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Synthesis and characterization of novel metal complexes with new azo-schiff base ligand derived from isatin and toxicological studies of its complexes as antibacterial

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Abstract--A New Azo-base-ligand was prepared [4-(((Z)-(2,4-dichlorophenyl)diazenyl)-3-((Z)-2-oxoindoline-3-ylidene)amino), (4DCPD)]-(Pyrimidine-2-yl)benzenesulfonamide). This ligand (4DCPS) with the metal ions Co(II), Ni(II) and Cu was also prepared in reaction to three chelate complexes (II). UV-Vis. Ligand along with its metal complexes were investigated based on spectra. In comparison to the one from free ligand, the (UV-Vis) electronic complex spectra showed bathochromic shifting. The Free ligand spectrum Mass & ¹HNMR has been taken and the Ligand FTIR spectra and its chelating complexes studied, indicating that there is coordination among the metal ions and the prepared ligand. A conductivity and magnetics, an elementary micro-analysis and the metal ion percentage were identified. The geometrical structure of the co(II), Ni(II) and Cu preparations depends on the results of these projects (II) and they are octahedral. The mole-ratio (M:L) is (1:2). The conductivity measurements show non-electrical properties, for all prepared complexes. The final stage involved the study of the biological activity of prepared component to

two type of pathogenic bacteria: (G+) Staph. aureus and Escherichia coli (G-) using Well diffusion methods. Three different concentration were tested (100, 500, 1000) ppm in Ethanol Absolute(99%) as a solvent. The prepared compounds showed different results (high, moderate, low, and inactive). While the new prepare Azo-Schiff (4DCPS) showed less inhibition growth against both type of bacteria in comparison with its complexes. Also, the metallic ligand complexes showed more inhibition activity against Gram positive than Gram negative.

Keywords---Azo-Schiff base ligand, Isatin derivatives, antibacterial Studies, Transition Metal Complexes.

1. Introduction

A lot of work was reported on spectral determining, synthesis, physical characteristics and elementary analysis for various types of azo - Schiff base ligands and their transitional and non transitional metal complexes - and inorganic chemistry [1] transition metal complexes containing Azo-Schiff base ligands. Azo - Schiff base ligands are currently of great interest in co-operative chemistry in chelating ligands and their metal complexes as a consequence of extensively studied bio-clinical, analytical and spectral complexes and many other engineering applications like medicines and dyes[2].

Azo Azomethine compounds are new (age) compares with azo and Schiff base [3] that have the dual functional groups at nitrogen atom with non-bonding electron pair [(-N=C-) and (-N=N-)] that owned it special chemical and physical properties. Azo-Schiff compounds can coordinate in many ways, first of them; it can coordinate via azomethine nitrogen secondly by using the two type of nitrogen atoms (azomethine and azo) and finally by the utilizing of azo nitrogen only[4].

Isatin (indoline-2,3-dione) is an important class of heterocyclic compounds, and is an indole derivative of the α , β - Di Ketone class. Isatin derivatives stand for synthesis substrates that can be used as a raw material for drug synthesis for the synthesis of a variety of heterocyclic compounds[5,6]. Isatin derivatives were recently attracted by the power of biological and pharmacological activities[7] in inorganic and medicinal chemistry. Isathine has a range of biological characteristics, such as antitumor, antimicrobials, anti-inflammatory, analgesic, antifungal, anti-convulsant, antiviral, anthelmintic, anti-HIV and antioxidant; and CNS depressant[8-10].

Some research groups found that the Azo-Schiff base metal complexes derived from Isatin can specially antitumor [11] also have widespread applications in diverse areas [12].The objective of this study is to synthesize and characterize Co(II),Ni(II) and Cu(II) complexes with the Newly synthesized Azo - Schiff base Ligand based on Isatin and Sulfadiazine.

2. Experimental

2.1. Materials and physical measurements

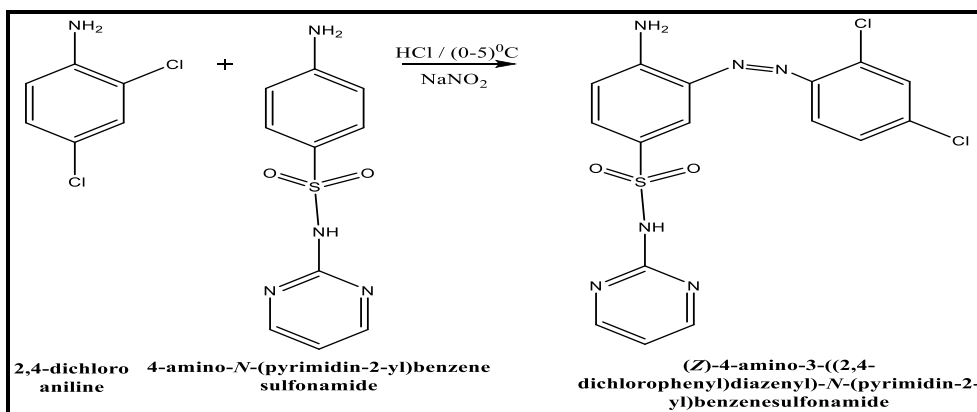
Every employed chemical has been very pure and were used with further purification based on (BDH, fluka or merck). Shimadzu Agilent Technologies 5975C was recorded in Mass Spectra. The micrometric unit of (EURO EA3000 Singl) micro-analysis C.H.N elemental analysis was carried out. Absorption spectra for solutions of the complexes of aqueous ethanol at room temperature were recorded using a Shimadzu UV-Vis 1700 spectrophotometer. With a quartz cell of 1cm, in the range of (4000-400) cm^{-1} with KBr disks, IR spectrums of FT-IR-8000 Shimadzu were recorded. Electrical conductance measured using the atomic absorption system through an atomic absorption spectrophotometer -5000 Perkin - Elmer, with a solvent concentration of 10-3M DMSO under room temperature.

2.2. Preparing new Azo-schiff base ligand (4DCPS).

A preparation of the ligand [4-((Z)-(2,4-dichlorophenyl)diazenyl)-3-(((Z)-2-oxoindolin-3-ylidene)amino)-N-(pyrimidin-2-yl)benzenesulfonamide] (4DCPS) included two steps the first one is preparation of the Azo compound [(Z)-3-amino-4-((2,4-dichloro phenyl) diazenyl)-N-(pyrimidin-2-yl)benzenesulfonamide](A).which was resulted from Diazotization reaction between of 2,4-dichloro aniline and Sulfadiazine. The second step was preparation of the new Azo- schiff base ligand by acid catalyzed condensation of the product of step one (A) with Isatin in glacial acetic acid (GAA) as a solvent.

2.2.1. Synthesis of Azo compound (A)

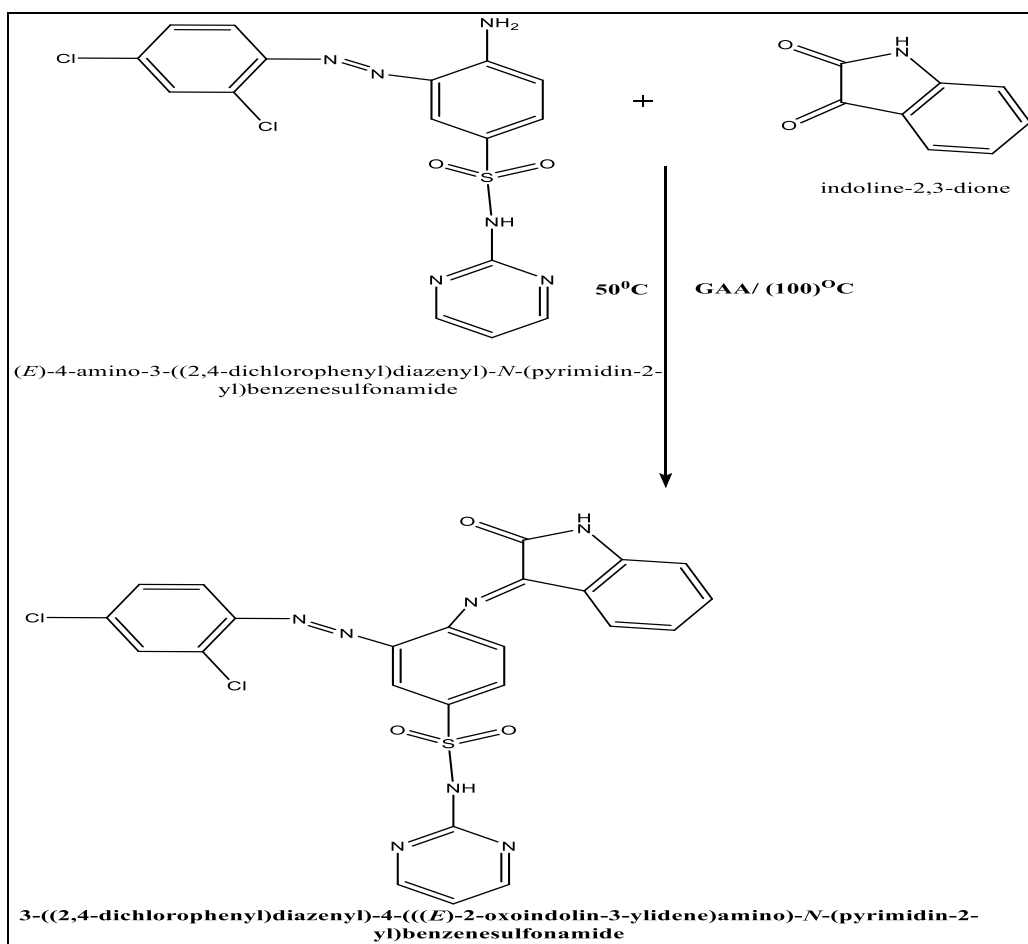
The Azo compound (A) was Prepared by defrost (1.6 g, 0.01 mol) of 2,4-dichloro aniline in 10 ml of distilled water and 5ml of concentrated hydrochloric acid, then the solution has refrigerated under lower than 5 °C. For this mixture, the solution of (0.65g, 0.01 mol) of sodium nitrate in 10 ml of distilled water has inserted drop wise at 0-5 °C. After completing the addition process, the solution was left to settle for half an hour .This diazonium salt solution has inserted drop wise to a 500 ml beaker having (2.5 g, 0.01 mol) of Sulfadiazine dissolved in 50 ml of alkaline 10 % NaOH the solution was cooled below 0 °C and acidified with dilute hydrochloric acid to pH = 8.0 .The mixture has been tolerable to stand overnight. The crude dye was filtered and recrystallized twice with ethanol and then oven dried at 50 °C for 1 hrs. (5)[13,14]. the melting point of the Azo was (150-152)°C , (85 %), and The structural formula of its shown in Scheme 1 .



Scheme 1: Preparation of Azo compound (A)

2.2.2. Synthesis of new Azo - Schiff base ligand (4DCPS).

A new heterocyclic Azo- Schiff base ligand (4DCPS) has prepared through condensation of Azo compound (A) (4.23 g ; 0.01 mol) which was dissolved in (50 mL) hot glacial acetic acid (GAA) then added to (1.47 g ; 0.01 mol) of Isatin was dissolved in 5ml GAA . A mixture has been refluxed with a stirring under 100°C for (50 hr)[13]. A clear colored solution was obtained. After this process was completed, the progress of the reaction was followed up by T.L.C., The mixture was poured over crushed ice. The solid is filtered out, wash with 2% Sodium bicarbonate solution and distilled water, after that, It has been recrystallized from hot abs. Ethanol[15,16]. The azo-Schiff base Ligand has dried over anhydrous CaCl₂. A melting point of new Azo - Schiff base ligand (DCPS) was (150-152)°C , (85 %), as depicted in (**Scheme 2**).



Scheme 2: Preparation of the ligand (4DCPS)

2.2.3. Preparing Transition metal complexes

Dissolve (1,104g; 0,002mol) Azo - Schiff base (4dCPs) in (15 ml) hot ethanol into (1:2) chelate complexes of the metal and the ligand. The (CoCl₂.6H₂O,

NiCl₂.6H₂O and CuCl₂.2H₂O of(0.001 mol) hydrated metal chloride salts were dissolved into hot ethanol(15 ml) and mixed to the ligand solution of hot ethanol and refluxed on a hot plate for 1 hour. In each case, the complexes are separated. The material has been filtered, ethanol washed and vacuum-dried. Table.1 collects the ligand and its complex physical properties along with analyzed data.

Table 1. Physical features along with analytical data of the ligand (4DCPS) and its complexes

Compound	Color	M.Wt	M.P°C	Yield %	R _f (Met:Ben.) (4:1)
C ₁₆ H ₁₂ N ₆ O ₂ SCl ₂	Orange	423.276	150-152	85	-----
C ₂₄ H ₁₅ N ₇ O ₃ SCl ₂	Dark Brown	552.391	161-163	81	0.681
[Co(C ₂₄ H ₁₅ N ₇ O ₃ SCl ₂) ₂ Cl ₂]	Brown	1787.00	274-276 Decmpose	82	0.775
[Ni(C ₂₄ H ₁₅ N ₇ O ₃ SCl ₂) ₂ Cl ₂]	Brown	1786.76	196-198	84	0.684
[Cu (C ₂₄ H ₁₅ N ₇ O ₃ SCl ₂) ₂ Cl ₂]	Brown-Olive	1239.23	273-274 Decmpose	87	0.564

3. Results and Discussion

The metal complexes have been non-water soluble and soluble in acetone, DMF, DMSO, methanol, CHCl₃ and ethanol.

3.1. Mass spectrum

A mass spectrum of new Azo-Schiff base ligand was recorded below room temperature .A gotten Confirmed peak the ligand formulas that are expected to be . Ligand's mass spectrum shows the molecular ion peak. at m/z 552.9 (5.26 %) compound (C₂₄H₁₅N₇O₃SCl₂) confirm the proposed chemical formulas as shown in (Fig. 1).

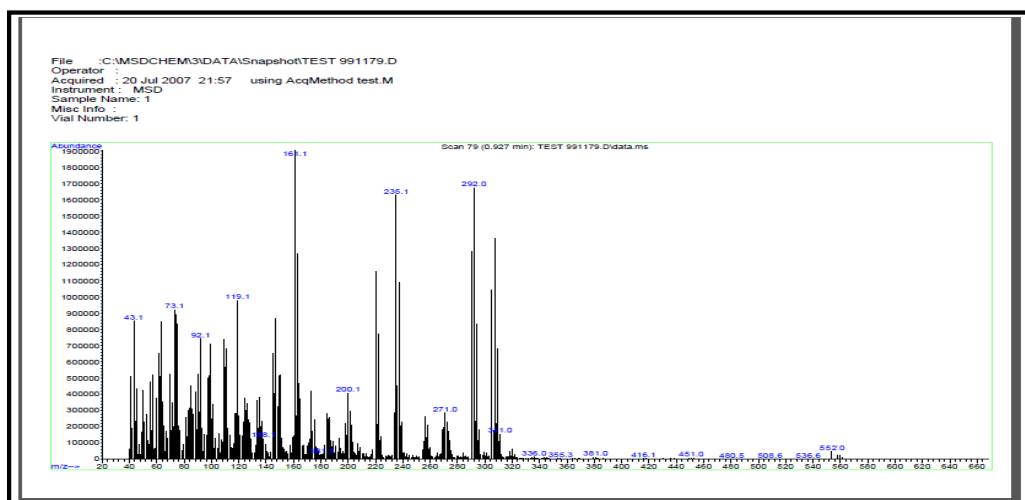


Figure 1. Mass spectrum of the Azo—Schiff base ligand (4DCPS)

3.2. FTIR spectra of Azo-Schiff base ligand and its complexes

The FTIR Azo-Schiff base ligand spectral data (Fig2) and its complexities identified in Table 2. The FTIR The spectra of the complexes were compared with the spectra of free bonding. for determining the coordination sites that is possibly included in chelation. When a comparison was made between the spectrum of the new Azo-Schiff base ligand and its metallic complexes under study, it was found that The emergence of a new azo-Schiff ligand spectrum is significantly observed stretching band belonging to the amide carbonyl group ν (NH-C = O) within the Isatin ring, and this band was almost constant. At frequency 1734 cm^{-1} in the spectra of the complexes under investigation. Also, a wide vibration band It appeared in frequency 3390 cm^{-1} belonging to the stretch of vibration ν (N - H) in the pyrimidine ring, and nothing was observed in the position and shape of this band when compared with spectrums of the metal complexes [17,18]. Also, the spectrum of the ligand showed a wide vibration band at frequency 3257 cm^{-1} belonging to the ν (N-H) sulfonation contained within the sulfadiazine molecule, and no significant change was observed in the position and shape of this band when compared with the spectra of metal complexes [19].

The spectrum of the new ligand showed a stretching band in frequency 1498 cm^{-1} , which was attributed to the stretching vibrations of the ν (N = N) of the azo group, experienced a change in the shape, intensity, or site of the spectra of the metallic complexes towards lower frequencies, which clearly Shows the participation of a nitrogen atom in this group. During the coordination process. A strong-intensity stretch band at the frequency 1581 cm^{-1} attributed to the stretching vibrations of the ν (C = N1) of the azomethine group suffered a change in the shape, intensity, or location in the spectra of the metallic complexes, which clearly Shows the participation of a nitrogen atom of this group In the process of coordination With metal ions to form chelating complexes[20]. Likewise, the spectra of the metallic complexes showed new absorbance of weak intensity, and at low frequencies ($518\text{--}580\text{ cm}^{-1}$ and $(435\text{--}493)\text{cm}^{-1}$ without the ligand spectrum, these bands were attributed to the vibration frequencies of the bonds ν (M - N1)

and $\nu(M-N2)$, respectively[21]. The study showed that the ligand acts as an octagonal bond in harmony with the metal ions. through nitrogen atom of azo group and nitrogen atom of imine group .as showed in Figer2 and 3.

Table 2. Characteristic FTIR absorption bands of the ligand (4DCPS) and its complexes in cm^{-1} units

Compound	$\nu(\text{NH})_{\text{Imid.}}$ cm^{-1}	$\nu(\text{C-H})_{\text{Pyrm.}}$ cm^{-1}	$\nu(\text{N=N})$ cm^{-1}	$\nu(\text{C=N})$ cm^{-1}	$\nu(\text{M-N1})$ cm^{-1}	$\nu(\text{M-N2})$ cm^{-1}
$\text{C}_{16}\text{H}_{12}\text{N}_6\text{O}_2\text{SCl}_2$	-----	3105	1498	-----	-----	-----
$\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2$	3390	3086	1487	1581
$[\text{Co}(\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2)_2\text{Cl}_2]$	3360	3107	1456	1587	524	493
$[\text{Ni}(\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2)_2\text{Cl}_2]$	3358	3111	1456	1587	520	489
$[\text{Cu}(\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2)_2\text{Cl}_2]$	3360	3109	1458	1591	580	524

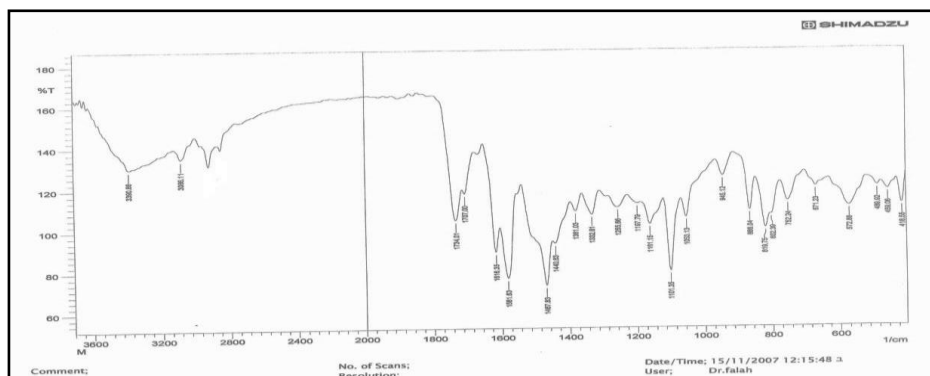


Figure 2. IR spectrum of the ligand (4DCPS)

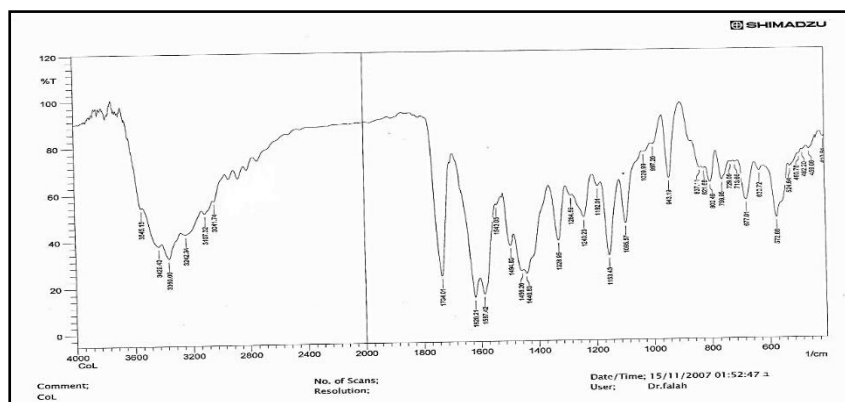


Figure 3. IR spectrum of ion complex of Co(II) with the ligand (4DCPS)

3.3. Electronic spectra

Electronic spectrums of ligand (4DCPS) (Fig.4) and its Co(II),Ni(II)and Cu(II) complexes have been investigated and the spectral data have been recorded in Table (3) . The UV-Vis spectrum of the Azo-Schiff base The ligands is mainly distinguished by three peaks at 290and 320) nm for ($\pi \rightarrow \pi^*$) transition and at (336)nm allocated to ($n \rightarrow \pi^*$) transition. In the electronic spectra of all arranged complexes, these electronic transitions were pushed in the direction of higher frequencies, confirming the ligand's coordination with metal ions. [21].

The electronic spectrum of Co(II) complex(Fig.5) displayed a new absorption peak (364)nm which may be attributed to (d-d) electronic transition type ${}^4T_{1g}(F) \rightarrow {}^4T_{1g}(P)$,suggesting octahedral geometry around Co(II) ion [22]. One new absorption peak was discovered in the electronic spectra of the Ni (II) complex., at (456)nm ³ which shielded (d-d) electronic transition type may be assigned to charge transfer spectrum $A_{2g} \rightarrow {}^3T_{1g}(P)$. This peak was in a worthy octahedral geometry conformance for Ni(II) complex. [18]. The Cu(II) complex's electronic spectra revealed a new absorption peak at (354) nm, which corresponds to the charge transfer spectrum .,suggesting distorted octahedral geometry around Cu(II) ion [19].

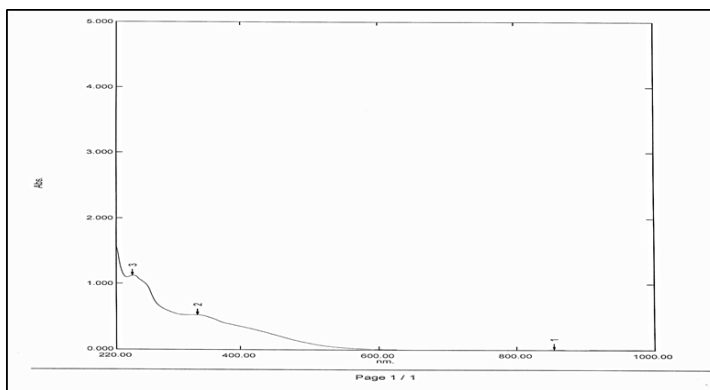


Figure 4. Absorbance spectrum of ligand (4DCPS)

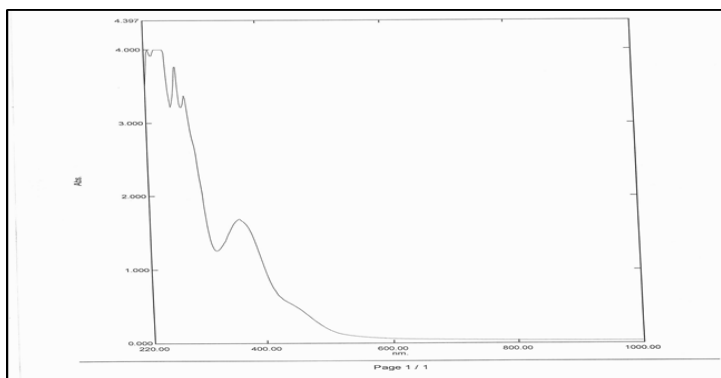


Figure 5. Absorbance spectrum of ligand (4DCPS) with ion complex of Ni(II)

Table 3. The electronic spectra of the ligand (4DCPS) and its chelate complexes

Compounds	Absorption band nm Wave number(cm^{-1})	Assignment	Proposed Geometrical
$\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2$	290nm(34482 cm^{-1}) 320nm(31250 cm^{-1}) 336nm(29761 cm^{-1})	$\pi \rightarrow \pi^*$ $\pi \rightarrow \pi^*$ $n \rightarrow \pi^*$	---
$[\text{Co}(\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2)_2\text{Cl}_2]$	364 nm (27472 cm^{-1})	${}^4\text{T}_{1g}(\text{F}) \rightarrow {}^4\text{T}_{1g}(\text{P})$	Oh
$[\text{Ni}(\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2)_2\text{Cl}_2]$	456nm(21929 cm^{-1})	${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{1g}(\text{F})$	Oh
$[\text{Cu}(\text{C}_{24}\text{H}_{15}\text{N}_7\text{O}_3\text{SCl}_2\text{Cl})]$	354nm(28248 cm^{-1})	${}^2\text{E}_g \rightarrow {}^2\text{T}_{2g}$	Oh

3.4. Magnetic measurements

3.4.1. Based on three unpaired electrons, the Co (II) complex explains magnetic moment eff. (4.31 B.M). This number suggests that the Co (II) ion is in an octahedral environment. [20].

3.4.2 Under room temperature, the Ni (II) complex explains magnetic moment eff. (3.56 B.M) in terms of dual unpaired electrons. Around the Ni (II) ion, this value suggests an octahedral shape. [21].

3.4.3. The octahedral geometry is theoretically suggested by the magnetic moment value eff. of the Cu (II)[22] complex (1.69 B.M).

In eff., the magnetic moment was shown table (4)

3.5. Conductivity measurements

All soluble complexes have molar conductivity magnitudes in the range of (30.0–37.5) $\text{S.cm}^2 \cdot \text{mol}^{-1}$ in DMSO solvent at 10⁻³M at room temperature [1,2]. These

magnitudes specify minor conductivity and non-ionic structure (1:1). The magnitudes of conductivity were recorded in table 4.

Table 4. Molar Conductivity and Magnetic moment μ_{eff} . of Chelate complexes

Complexes	Molar Conductivity $\text{S.cm}^2.\text{mol}^{-1}$	μ_{eff} . B.M
$[\text{Co}(\text{C}_{21}\text{H}_{22}\text{N}_6\text{O})_2]\text{Cl}_2$	70.11	4.01
$[\text{Ni}(\text{C}_{21}\text{H}_{22}\text{N}_6\text{O})_2]\text{Cl}_2$	75.98	3.18
$[\text{Cu}(\text{C}_{21}\text{H}_{22}\text{N}_6\text{O})_2]\text{Cl}_2$	73.14	1.73

3.6. ^1H NMR spectra

Figure (6) shows The ^1H NMR spectrum of the New Azo-Schiff base ligand in a DMSO-d₆ as a solvent shows the following signals :

a single (singlet) signal at (11.04 - 11.08) ppm belonging to the proton of the nitrogen atom bound to the sulfonic group (-SO₂-NH-) [23]. While the amide group protons (-NH-C = O) of the Isatin ring showed a single signal within the range (10.48-10.77) ppm . While a multiplet appeared in the range (7.72-8.14) ppm, which belongs to the protons of the pyrimidine ring, and a multiplet (multiplet) appeared in the range (8.52-9.56) ppm, which belongs to the protons of the aromatic ring containing the two atoms Chlorine showed a multiplet while within the range (7.23-7.62) ppm, which is one of the Isatin ring's protons [24]. A multiplet appeared within the range (6.79-7.17) ppm, which belongs to the aromatic ring protons, and this is consistent with what was stated in the literature [25] and finally, the spectrum showed a single signal belonging to the protons of the solvent DMSO-d₆ at the range (2.47-2.55) ppm and A single signal at the range (3.29-3.45) ppm belongs to the protons of the water molecule D₂O.

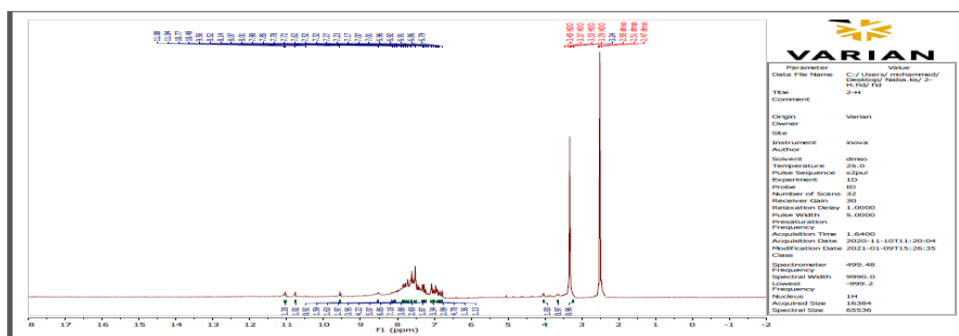


Figure 6. ^1H NMR spectrum of the new ligand (4DCPS)

3.7. Micro analysis

The 1:2 [M:L] ratio complex elemental analysis data have shown theoretical values that are well in line with the data found as listed in the table (5). TLC technology and C.H.N study have tested the purity of the azo-schiff base ligand.

Table 5. The elemental analysis data of the ligand (4DCPS) and its chelate complexes

compound	Found (Calc.)%				
	%C	%H	%N	%S	%M
$C_{24}H_{15}N_7O_3SCl_2$	(52.137) 50.460	(2.715) 2.457	(17.741) 17.828	(5.793) 5.168	-----
$[Co(C_{24}H_{15}N_7O_3SCl_2)_2Cl_2]$	(48.250) 47.250	(2.513) 2.922	(16.296) 15.296	(2.804) 2.018	(10.668) 10.558
$[Ni(C_{24}H_{15}N_7O_3SCl_2)_2Cl_2]$	(45.989) 45.570	(2.395) 1.981	(15.649) 14.653	(2.554) 2.653	(10.624) 10.501
$[Cu(C_{24}H_{15}N_7O_3SCl_2)_2Cl_2]$	(45.811) 45.686	(2.386) 2.623	(15.669) 15.588	(2.545) 2.547	(11.504) 11.409

4. Structure Suggestion

Based on the mass spectrum, ¹HNMR, FTIR, and UV-Vis spectra, as well as elemental microanalysis, molar Conductivity, and magnetic moment for the ligand (L1) and Co(II), Ni(II), and Cu(II) complexes, we propose that the ligand behaves as a pidentate on complexation with metal ions via the nitrogen atoms of two imine groups. For each compound, the molar ratio M:L was 1:2. All complexes have octahedral geometry in regard to these implications, as shown in Figure (7).

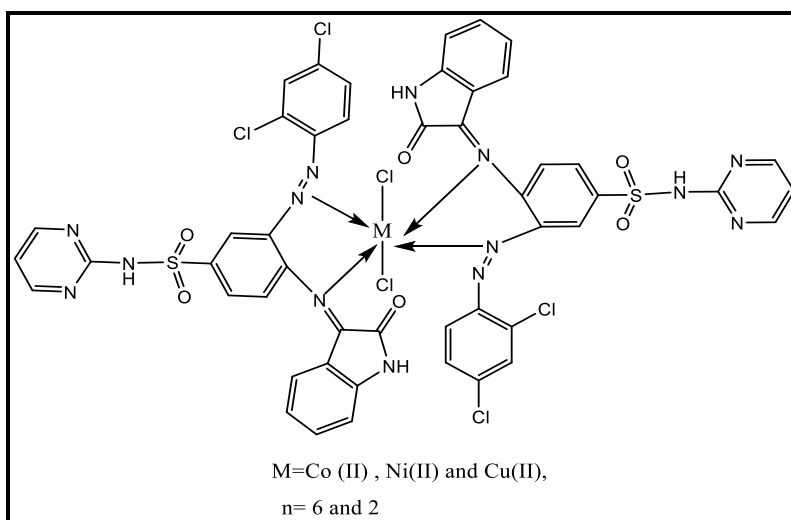


Figure 7. The suggested structural of Co (II), Ni(II) and Cu (II) with Azo-Schiff base ligand (4DCPS).

5. Toxicological Studies

Antibiotics were developed from the preparation of new derivatives of chemical treatments (26), due to the presence of many bacteria that are resistant to antibiotics, and among these chemical treatments are heterocyclic compounds containing Isatin. Where there is Isatin in the composition of many pharmaceutical compounds for ease of preparation and biological effectiveness (27), and many active compounds contain Isatin in their composition. Much research has pointed to the wide variety of heterocyclic compounds that are antimicrobials(28,29).

Many important and ongoing investigations have been carried out to determine the processes by which antibiotics and chemicals function to limit the growth or kill microorganisms. (30,31). One of the most important characteristics that any chemical or biological treatment must have is the selective toxicity, which means that the drug is harmful to the pathogen and not harmful to the host, where the selectivity is relative and not absolute, and this requires that the treatment be with a certain concentration that may be effective to eliminate the germs that cause inflammation. (32).

According to what was mentioned, the direction was to study the biological activity of the new compounds prepared in this study in two isolates of pathogenic bacteria, one of which is gram-positive (+G) (*Staphylococcus aureus*) and the other is gram-negative (G-) (*Escherichia coil*). The study of the sensitivity of bacteria by etching diffusion method, and concentrations of (100, 500, 1000) ppm were used in this method in DMSO solvent under the same conditions.

5.1. Efficacy of the prepared compounds against gram-negative bacteria

The results of this study show that the ligand (4DCPS) showed the highest inhibitory effect towards Ecoil bacteria at the highest concentration of (1000) ppm if the average diameter of the inhibition halo reached (15 mm), while it appeared at the lowest concentration of (100) ppm less effect than it is at high concentrations if it reached The average diameter of the damping halo is (12mm). The complexes, especially [CoL], showed the highest inhibitory effect at the highest concentration of ppm (1000), as the CoL complex showed. The highest inhibitory effect was the rate of inhibition reached (20mm) towards gram-negative bacteria, while the [NiL] complex showed the highest inhibitory diameter at ppm (1000) towards bacteria, where the inhibition belt diameter was (15 mm), while the [CuL] complex showed the highest effect. Inhibitory at the highest concentration (1000ppm), where the diameter of the inhibition was (15mm).

5.2. Efficacy of the prepared compounds against gram-positive bacteria

The ligand (4DCPS) showed an inhibitory effect at the highest concentration (1000ppm) towards the studied bacteria if the average diameter of the inhibition halo was (10mm), while it showed the least inhibitory effect at the lowest concentration (100ppm), as it reached the diameter of the inhibition halo (7mm). [NiL] showed the highest effect in the concentration of ppm (500), where the belt diameter of inhibition reached (23 mm) towards the bacteria studied. As for the

[CuL] complex, it showed the highest inhibitory effect with a concentration of (1000) with a diameter of (20mm) inhibition against bacteria. As for the CoL complex, the inhibition rate was (30 mm) at a concentration of (500ppm) towards the studied bacteria.

We note from the results obtained that the metal complexes prepared in this study have a lower ability to inhibit gram-negative bacteria in most compounds than their ability against gram-positive bacteria (33), due to the presence of a double membrane surrounding the bacterial cell. Gram has an outer membrane in addition to the inner membrane consisting of two layers, one of which is protein lipids, and the other is lipids combined with polysaccharides. As for gram-positive bacteria, their cell wall consists of a thick mucopeptides layer composed of amino acids with monosaccharides, so they are less resistant to antibiotics and drugs (34,35). From the results obtained, the prepared ligand (4DCPS) showed less inhibitory activity towards the two types of gram-positive and gram-negative bacteria compared with its complexes, and this is due to the small spread that bacterial species show towards metals when studying (36). It can be said that the ligand and its complexes at a concentration of ppm (1000) can act as powerful antivirals that may have the same effect for other types of bacteria that have not been tested, and the ligand and its complexes may not show similar activity in vivo.

Despite bacteria's sensitivity to it in the lab, where what happens in the living body sometimes differs from what we see on invitro dishes, because the therapeutic process usually involves a series of complex metabolic and physiological reactions, and it can be difficult to measure despite knowing the treatment's final results, whether positive or negative, because there are many factors that can interfere with the therapeutic process. (37). The results are shown in the table (6) and figure(8) .

Table 6 The inhibitory zones of the novel ligand (4DCPS) and their metal complexes for the microorganisms under study at concentrations of (1000, 500, 100) ppm.

Compound	(+) G	(-) G	(+) G	(-) G	(+) G	(-) G
	At 100 ppm	At 100 ppm	At 500 ppm	At 500 ppm	At 1000 ppm	At 1000 ppm
$C_{24}H_{15}N_7O_3SCl_2$	7	12	8	13	10	15
$[Co (C_{24}H_{15}N_7O_3SCl_2)_2Cl_2]$.	10	10	30	14	20	20
$[Ni (C_{24}H_{15}N_7O_3SCl_2)_2Cl_2]$.	7	10	23	15	15	15
$[Cu (C_{24}H_{15}N_7O_3SCl_2)_2 Cl_2]$.	7	7	12	10	15	12

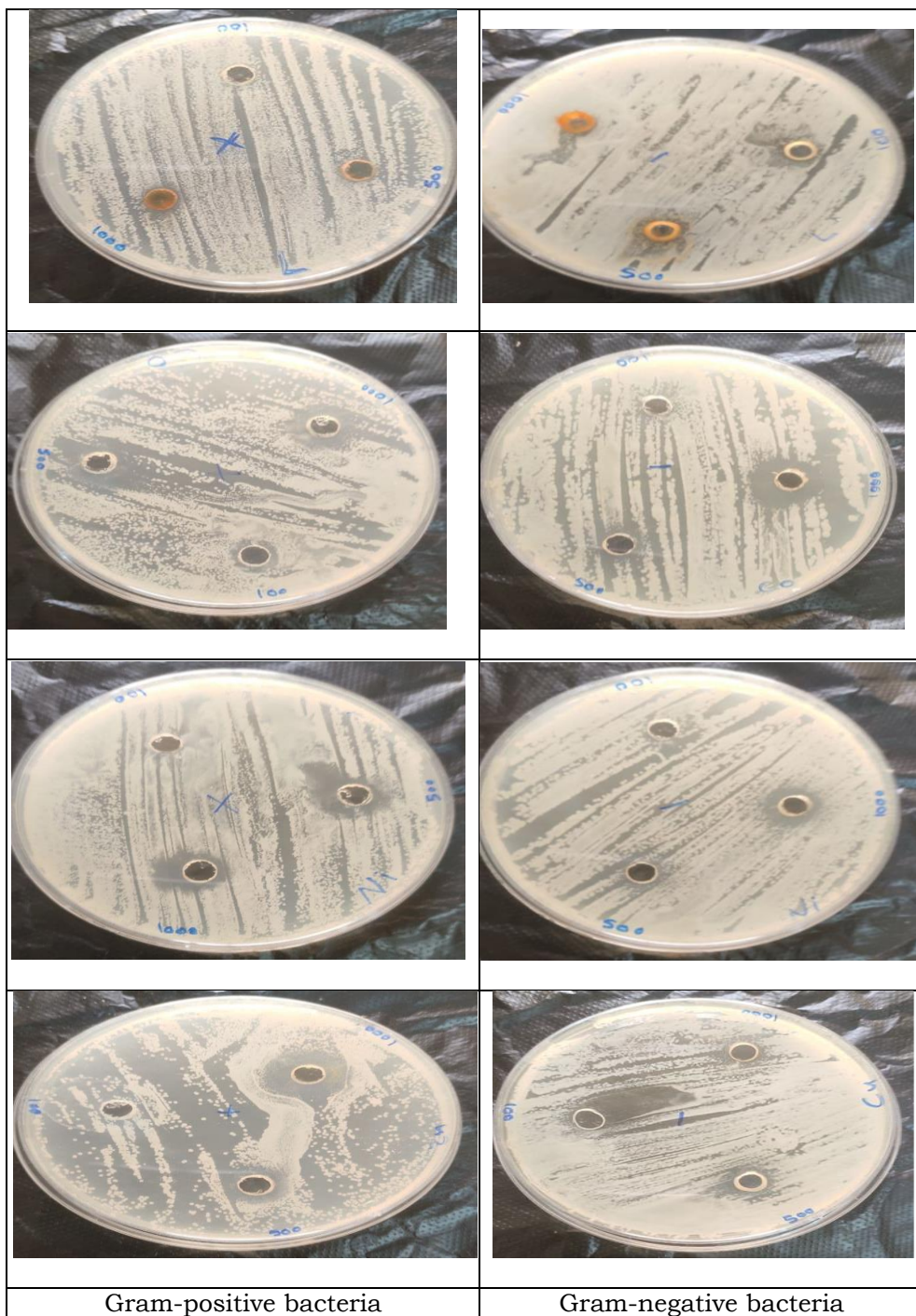


Figure 8. Biological activity of the new Azo-Schiff base ligand (4CDPS) and its metal complexes against Gram-negative and Gram-positive bacteria.

5. Reference

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