Synthesis, Characterization, Antimicrobial of Studies New 2, 2'-(1Z, 2Z)-ethane-1, 2 Diylidenedi (2Z) Hydrazin-1-yl-2-ylidene] bis (5-phenyl-1, 3, 4-Oxadiazole) and their Transition Metal Complexes

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Abstract

A new ligand 2,2'-(1Z,2Z)-ethane-1,2-diyldenedi(2Z)hydrazin-1-yl-2-ylidene]bis(5-phenyl-1,3,4-oxadiazole) and its Cr (III), Co (III) and Ni (II) complexes were synthesized. The new ligand and its complexes have been characterized on the basis their spectra of:HNMR, mass, Fourier transform infrared (FTIR), as well as magnetic susceptibility, elemental analysis[C, H, N] and conductance measurements. The program of hyper hem 7.51 has been used up for theoretical accounts using PM3 method [1] to study the electrostatic potential that provided good information about the complexity site. Of the results obtained we can suggest octahedral geometrics for Cr (III) and Co (III) complexes, while tetrahedral geometry for Ni (II) complex. A ligand and its complexes were screened for their antibacterial activity against two kinds of strains Escherichia coli (gram negative bacterial strains) and staphylococcus aureus (gram positive bacteria strains), this research showed excellent results in comparison with Ciprofloxacin as standard drug.

Keywords: Ligand, Complexes, Characterization, Hyper Chem, Electrostatic potential, Antibacterial.

Introduction

Ox diazoles and their derivatives can regard as simple five members heterocyclic have one oxygen and two nitrogen atoms. The Ox diazoles subsist in different isomeric forms such as 1,2,5-oxadiazoles, 1,2,4-oxadiazoles, 1,2,3-oxadiazoles and 1,3,4-oxadiazoles [2]. the isomer 1,3,4-oxadiazoles reverts to the diazoketone tautomer (unstable)[3].

Compounds containing 1,3,4-oxadiazole moiety play an important application in the field of biological activities as antibacterial [4,5], antifungal[6], anti-inflammatory [7], anti-cancer[8], anticonvulsant[9], antiviral [10], anti-HIV [11], anti-diabetic[12], anti-tubercular [13], lipid per oxidation inhibitor [14], other application of 1,3,4-oxadiazole as insecticidal [15], antioxidant [16], corrosion inhibitor [17], fluorescent and colorimetric chemo sensors [18], dyes [19], polymers material [20], light emitting diodes [21].

Experimental

Synthesis of Benzohydrazide (A)

A mixture of Ethyl benzoate (14ml, 0.1mol) and hydrazine monohydrate (14ml, 0.1mol) in ethanol absolute (100 ml) were refluxed for 6 hours, the mixture was evaporated to half volume, cooled, filtered and washed with ethanol absolute [22] .the solid (A) was lighting white ,melting point 115°C , yield 95%.

Synthesis of 5-phenyl-1, 3, 4-oxadiazole-2-thiol (B)

Benzohydrazide (A) (10 gm , 0.1mol), (4.1g, 0.1mol) of Potassium Hydroxide and carbon disulfide (5ml,0.1mol) were refluxed in ethanol absolute (100ml) .the solvent was
evaporated and acidified with HCl (25%) then the precipitated was filtered and the result solid was recrystallized from ethanol absolute [23]. The solid (B) was yellow, melting point 220°C, yield 70%.

Synthesis of 2-hydrazinyl-5-phenyl-1, 3, 4-oxadiazole(C)

5-phenyl-1,3,4-oxadiazole-2-thiol (B) (10gm, 0.1mol) and hydrazine monohydrate (4ml, 0.1mol) in ethanol absolute as solvent (50 ml) were refluxed for 15 hours. White precipitate appeared in round bottom[24]. White precipitate was filtered and recrystallized from ethanol absolute. melting point 240°C, yield 85%.

Synthesis of 2, 2'-(1Z, 2Z)-ethane-1, 2-diylienedi (2Z) hydrazin-1-yl-2-ylidene] bis (5-phenyl-1, 3, 4-oxadiazole (L)

The ligand was synthesized by condensation of 2-hydrazinyl-5-phenyl-1,3,4-oxadiazole (C) and glyoxalin in 2:1 molar proportions in ethanol absolute (100ml) then the mixture refluxed for 10 hours (monitored by TLC) [25] [26]. The ligand was precipitated, filtered and recrystallized from ethanol absolute to get brown ligand melting point 200°C, yield 60%.
Preparation of Complexes

The complexes were synthesized by mix (0.001 mol) from ligand with salts (CoCl2.6H2O, CrCl3.6H2O and NiCl2. 6H2O) both alone in (100ml) ethanol absolute and refluxed for 2 hrs (monitored by TLC) then the precipitate was filtered and wash several times with ethanol or aqueous ethanol to removed unreached salts or ligand, then precipitated complexes was dried [27].

Analysis and Physical Measurements

Physical properties and elemental microanalysis CHN shown in Table 1

Table 1: Physical properties, elemental microanalysis data of the ligand and its complexes

<table>
<thead>
<tr>
<th>No</th>
<th>Formula</th>
<th>Color</th>
<th>C%</th>
<th>H%</th>
<th>N%</th>
<th>Λ Scm² mol⁻¹</th>
<th>M.p °C</th>
<th>µeff B.M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C₁₀H₁₂N₂O₄(L)</td>
<td>brown</td>
<td>57.91Exp.</td>
<td>57.75 Cal.</td>
<td>3.68Exp.</td>
<td>3.77 Cal.</td>
<td>29.88 Exp.</td>
<td>29.93 Cal.</td>
</tr>
<tr>
<td>2</td>
<td>Cr(L₂)Cl₂</td>
<td>Black</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>32</td>
<td>210</td>
<td>4.18</td>
</tr>
<tr>
<td>3</td>
<td>Co (L) Cl₂</td>
<td>Dark grey</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>11</td>
<td>170</td>
<td>0.93</td>
</tr>
<tr>
<td>4</td>
<td>Ni(L)Cl₂</td>
<td>black</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>12</td>
<td>162</td>
<td>0.41</td>
</tr>
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</table>

FT-IR Spectral

FT-IR of the synthesized ligand and its complexes were carried out using KBr disc to ligand and CsI for complexes. The free ligand (L) exhibited six major bands at (3316) cm⁻¹, (1644) cm⁻¹, (1538) cm⁻¹, (1487) cm⁻¹, (1326) cm⁻¹, and (1081) [28] Which are attributable to (υNH₂), (υC=N) imine, (υC=O)Oxa, (υC-O-C)sym, (υ C-O-C)asy and structure movement bands respectively, as shown below(table 2). New bands were formed attributed to the coordinated (M- N), (M- O) and (M-Cl) bonds and appeared at the region (567-559) cm⁻¹ (499) cm⁻¹ and (290-292) cm⁻¹ respectively. This indicates that the coordinate occurred through the (N), (O) and (Cl) atoms.

Table 2: Infrared spectra of L and its metal complexes (υ cm⁻¹)

<table>
<thead>
<tr>
<th>NO</th>
<th>u(NH)</th>
<th>u(C=N) imine</th>
<th>u(C=N) oxadiazole</th>
<th>u (C-O-C)</th>
<th>Struc. Movement</th>
<th>M-N</th>
<th>M-Cl</th>
<th>M-O</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>3488</td>
<td>1644</td>
<td>1538</td>
<td>1487</td>
<td>1326</td>
<td>1081</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>1</td>
<td>3485</td>
<td>1644</td>
<td>1538</td>
<td>1455</td>
<td>1326</td>
<td>1076</td>
<td>567</td>
<td>292</td>
</tr>
<tr>
<td>2</td>
<td>3488</td>
<td>1644</td>
<td>1538</td>
<td>1455</td>
<td>1326</td>
<td>1078</td>
<td>562</td>
<td>291</td>
</tr>
<tr>
<td>3</td>
<td>3486</td>
<td>1684</td>
<td>1538</td>
<td>1455</td>
<td>1326</td>
<td>1076</td>
<td>559</td>
<td>290</td>
</tr>
</tbody>
</table>

Nuclear Magnetic Resonance

The ¹H-NMR spectra of the ligand showed signals at (6 ppm, 2H) and (9. 2 ppm, 2H) due to N-H protons and C-H protons respectively. Signals at [ (7.4-7.8) ppm, 10H] due to chemical shifts of aromatic ring protons linking the oxadiazole ring [29] as shown in the Figure below.

Mass Spectra

The mass spectra of ligand appeared molecular ion peak at 374 m/z which is in conformity with the molecular formula C₁₅H₁₄N₆O₄. Other peaks are due to the subsequent fragments like [C₁₅H₁₄N₆]⁺=342 m/z, [C₁₀H₈N₆O]⁺=229 m/z, [C₉H₇N₄O]⁺=187 m/z, [C₈H₆N₃O]⁺=160 m/z, [C₇H₅N₂O]⁺=145 m/z, [C₆H₄N]⁺=136 m/z, [C₅H₃NO]⁺=119 m/z, [C₅H₅]⁺=64 m/z, [C₅H₃]⁺=64 m/z. The mass spectral of the Cr(III) complexes showed molecular ion peaks at 907 m/z corresponding to [Cr (L₂Cl₂)]⁺ stoichiometry. This complex shows another a fragmentation peaks at 872 m/z, 836 m/z, 801 m/z due to loss one, two and three chlorine atom respectively. The mass spectral of the Co(II) complexes showed molecular ion peaks at 504 m/z corresponding to [Co(L)Cl₂]⁺ stoichiometry. This complex shows another a
fragmentation peaks at 469 m/z, 433 m/z due to loss one and two chlorine atom respectively. The mass spectral of the Ni(II) complexes showed molecular ion peaks at 504 m/z corresponding to [Ni(L)Cl₂]^+. This complex shows another a fragmentation peaks at 469 m/z, 433 m/z due to loss one and two chlorine atom respectively.

**Magnetic Susceptibility**

The magnetic momentum for each metal complex is listed in table 1. These magnetic measurements give an idea about the electronic state of the transition metal ion of the complexes. The observed magnetic momentum value of Cr (III) complex was 4.18 BM, expected for octahedral geometry. The magnetic momentum value was 0.93 BM for Co (II) complex with six paired electrons, this value confirms that cobalt (II) is oxidized to cobalt (III) suggesting octahedral geometry. 0.41 BM for Ni (II) suggesting square planar geometry respectively [30].

**Biological Study**

The antibacterial efficiency of ligand and its complexes were evaluated by using agar spread method. Two type of bacteria have been used, Gram Positive Bacteria as Staphylococcus Aureus and Gram Negative Bacteria as Escherichia Coli (E. Coli), using Ampicillin as standard drug. The bacteria inhibition was calculated in millimeter. Nutrient agar was used as culture medium, dim ethyl Sulfoxide used as solvent. The concentration of all compounds in this solvent was 10-3, using disc susceptibility test.

These techniques include the exposure of the zone of inhibition toward the spread of bacteria on agar dish. The dishes were Put in the incubator for 24hr. at 37 °C [31]. From the observation of the results in Table (3), Affirms that all compound shows good antibacterial activity. Out of all the synthesis compounds Nickel (II) complex is more bactericidal than others even the standard drug.

**Table 3: Anti-bacterial data of ligand and its complexes**

<table>
<thead>
<tr>
<th>Antibacterial Data of Compounds (3) Compound</th>
<th>Escherichia coli Inhibition zone(mm)</th>
<th>Staphylococcus Aurens Inhibition zone(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>L= C₆H₆N₈O₂</td>
<td>...</td>
<td>25</td>
</tr>
<tr>
<td>[Cr(L₂)Cl₂]Cl</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>[Co(L₂)Cl₂]</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>[Ni(L₂)Cl₂]</td>
<td>40</td>
<td>32</td>
</tr>
</tbody>
</table>

**Electrostatic Potential (MEP) .Molecular**

Electrostatic potential is very important in finding the active site in the molecule system with a positive point charge. The species that have positive charge tend to attack a strongly negative (electrophilic attack). Electrostatic potential of free ligands were measured and plotted as 2D contour to find the active site of molecule [32] as shown in Figures [1-5].
Figure 2. HOMO Electrostatic Potential as Contours for L.

Figure 3. Graphical presentation of stereochemistry of the complexes \([\text{Cr}(L)_2\text{Cl}_2]\)Cl.

Figure 4. Graphical presentation of stereochemistry of the complex \([\text{Co}(L)_2\text{Cl}_2]\).

Figure 5. Graphical presentation of stereochemistry of the complex \([\text{Ni}(L)_2\text{Cl}_2]\).
Figure 5. IR spectra of Ligand

Figure 7. IR spectra of \([\text{Cr}(L)_2\text{Cl}_3]\)Cl

Figure 8. IR spectra of \([\text{Co}(L)_2\text{Cl}_2]\)

Figure 9. IR spectra of \([\text{Ni}(L)_2\text{Cl}_2]\)
References


