosemicarbazones with β -diketones and 4-aminoantipyrineReham H. Najem v¹ and Hasan A. Hasan^{2,*}

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Abstract. Schiff base ligands were synthesised in this work, the first is (Z)-2-((Z)-3-((1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl)imino)-1,3-diphenylpropylidene) hydrazine-1-carboxamide, the second is (Z)-2-((1E,5Z,6E)-5-((1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl)imino)-1,7-bis(4-hydroxy-3-methoxyphenyl)hepta-1,6-dien-3-ylidene)hydrazine-1-carbothioamide. The Schiff base ligands both were synthesised using the same method (the single pot reaction), using EtOH as the reaction medium and GAA as the catalyst in fixed temperature at 70 °C and reflux for 6 hrs. The starting materials of HL1 were semicarbazide, 4-aminoantipyrine and dibenzoyl methane, while the starting materials of HL2 were TSC, 4-AAP and Curcumin.

The ligands proved to be bi-dentate ligands that coordinate from the azomethane groups. FT-IR, U.V-Visible, ¹H and ¹³C-NMR, molar conductivity, and magnetic susceptibility were used to identify all the compounds produced. The metal ions used in preparing the complexes in this work were Co(II), Cu(II) and Cr(III). Schiff base and its complexes were evaluated for antibacterial activity against four bacterial strains of Gram-negative (*Escherichia coli* and *Pseudomonas aeruginosa*), Gram-positive (*Staphylococcus aureus* and *Bacillus Subtilis*) and two types of fungi (*Candida albicans* and *Rhizopus Sporium*), the results were positive for all compounds tested.

Keywords: Schiff base, Curcumin, 4-aminoantipyrine

Introduction

During the past few decades, the Schiff base metal complexes have been under attention due to their role in coordination chemistry, easy preparation, and the diversity of their structure. Schiff base is considered a bioactive compound; for example, these compounds behave as anti-cancer agents. The free ligands have a weaker biological effect when compared to their metal complexes^{1,2}. Antipyrines played an essential role in drug development fields; also, they helped in monitoring and observing patients with chronic liver illness (Hepatitis B virus (HBC), hepatitis C virus (HCV) and alcohol-related disease)^{3,4}. 4-aminoantipyrine condensation with suitable compounds such as ketones, aldehydes, thiosemicarbazones, carbazones or compounds with a similar structure results in flexible ligands which can coordinate with various metal ions⁵. β -diketones based Schiff base ligands have an important role in developing coordination chemistry; also, they play an important role in biochemical systems⁶. In this study, the β -diketones used are Curcumin and dibenzoyl methane; both are known for their biological activity and behavior as antihyperglycemic, anti-inflammatory, anti-cancer, insecticidal, anti-Alzheimer's, gastroprotective, antifungal, antibacterial agents⁷. Also significant are semicarbazones and thiosemicarbazones; they are made up of the scaffolds NH₂-CO-NH-NH- and NH₂-CS-NH-NH- respectively.

Thiosemicarbazones' and semicarbazones' capacity to coordinate with transition and main group metallic cations is due to the extended delocalization of electron density over their skeleton, which is increased by substitution at the N (4)-position^{8,9}. The goal of this study was to synthesize and characterize Schiff bases with two azomethine groups derived from diketones (Curcumin and dibenzoylmethane), 4-amino antipyrine, semicarbazide and thiosemicarbazide, in order to test the ligand and its complexes' efficient biological activity against various types of bacteria and fungi.

Materials and methods

The device used to measure the melting point is (MPA160 Digi Melt); a device type (jew wary, model 4070) was used to measure the molar conductivity of the metal complexes. The FT-IR spectroscopy was evaluated using (Shimadzu FT-IR 8400S) spectrophotometer. The UV-Vis spectra of the ligands and their transition metal complexes were recorded in DMSO at 0.001M using (the UV 160A Shimadzu apparatus). Balance Johnson Matthey device was used to measure the magnetic susceptibility of the metal complexes, and NMR spectroscopy was recorded using device type (Inova 500). Finally, The Mass spectrum was recorded using (Sciex Esi) spectrometer.

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Synthesis of Schiff base ligand HL¹

For the preparation of HL¹ a mixture of 4-aminoantipyrine, semicarbazide and dibenzoylmethane was refluxed for six hrs. with stirring at a fixed temperature of 70 °C. after that, the solution was left to evaporate for a day the resulted ligand was a yellow-colored, needle-shaped crystal and odorless.

The structure was confirmed by the data collected from elemental analysis, FT-IR, ¹H-NMR and ¹³C-NMR; the synthesis of the ligand and it complexes is illustrated in Figure 1. HL¹ : (Z)-2-((Z)-3-((1,5-dimethyl-3-oxo-2-

phenyl-2,3-dihydro-1H-pyrazol-4-yl)imino)-1,3-diphenylpropylidene) hydrazine-1-carboxamide. Yield: 75 %, elemental analysis found% :69.49 C, 5.621 H, 18.11 N, 6.78 O, Calculated%: 69.51 C, 18.01 N, 5.66 H, 6.86 O. IR (KBr): 1624 (C=N), 1670 (C=O), 3398(NH), 3210 and 3175 (NH₂). ¹H-NMR (δ/ppm): 2.44 (s, 3H, C-CH₃); 3.21 (s, 3H, N-CH₃); 10.74 (s, N-H), 7.33-7.71(m, 15H aromatic); 7.21 (s, NH₂). ¹³C-NMR δ/ppm: 150.69 and 161.85 (C=N), 124.86-137.60 (Caromatic), 157.67 and 159.69, 12.76 (C-CH₃), 37.32 (N-CH₃), 41.15 (CH₂).

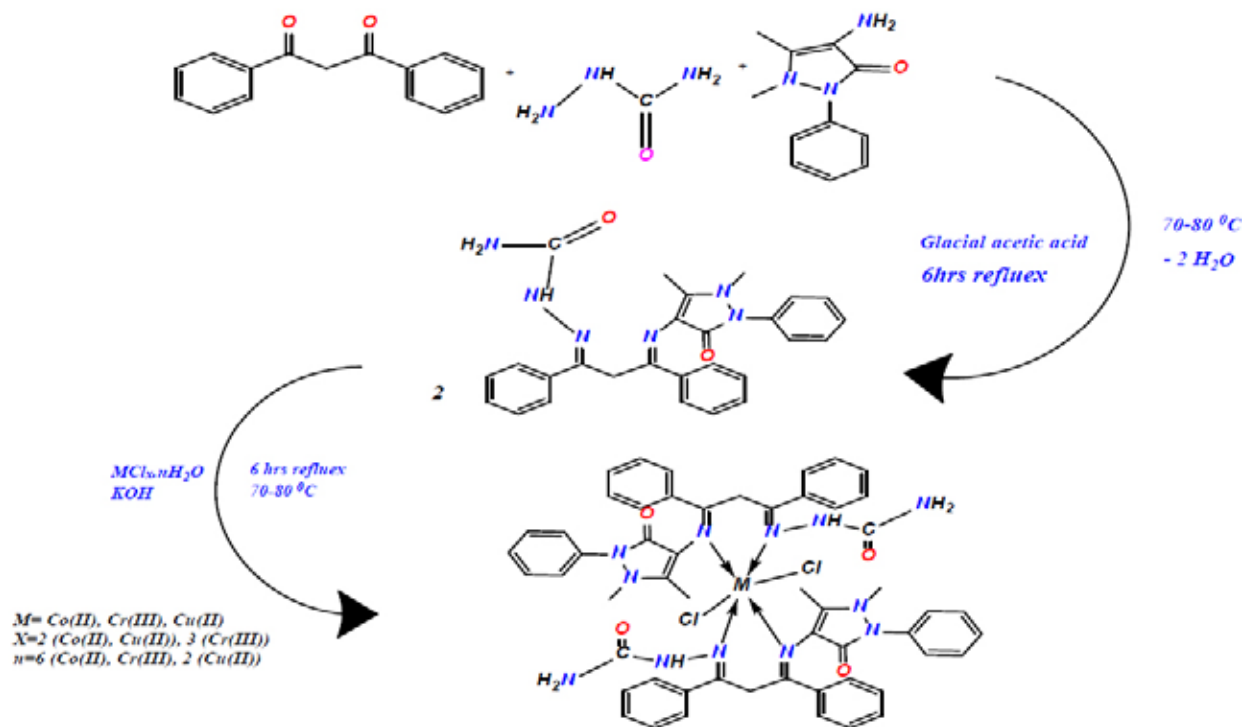


Figure 1. Synthesis route for HL¹ and its metal complexes

Synthesis of Schiff base ligand HL²

Curcumin (0.368 gm, 1 mmol) was dissolved in 20 ml ethanol, then adding four drops of GAA as a reaction catalyst, 0.204 grams (1mmol) 4-aminoantipyrine dissolved in 20 mL ethanol and 0.09 gm (1mmol) thiosemicarbazide dissolved in 20 mL ethanol were all progressively added at the same time. This mixture was refluxed by stirring at 70 °C for 6 hours; TLC was used to monitor the reaction. A dark brown precipitate was isolated and recrystallized from hot ethanol. The structure was confirmed by the data collected from elemental analysis, FT-IR, ¹H NMR and ¹³C NMR. The synthesis of the ligand is illustrated in Figure 2. [HL²]: (Z)-2-((1E,5Z,6E)-5-((1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl)imino)-1,7-bis(4-hydroxy-3-methoxyphenyl)hepta-1,6-dien-3-ylidene)hydrazine-1-carbothioamide. Yield: 77%. Elemental analysis, calculated for C₃₁H₃₀N₆O₃S: C 65.71, H 5.34, N 14.83, O 8.47, S 5.66%. The analysis found: C 65.64, H 5.39, N 14.92, O 8.51, S 5.54 %. IR (KBr, cm⁻¹): ν (C=O) 1670, ν (C=N) 1627, ν (N-H) 3441, ν (C=S) 817. ¹H NMR (δ/ppm): 2.44 (s, 3H, -CH₃-C); 3.21 (s,

3H, -CH₃-N); 10.69 (s, N-H), 7.33-7.51(m, 15H aromatic); 9.23 (s, NH₂), 9.35 (O-H), 4.26 (s, 2H, NC-CH₂-CN). ¹³C NMR δ/ppm: 150.69 and 161.85 (C=N), 124.86-137.60 (Caromatic), 157.67 and 159.69 (HC=CH), 12.76 (C-CH₃) and 37.32 (N-CH₃), 41.15 (CH₂).

Synthesis of metal complexes

a) [HL¹] complexes: complexes were prepared by dissolving 0.466 gm (1mmol) of HL¹ ligand in 10 ml ethanol, followed by adding an equivalent of KOH (0.5 mmol) of the metal salt (CoCl₂.6H₂O, CuCl₂.2H₂O, CrCl₃.2H₂O) dissolved in 3 ml ethanol which was added as dropwise on the mixture of the ligand with KOH, the mixture was refluxed for 6hrs with continuous stirring at fixed temperature 70-80 °C. The mixture was filtered, and the participants washed several times with cold ethanol and then recrystallized from hot ethanol. Figure 1 depicts the suggested geometry of the recrystallized structures.

b) [HL²] complexes: In 20 mL of ethanol, 0.627 gm (1mmol) of the Schiff base (ligand) was dissolved, and the equivalent of KOH was added; the solution of the

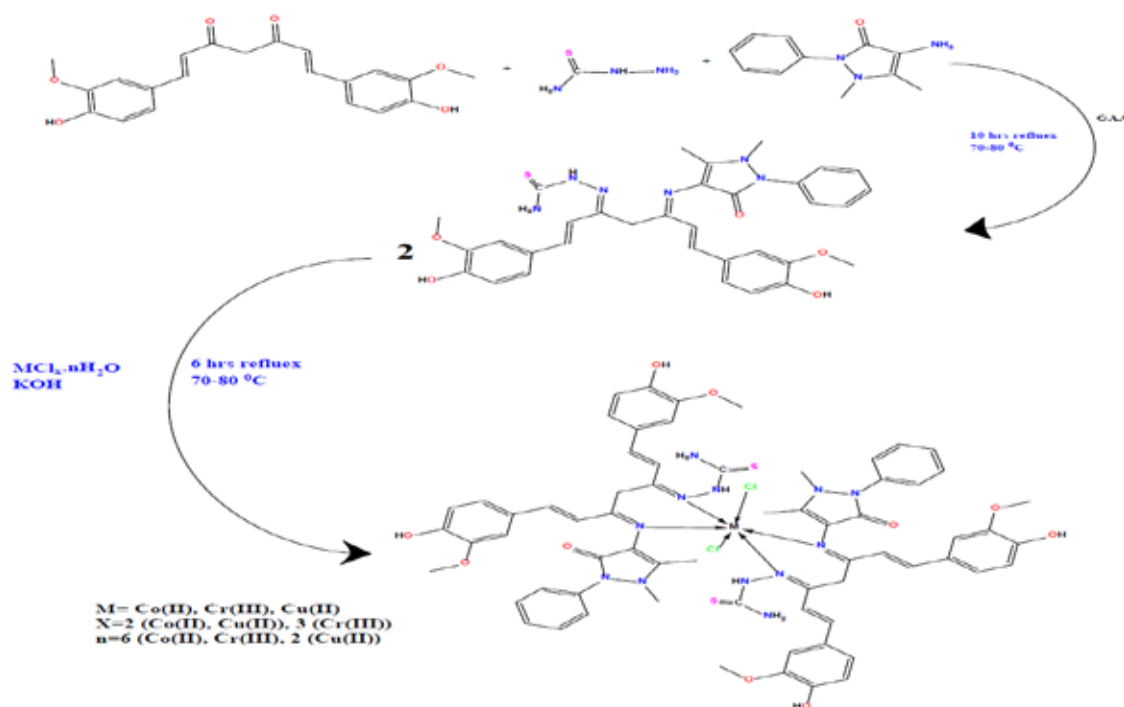


Figure 2. Synthesis route for HL² and its metal complexes

metal chloride (0.5 mmol) was added dropwise addition with continual stirring and reflux for 6 hours at fixed temperature 70-80 °C, (3 mmol) of CoCl₂·6H₂O, CuCl₂·2H₂O, CrCl₃·2H₂O (dissolved in 3 mL ethanol) was added progressively to the mixture. The residues that formed were separated, rinsed with cold ethanol multiple times, and then recrystallized from hot ethanol. The proposed geometry of the recrystallized structure is shown in Figure 2.

Results

All complexes were generally synthesized by reacting the metal salts with the Schiff base in a 1:2 mole ratio (metal salts: Schiff base). All of the complexes were colored solid compounds. Table 1 shows that the analytical findings corresponded with the proposed formula of a 1:2 metal: Schiff base molar ratio. The complexes synthesized using HL¹ were soluble in dimethylformamide and dimethyl sulfoxide, and it has partial solubility in chloroform, ethanol, methanol and water. In contrast, the complexes of HL² were soluble in water, DMSO and DMF and had a partial solubility in ethanol and methanol. Some of the physical and chemical characteristics are shown in Table 1.

FT-IR spectra

The spectrum of Schiff base ligands showed a band at 1624 cm⁻¹ that referred to the imine group in HL¹ and 1627 cm⁻¹ for HL² ligand, also a band appeared at 1670 cm⁻¹ that assigned to the carbonyl group (C=O), the thione band was assigned at 817 cm⁻¹ for HL². The NH indicating band is set for HL¹ at 3441 cm⁻¹ and 3417 cm⁻¹ for HL², and the OH group band of [HL²] appears at 3525 cm⁻¹ 10-13. Otherwise, the spectrum of the complexes showed shifting in the imine band, and the shifting range was 1600-1624cm⁻¹; the carbonyl group and the thione group did not show any noticeable shifting, which means the two groups did not participate in the coordination with the metal ions. Also, new bands for stretching frequencies of M-N have been allocated at 460-420 cm⁻¹ 14. Another band was observed at a range of 243-260 cm⁻¹; indicating the formation of the M-Cl coordination bond 11. The data are listed in Table 2, and the FT-IR spectrum is shown in Figures 3 and Figure 4.

Compounds	M.Wt	M.P	Color	Yield%
HL ¹ (Schiff base) C ₂₇ H ₂₆ N ₆ O ₂	466	228-230	Yellow	80
[Co(HL ¹) ₂ Cl ₂]	1062	284-286	Green	73
[Cr(HL ¹) ₂ Cl ₂]Cl	1055	280-282	Green	77
[Cu(HL ¹) ₂ Cl ₂]	1067	190-192	Brown	65
HL ² (Schiff base) C ₃₃ H ₃₄ N ₆ O ₅ S	627	241-243	Brown	88
[Co(HL ²) ₂ Cl ₂]	1383	170-172	Dark Green	68
[Cr(HL ²) ₂ Cl ₂]Cl	1376	190-192	Green	88
[Cu(HL ²) ₂ Cl ₂]	1388	216-217	Brown	60

Table 1. Some of the physical and chemical characteristics of the synthesized compounds

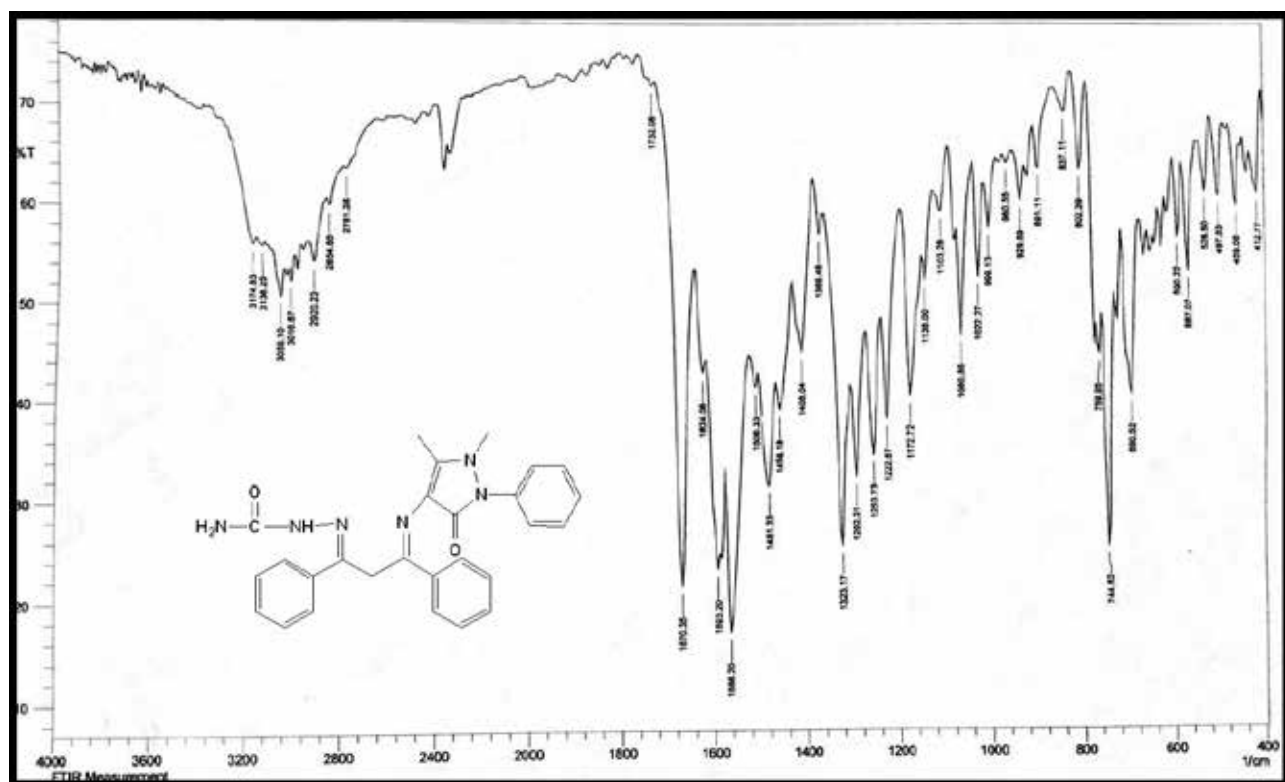


Figure 3. FT-IR spectrum of HL1

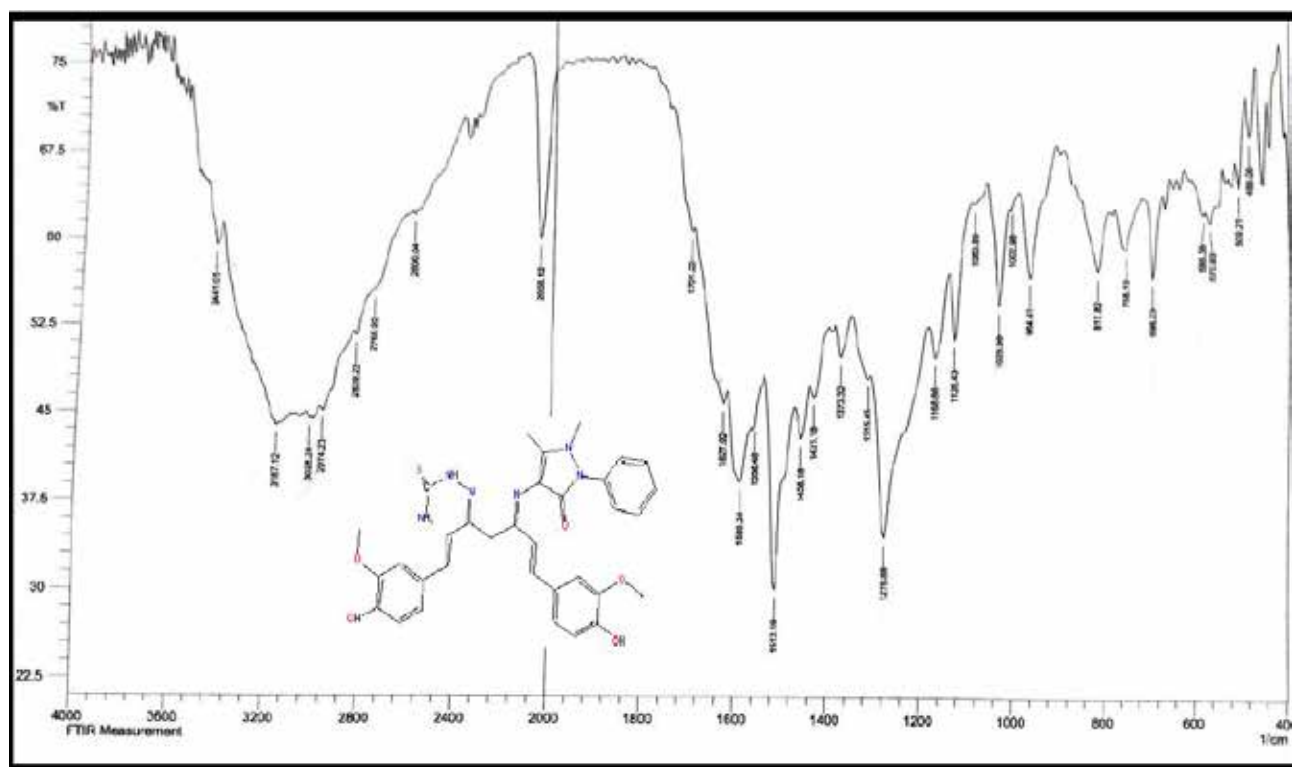


Figure 4. FT-IR spectrum of HL2.

Compounds	C=N	NH	C=O	C=S	M-N	M-Cl
HL ¹ (Schiff base) C ₂₇ H ₂₆ N ₆ O ₂	1624	3441	1670	-----	-----	-----
[Co(HL ¹) ₂ Cl ₂]	1600	3410	1670	-----	468	260
[Cr(HL ¹) ₂ Cl ₂]Cl	1616	3414	1670	-----	466	250
[Cu(HL ¹) ₂ Cl ₂]	1620	3414	1670	-----	466	245
HL ² (Schiff base) C ₃₃ H ₃₄ N ₆ O ₅ S	1627	3417	1670	817	-----	-----
[Co(HL ²) ₂ Cl ₂]	1620	3441	1670	816	460	275
[Cr(HL ²) ₂ Cl ₂]Cl	1624	3444	1670	817	462	283
[Cu(HL ²) ₂ Cl ₂]	1620	3444	1670	817	468	277

Table 2. FT-IR selected data of the ligands and their metal complexes

Electronic spectra

The ligands' absorption spectra revealed peaks at 270–290 nm due to the $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ peaks around 340 nm; Figure 3 shows the ranges of the ligands. The complexes revealed intra-ligand fields at 267–289 and 340–347 nm; this slight shift is considered to approve the ligand \rightarrow metal coordination, charge transfer peaks at 363 nm¹³⁻¹⁵, and d-d transition peaks as follows; The electronic spectra of ligand's HL¹ metal complexes confirmed an octahedral geometry of the synthesized complexes where the peaks

exhibited was like the following; Co(II) complex exhibited a peak at 782nm that is related to the electronic transition ${}^4T_{1g} \rightarrow {}^4T_{2g}$, Cr(III) complex showed a peak at 779 nm which refers to the electronic changes ${}^4A_{2g}^{(F)} \rightarrow {}^4T_{2g}^{(F)}$, The Cu(II) complex d-d transitions display two peaks at the d-d region at 778nm and 760 nm which are related to ${}^2B_{1g} \rightarrow {}^2A_{2g}$ ¹³⁻¹⁷. The HL² complexes spectral data were as follows; Co(II) complex displayed peaks at the d-d region at 700 nm related to the electronic transition ${}^4T_{1g}^{(F)} \rightarrow {}^4A_{2g}^{(F)}$,

Compounds	Conc. mol L ⁻¹	λ (nm)	$\bar{\nu}$ (cm ⁻¹)	ϵ_{max} (dm ³ mol ⁻¹ cm ⁻¹)	transition	Assignments
HL ¹ (Schiff base) C ₂₇ H ₂₆ N ₆ O ₂	1 X 10 ³	271	36900	1334	$\pi \rightarrow \pi^*$	-----
		345	28985	2431	$n \rightarrow \pi^*$	
		367	27247	1206	$n \rightarrow \pi^*$	
[Co(HL ¹) ₂ Cl ₂]	1 X 10 ³	266	37593	1030	$\pi \rightarrow \pi^*$	Octahedral
		348	28735	1150	$n \rightarrow \pi^*$	
		782	12787	3	${}^4T_{1g} \rightarrow {}^4T_{2g}$	
[Cr(HL ¹) ₂ Cl ₂]Cl	1 X 10 ³	267	37453	1237	$\pi \rightarrow \pi^*$	Octahedral
		345	28985	2064	$n \rightarrow \pi^*$	
		360	27777	1118	C.T	
		779	12836	4	${}^4A_{2g}^{(F)} \rightarrow {}^4T_{2g}^{(F)}$	
[Cu(HL ¹) ₂ Cl ₂]	1 X 10 ³	270	37037	1369	$\pi \rightarrow \pi^*$	Octahedral
		364	27472	865	$n \rightarrow \pi^*$	
		760	13157	3	${}^2B_{1g} \rightarrow {}^2A_{2g}$	
		778	12853	92	${}^2B_{1g} \rightarrow {}^2A_{2g}$	
HL ² (Schiff base) C ₃₃ H ₃₄ N ₆ O ₅ S	1 X 10 ³	269	37174	1127	$\pi \rightarrow \pi^*$	-----
		345	28985	1763	$n \rightarrow \pi^*$	
		363	27548	1300	$n \rightarrow \pi^*$	
[Co(HL ²) ₂ Cl ₂]	1 X 10 ³	345	28985	1912	$n \rightarrow \pi^*$	Octahedral
		700	14285	27	${}^4T_{1g} \rightarrow {}^4T_{1g}^{(F)}$	
[Cr(HL ²) ₂ Cl ₂]Cl	1 X 10 ³	273	36630	2097	$\pi \rightarrow \pi^*$	Octahedral
		345	28985	2344	$n \rightarrow \pi^*$ CT	
		365	27397	1299	${}^4A_{2g} \rightarrow {}^4T_{2g}$	
		803	12453	17		
[Cu(HL ²) ₂ Cl ₂]	1 X 10 ³	271	36900	2051	$\pi \rightarrow \pi^*$	Octahedral
		345	28985	2187	$n \rightarrow \pi^*$	
		682	14662	4	${}^2B_{1g} \rightarrow {}^2A_{1g}$	
		626	15974	6	${}^2E_g \rightarrow {}^2T_{2g}$	

Table 3. Electronic spectral data of the ligands and their complexes

the complex's magnetic moment equals 3.88 BM, the data suggested an octahedral geometry. The Cr(III) complex spectra exhibited a peak at 803 nm related to ${}^4A_{2g} \rightarrow {}^4T_{2g}$, the electronic spectrum and the magnetic moment of the complex, which equals 2.91 BM confirm an octahedral geometry structure. According to the electronic spectrum data collected, an octahedral geometry was suggested for the Cu(II) complex, where peaks were detected at 626 nm and 682 nm that are referring to ${}^2E_g \rightarrow {}^2T_{2g}$ and ${}^2B_{1g} \rightarrow {}^2A_{1g}$, and the magnetic moment of the complex is 2.15 BM¹³⁻¹⁷

The molar conductivity of the ligands and its complexes measured in (S.cm² mol⁻¹) were as following: HL1 (5.7), [Co (HL1)2Cl2] (0.7), [Cr (HL1)2Cl2]Cl (29), for [Cu (HL1)2Cl2] (3.6), HL2 (9.3), [Co (HL2)2Cl2] (23), [Cr (HL2)2Cl2]Cl (33.14) and for [Cu (HL2)2Cl2] (22).

Also, the magnetic susceptibility were measured and the results were: [Co (HL¹)₂Cl₂] (3.962), [Cr (HL¹)₂Cl₂]Cl (4.05), [Cu (HL¹)₂Cl₂] (2.23), [Co (HL²)₂Cl₂] (3.88), [Cr (HL²)₂Cl₂]Cl (3.91) and for [Cu (HL²)₂Cl₂] (2.15).

Mass spectroscopy

In the Schiff base ligands, mass spectrum Figure 4 the HL1 spectrum has a well-defined molecular ion peak at m/z = 467 amu, which correlates (M + 1) with the Schiff base ligand's molecular formula (C₂₇H₂₆N₆O₂). The spectra of HL1 ligand reveal a succession of peaks at m/z 409, 332, 290, 199, 184, 105, 70 and 56, amu, which correspond to the fragments. The strength of these peaks indicates the pieces' stabilities. At the same time, the Mass of HL2 exhibited peaks at m/z+=627 amu attributed to

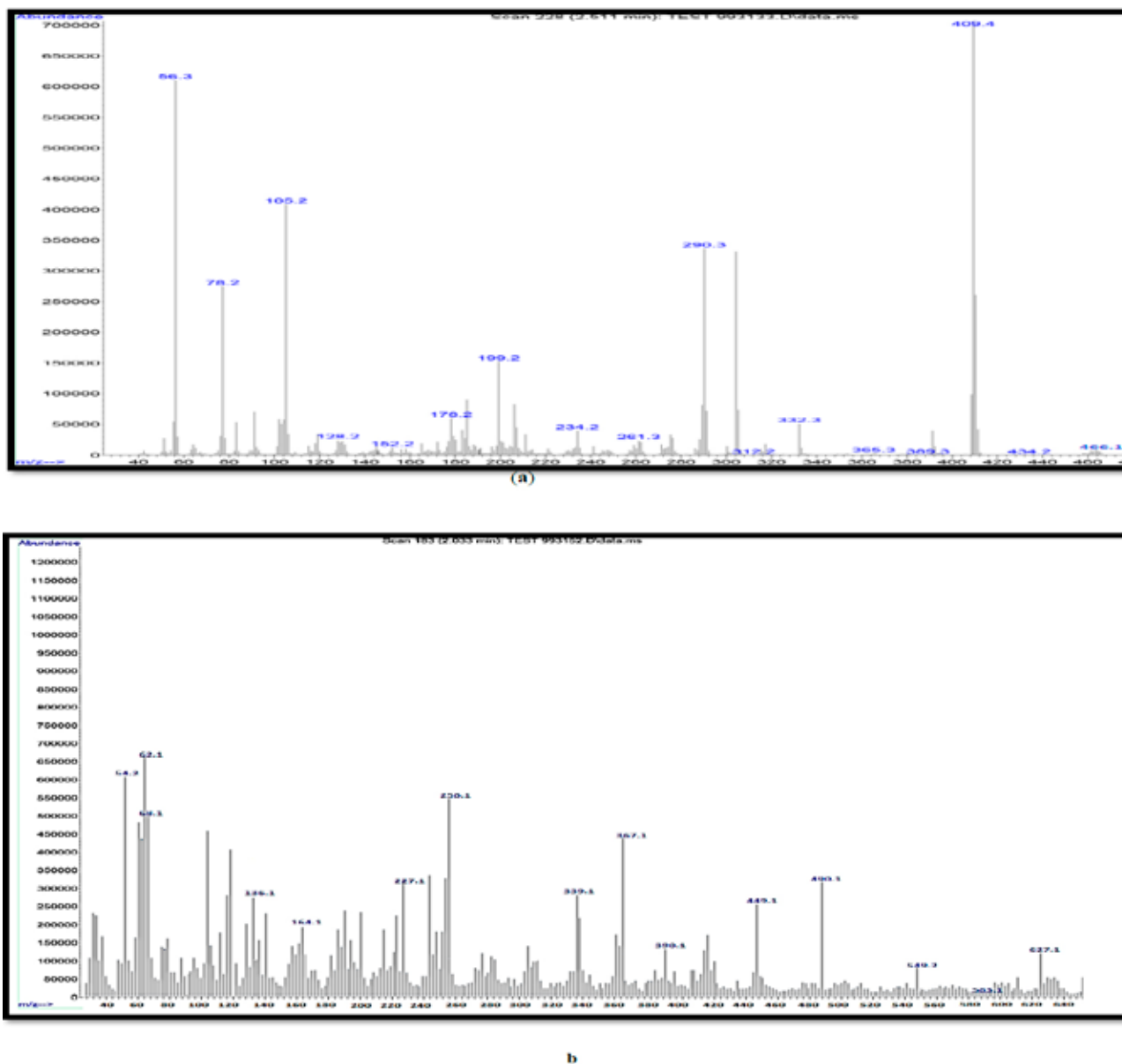


Figure 5. This is a Figureure.: (a) mass spectrum of HL¹ (b) mass spectrum of HL²

[M+1] of the ligands molecular formula (C₃₃H₃₄N₆O₅S). Also, it revealed peaks at 594.1, 490.1, 449.1, 390.1, 367, 339, 227, 164, 136, 77, and 54 amu that are attributed to the fragments 18.

The ¹H and ¹³C -NMR spectra of the ligands

According to a literature review, NMR spectroscopy is required to determine the structure of various compounds; the NMR spectra were recorded in DMSO-d₆ (dimethyl sulfoxide) using TMS (tetramethyl silane) as standard.

For HL¹ the signals were at 10.74ppm (NH), 7.21 ppm (NH₂), 5.16 ppm (N=C-CH₂-C=N), 7.33-7.71 ppm (H aromatic) and the signals referring to the CH₃ is overlapped by the DMSO signal. While for HL² the signs were 9.23 ppm (NH₂), 9.35 ppm (OH), 10.69 ppm (NH), 7.33-7.51 ppm (H aromatic), 4.26 ppm (N=C-CH₂-C=N). A slight downfield shift was observed in the signals of significant complexes ¹⁹⁻²¹. The spectra are shown in Figure 6 and Figure 7.

The ¹³C-NMR For HL¹, the signals of the aromatic carbons are located at 124.86-137.6 ppm, the carbon of the imine

Functional groups	HL ¹		HL ²	
	¹ H-NMR (ppm)	¹³ C-NMR (ppm)	¹ H-NMR (ppm)	¹³ C-NMR (ppm)
C-H (aromatic)	7.33 – 7.72	124.86 -137.6	7.33 -7.51	124-137
C=N	-----	150.69 & 161.85	-----	155.18 & 156.71
N-H	10.74	-----	10.69	-----
N-H ₂	7.21	-----	9.23	-----
CH ₂	5.16	41.15	4.26	12.76 & 37.32
CH ₃	2.39 & 3.18	12.73	2.37 & 3.18	39.70
OH	-----	-----	9.35	-----
HC=CH	-----	-----	6.81 & 6.82	115.3
C=S	-----	-----	-----	179.61
C=O	-----	159.69 & 157.67	7.33 -7.51	124-137

Table 4. NMR spectral data of the ligands

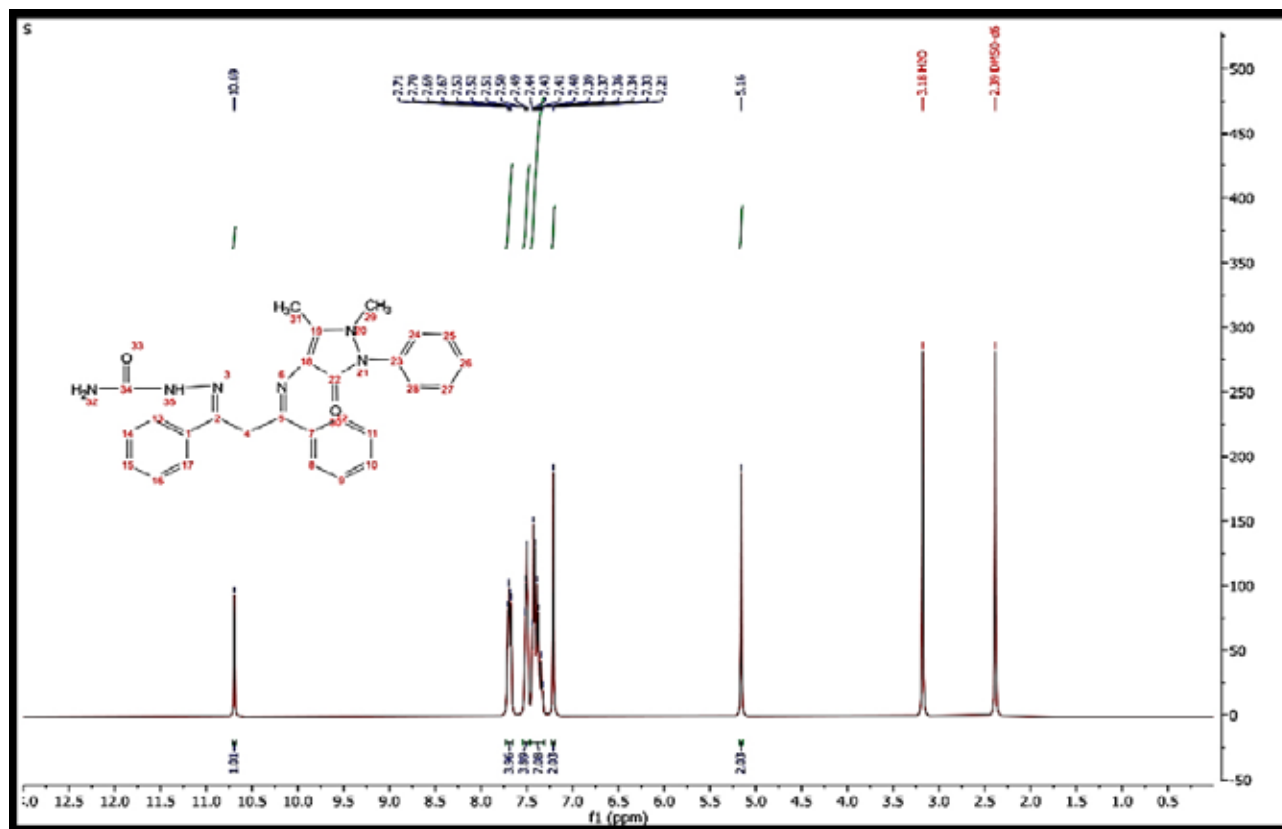


Figure 6. ¹H NMR spectrum of the first Schiff base HL¹

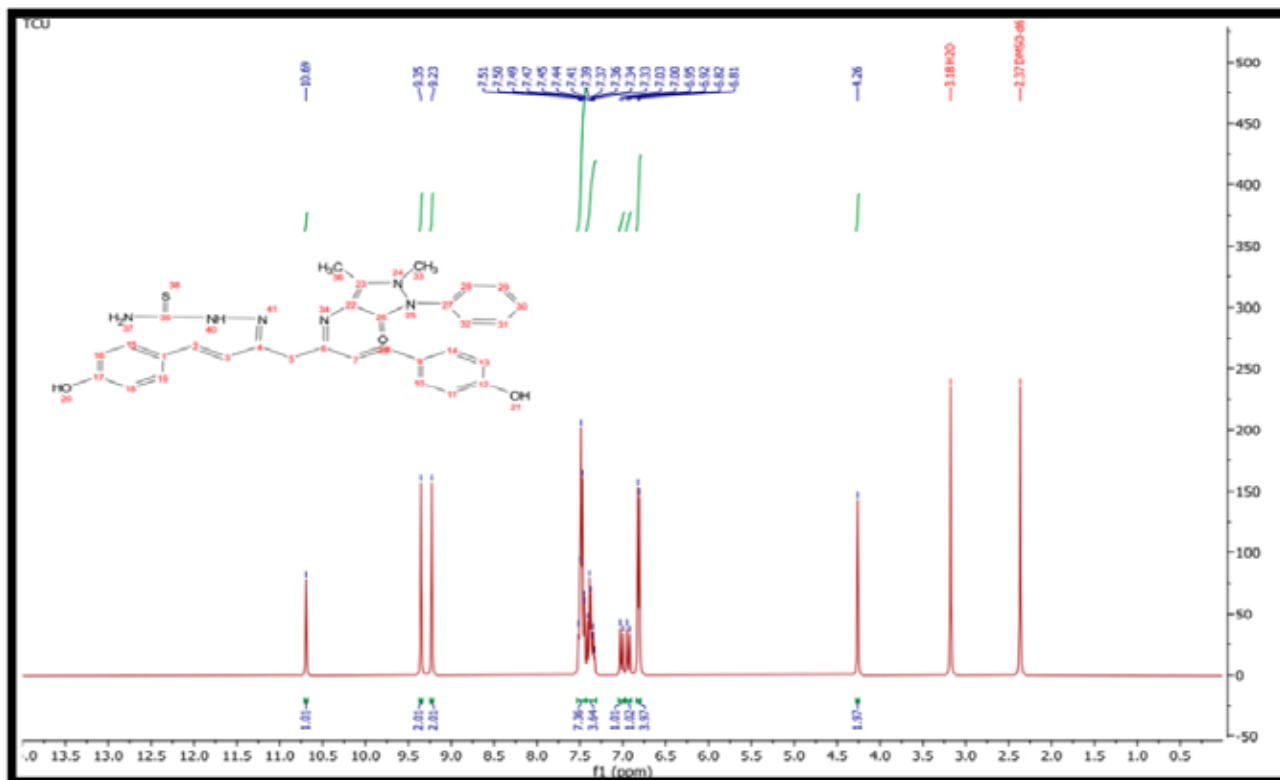


Figure 7. ¹H NMR spectrum of the first Schiff base HL²

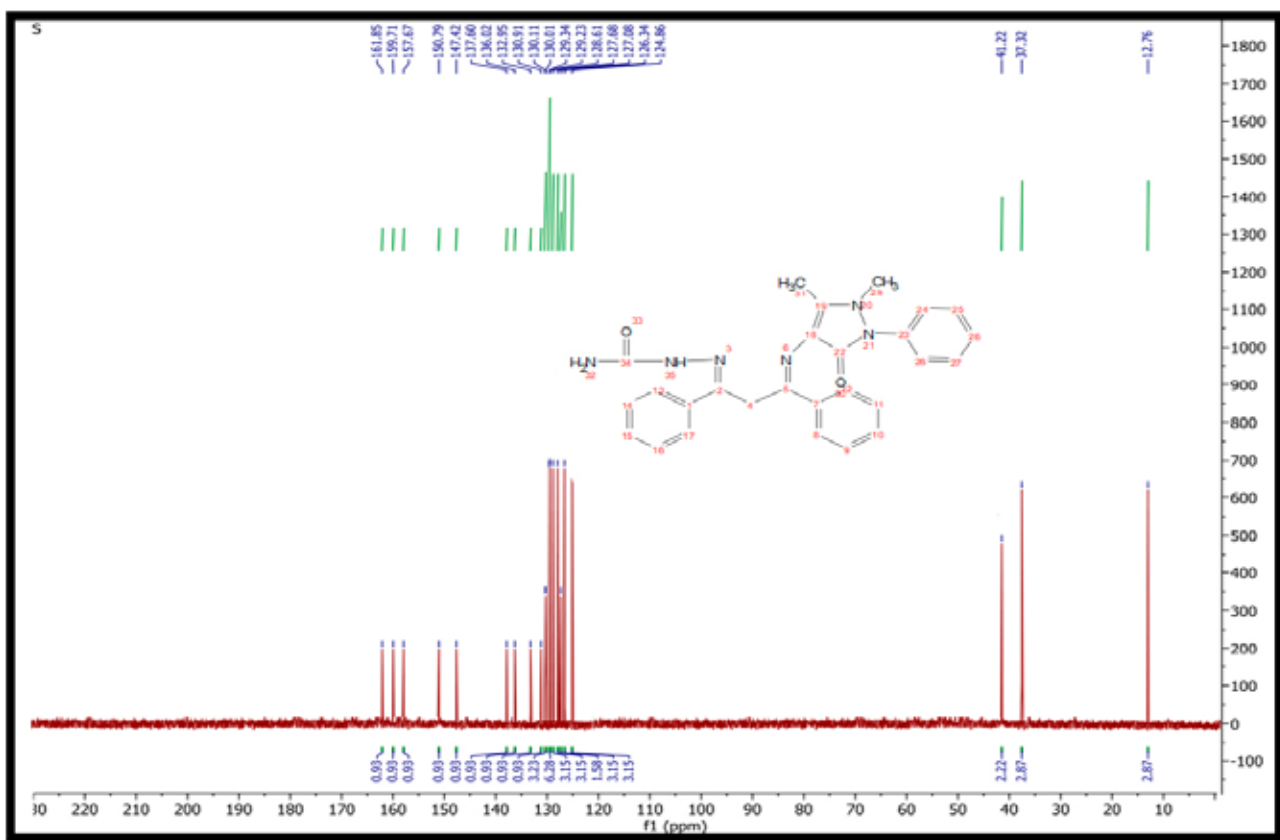


Figure 8. ¹³C NMR spectrum of the first Schiff base HL¹

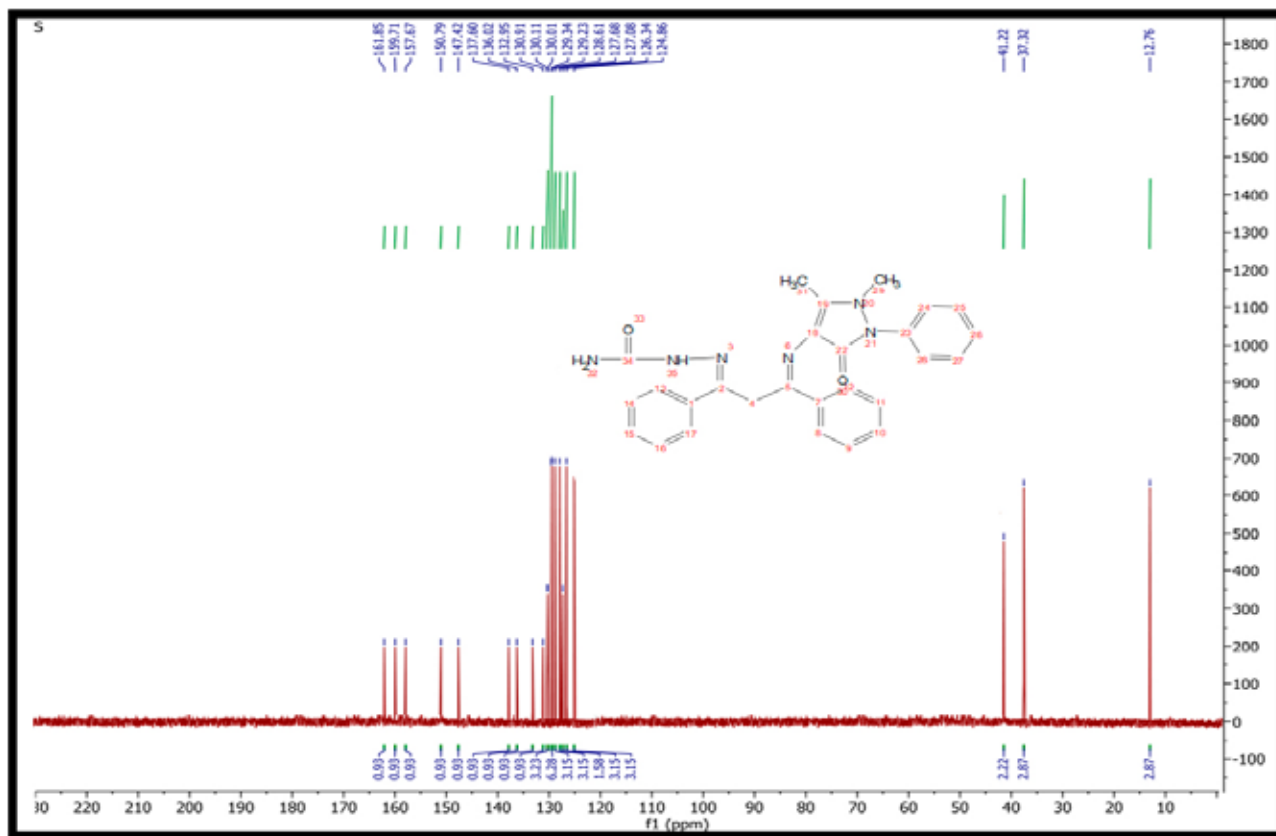


Figure 9. ^{13}C NMR spectrum of the first Schiff base HL^2

Compounds	Bacillus Subtilis	Staphylococcus Aureus	Escherichia coli	Pseudomonas aeruginosa	Candida albicans	Rhizopus Sporium
Ceftriaxone (antibiotic)	25	19	16	28	18	15
HL^1 (Schiff base) $\text{C}_{27}\text{H}_{26}\text{N}_6\text{O}_2$	26	10	14	20	15	11
$[\text{Co}(\text{HL}^1)_2 \text{Cl}_2]$	24	12	12	21	18	11
$[\text{Cr}(\text{HL}^1)_2 \text{Cl}_2]\text{Cl}$	27	11	11	23	18	11
$[\text{Cu}(\text{HL}^1)_2 \text{Cl}_2]$	28	10	14	22	17	12
HL^2 (Schiff base) $\text{C}_{33}\text{H}_{34}\text{N}_6\text{O}_5\text{S}$	25	13	11	23	17	17
$[\text{Co}(\text{HL}^2)_2 \text{Cl}_2]$	25	13	13	23	16	16
$[\text{Cr}(\text{HL}^2)_2 \text{Cl}_2]\text{Cl}$	27	12	11	24	17	17
$[\text{Cu}(\text{HL}^2)_2 \text{Cl}_2]$	26	12	11	23	17	18

Table 5. Biological activity data of the ligands and their metal complexes

(C=N) group signal at 150.69 and 161.85 ppm, the signal of the carbonyl group was located at 157.67 and 159.69 ppm, finally, for HL^1 the signals of the aliphatic carbons were located at 12.76 (C- CH_3) and 37.32 ppm (N- CH_3) and 41.15 ppm (CH_2) [19-21]. When speaking of HL^2 signals, they were explained as the following 179.61 ppm indicates the thione (C=S) group, the aromatic carbons are located at 124-137 ppm, while the aliphatic carbons signals are located at 12.76 (CH_3) and 41.5 ppm indicating the CH_2 group that is located between the imine groups, and finally, the carbons of the imine group have two signals 155.18, and 156.71 ppm and the deference in signals results from the deference in the electronic environment surrounding the group [19-21]. The spectra are shown in Figure 8 and Figure 9.

Biological activity studies

The effect of the synthesized compounds was evaluated using the agar diffusion technique on four types of bacteria (*E. Coli*, *P. aeruginosa*, *S. aureus* and *B. Subtilis*) and two types of fungi (*C. albicans* and *Rhizopus sporium*). The inhibition zone (IZ) of 1×10^{-3} M of the compounds was compared to the IZ of Ceftriaxone antibiotic as standard [22]. The bacteria and fungi were chosen for their recognized impact on various illnesses; they exhibit varying resistance to medicines and medicinal compounds. The ligand and its complexes demonstrated a reasonable zone of inhibition.

Discussion

Schiff compounds were synthesized and characterized using multiple techniques, and were approved to have better biological activity than the antibiotic used as a standard and the physical activity

Conclusions

The Schiff base ligand was synthesized by reacting dibenzoyl methane 1mmol with 4-aminantipyrine 1mmol and semicarbazide 1mmol (HL¹). The imine group atoms (N) performed it as bidentate coordinates. The Schiff base ligand (HL²) was synthesized by reacting curcumin 1mmol with 4-aminantipyrine 1mmol and thiosemicarbazide 1mmol. It turned out to be a bidentate ligand coordinate from the imine group. All complexes were produced based on available data such as FT-IR, UV-Visible, ¹³C, ¹H-NMR, molar conductivity, and magnetic susceptibility to adopt an octahedral geometric form. When tested for biological effectiveness against four types of bacteria and two types of fungi, all compounds gave a positive result; the synthesized compounds showed adequate inhibition in various ranges against the bacterium spores and the effect on the fungi spores.

Author Contributions: The experimental part of the research, measurements and preparation of the research draft were done by Reham H. Najem. The work was supervised and corrected by professor Hasan A. Hasan.

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