Preparation, Characterization and Biological Activity of some Metals (II) with Glycine Complexes

Sumayyah M. A. Othman,¹ Farrhat F. Mohammed² & Omelhana O. Hamad³

(¹Authority of Natural Science Research and Technology, Tripoli, Libya. ²,³Chemistry Department, Faculty of Science, EL-MARJ, University of Benghazi, Libya)

Abstract.

In this work-study metals (II) coordination compound of Glycine were preparation and characterized using by infrared and UV-V is spectroscopy technique and Magnetic Susceptibility Measurements (BM). The complexes were studed for biological activity (an antibacterial activity of the complex).The stoichiometric the reaction between the metal(II) ion and ligands ion molar ratio(1:2)[where M= Ni,Co, Zn and glycine].

Keywords preparation of complexes, UV-V is spectroscopy technique, biological activity.

ملخص: 

في هذا العمل تم تحضير معقد من المعادن الثنائية مع الجليسي وتم تمييزها باستخدام الأشعة تحت الحمراء والأشعة فوق البنفسجية وهي تقنية التحليل الطيفي وقياسات الحساسية المغناطيسية (BM). تم دراسة المعقدات من أجل النشاط البيولوجي (نشاط مضاد للجراثيم للمعقد). القياس المتكافئ هو التفاعل بين أيون المعادن (II) ونسبة مولية الأيونية الرابطة (1: 2) [حيث Ni = M] 

الكلمات الأساسية: تحضير المعقدات، الأشعة فوق البنفسجية، تقنية التحليل الطيفي، النشاط البيولوجي.
1. INTRODUCTION.

In recent years transition metals amino acid complexes have received much attention because the proved to be useful antibacterial agent applied against staphylococcus aureus, Escherichia coli, nutritive supplies for humans and animals [1,2]. Twenty natural amino acids comprise the building block of proteins, which are chemical species indispensable to perform a large number of biological function [3]. From these twenty amino acid, eight are essential and cannot be products by human body. Complexes of transition metal with amino acids in proteins and peptides are utilized in numerous biological processes, such as oxygen conveyer, electron transfer and oxidation. In these processes the enzymatic active site which is very specific, forms complexes with divalent metal ions [4]. This has mandated continued search for new antimicrobial compounds, including coordination complexes of biologically important molecules [5-8]. The increased lipophilic character of these coordinated compounds, with the resultant enhanced ability to permeate the cell membrane of the microbes, have been suggested as reasons for their improved activity over their parent ligands [9,10]. Chelation, which has been reported to reduce the polarity of the metal ion by partial sharing of its positive charge with the donor group of ligands, also supports this theory [11,12]. The study of model species such as the simple amino acids can assist in the interpretation of more complex system. Amino acid. H at the other end and sufficient Glycine has the neutral donor N at one end and acidic replaceable length to span two adjacent coordinating sit and the resulting complexes is a non-electrolyte chelate or inner complex compound.

Glycine is the simplest amino acid in the body and the only protein amino acid that does not have optical isomers, Glycine consists of a single carbon molecule attached to an amino and a carboxyl group. Its small size helps it to function as a flexible link in proteins all allows for the formation of helices, an extracellular signaling molecule, recognition sites on cell membranes and enzymes, a modifier of molecular activity via conjugation and Glycine extension of hormone precursors. There is substantial experimental evidence that free Glycine may have a role in protecting tissue, against insults such as ischemia hypoxia and reperfusion (4) Glycine is a necessary building block for all protein in the body, Glycine plays a major role in calcium absorption, building muscle protein, recovering from surgery or sports.
injuries and body's production of hormones, enzymes and antibodies. It has been suggested that Glycine may be beneficial for those with herpes simplex infection [13].

2. MATERIALS AND METHODS.

2.1. General.

All reagents and solvents used were of analytical grade. Melting points (M.P) were measured using open capillary tubes on a Gallen-kamp (variable heater) melting point apparatus. The UV-Vis spectra were obtained using a Genesis 10 UV-Vis.

2.2 Preparation of complexes.

The Zn(II),Ni(II),Co(II) complexes of glycine ligand were prepared in 1:2 [metal : ligand] ratio by the addition of 0.01 M of appropriate metal salt (0.362gm, 0.499gm and 0.525gm for zinc, cobalt and nickel respectively) to a solution of the glycine 0.03 M (3.0gm) dissolved with stirring in distilled water with the addition of C2H3NaO2 (0.71gm) dissolved in 1ml distilled water with stirring then add to mixture drop by drop. The mixture was then heated on a water bath for 3 h. An immediate precipitation was obtained for majority of the complexes, while some required further concentration and cooling. The products obtained were filtered, washed with ethanol and dried in air.

2.3 Test organisms.

*Escherichia coli* and *Staphylococcus aureus*. The bacterial strains which obtained from Al Marj hospital.

2.4 Antibacterial activity determination.

The following microorganisms were tested: Gram negative- *Escherichia coli*; Gram positive *Staphylococcus aureus*, were cultivated and stored in Nutrient Agar (NA), the Muller-Hinton agar medium was used for antibacterial assay. The agar diffusion method was used to assess the antimicrobial activity of the extracts Equip the bacterial suspension by take from 3-5 colonies of bacteria and put in 3-4 ml Normal saline then take from suspension 100 µl and put in all agar plates by sterile cotton swab. containing bacterial cultures incubated for 24 hours at 37°C then, the extracts were applied directly on agar plates using the drop method (100µL) [21,22]. Then the
prepared extracts are poured into the well in the standard concentration (100μL). All the plates were incubated for 24 hours at 37°C. Then the presence of zone of inhibition could be measured on the plates. All tests were performed in triplicate, and clear zones greater than 7 mm were considered as positive results because Cork borer was 7 mm in diameter [14].

2.5 UV-visible spectroscopy.
The UV-Visible transmittance spectra of the complexes were recorded on a Shimadzu UV-Vis 160 spectrophotometer, in quartz cells at the desired wavelength region. 3mM solution of complexes in DMSO was used in all UV-Visible measurements.

2.6 Magnetic Susceptibility Measurements (BM).
Magnetic susceptibility measurements have been widely used in studying the complexes of transition metals, if most of these metals possess a single electron and show characteristics. From the calculations and values of magnetic measurements, you can determine the Molecule formula and the geometry as well as the complex geometrical shape. Also from the obtained result, M-L is concluded to be a high spin complex or M-L as a low spin complex [14,15]. Magnetic susceptibility measurements are used to determine the extent of electron pairing, the stereochemistry and metal-metal interactions in the complexes.

3. RESULTS AND DISCUSSION.
3.1. Physicochemical Properties.
The complexes showed a wide range of colors that. Were in agreement with those obtained for similar coordination compounds.

Table 1. Some physical properties of the prepared complexes:

<table>
<thead>
<tr>
<th>Complexes</th>
<th>Color</th>
<th>MP (°C)</th>
<th>Wt of product (gm)</th>
<th>% Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Zn(Gly)₂]⁺²</td>
<td>Yellowish white</td>
<td>240</td>
<td>2.09</td>
<td>68.5</td>
</tr>
<tr>
<td>[Co(Gly)₂]⁺²</td>
<td>pink</td>
<td>225</td>
<td>2.45</td>
<td>59.7</td>
</tr>
<tr>
<td>[Ni(Gly)₂]**²</td>
<td>Bluish white</td>
<td>247</td>
<td>1.34</td>
<td>75.7</td>
</tr>
</tbody>
</table>

3.3 Magnetic Susceptibility Measurements (BM).
The magnetic susceptibility values of the complexes are Co(II) complex exhibited magnetic moment of (d⁶)(5.46M.B) with paramagnetic indicating the high spin
distorted octahedral geometry of the complex. The Ni(II) complex exhibited magnetic moment of \((d^8)(2.48\text{M.B})\) with paramagnetic indicated the Low spin nature of the complex octahedral geometry and four (square planar/tetrahedral)[5,20]. Also Zn(II) complex exhibited magnetic moment of \((d^{10})\) with diamagnetic indicated the Low spin nature of the complex and have tetrahedral geometry.

3.4 Infrared Spectra.
The Infrared spectra results study includes the figures (a,b,c) where comparing their vibration frequency with those of Glycine with metal ion.

3.4.1 Glycine - Complexes.
The Infrared spectra for Glycine indicate broadband at \(3170\text{cm}^{-1}-2529\text{cm}^{-1}\) and a medium band \(1507\text{cm}^{-1}\) correspond to \(-\text{NH}_2\) stretching. Where is this site shifted of the free ligand \((-\text{NH}_2)\) group which are coordination of the metal ions with the ligand was via the nitrogen atom [17-19]. It was also confirmed by similar shifts in the weak C-N stretching frequency of the ligand at \(1110\text{ cm}^{-1}\) to higher frequencies in the complexes [16].

New band at \(891\text{cm}^{-1}-886\text{cm}^{-1}\) and \(781\text{cm}^{-1}-694\text{cm}^{-1}\) were includes to the [M-N] and [M-O] bond stretching band frequencies, respectively and served as further evidence of coordination via the nitrogen and oxygen atoms of the ligand. While Ni(II) complex at \(3982\text{cm}^{-1}, 3153\text{cm}^{-1}\) and Zn(II) complex at \(3056\text{cm}^{-1}, 2824\text{cm}^{-1}\) and Co(II) complex at \(3007\text{cm}^{-1}, 2875\text{cm}^{-1}\).

These results correspond with literature value being similar to other metal complex with amino acid[17-19].

![Fig.1 (a). IR Spectra of [Ni(Gly)]2+](image)

![Fig.1 (b). IR Spectra of [Zn(Gly)]2+](image)
3.5 Electronic Spectra and UV visible spectra.

The electronic spectral data of the complex are give figures(d,e,f) of the prepared complexes show that the band of the ligand which is corresponding to n→π* is changed to higher wavelength in Zn(II), Ni(II) and Co(II) complexes indicating to combination of H₂N: → M and N: → M LMCT transition.

![Fig.1 (c). IR Spectra of [Co(Gly)₂]²⁺](image)

Fig.1(c). IR Spectra of [Co(Gly)₂]²⁺

![Fig.(d,e,f) UV/Vis Spectra complexes(Ni(II),(Co(II),Zn(II) with Glycine](image)

Fig.(d,e,f) UV/Vis Spectra complexes(Ni(II),(Co(II),Zn(II) with Glycine

The absorption band of complex showed ligand to metal charge transfer corresponded to the fig. (d, e, f). The d-d transition of the Co(II) complex have two absorption band 520nm,667nm in visible region due to the ⁴T₁g(F) → ⁴A₂g(F) and ⁴T₁g(F)→ ⁴T₁g(P) transition octahedral geometry. The d-d transition suggesting that the Ni(II) complex absorption band at 505nm,523nm and 544nm octahedral geometry and transition ³A₂g(F) → ⁷T₁g(F) , ³A₂g(F) → ¹T₁g(F) and ³A₂g(F) → E₁g transitions, respectively [23]. The d-d transition of the Zn(II) complex transition suggesting d-d transfer is intense charge transfer transition which are assigned to (INCT) [24-27].

3.6. Antibacterial activity.

There is no effect for free Glycine on the type of bacteria *Escherichia Coli* but we find that bacteria *Streptococcus* are more effective from the bacteria *Easy domonas* and this is as shown in the (table2). Also the Zn(II) complex has more effect on the three types of bacteria compared to the Ni(II),Co(II) complexes while the found
Ni(II) complex an effect on of bacteria *Streptococcus* from the Co(II) complex as shown in the (table2) [21-22].

**Table2.** Antibacterial for the Glycine and their Co(II), Ni(II) and Zn(II) Complexes:

<table>
<thead>
<tr>
<th>Glycine</th>
<th><em>Esherichia Coli</em></th>
<th><em>Streptococcus</em></th>
<th><em>Easy domonas</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>[Ni(Gly)₂]²⁺</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[Co(Gly)₂]²⁺</td>
<td>Resist</td>
<td>Resist</td>
<td>+</td>
</tr>
<tr>
<td>[Zn(Gly)₂]²⁺</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>

3.7. The effect of some antibiotics on the growth of laboratory bacteria.

Looking at the results in the (table3) recorded the effects of 3 commercial antibiotics available in pharmacies, which are the most common used and effective where we find that the antibiotic is the most effective of those antibiotics on *Esherichia Coli* bacteria is *Chloramphenicol* effect on different types of bacteria. As for the *CLINDAMYCIN* antibiotic, it had an effect on only one type of bacteria *Streptococcus* while the antibiotic *Ampicill/Sulbactam* dose not have any effect on these bacteria.

**Table3.** The effect of some antibiotics on the growth of bacteria:

<table>
<thead>
<tr>
<th></th>
<th><em>Esherichia Coli</em></th>
<th><em>Streptococcus</em></th>
<th><em>Easy domonas</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloramphenicol</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>CLINDAMYCIN</td>
<td>Resist</td>
<td>+</td>
<td>Resist</td>
</tr>
<tr>
<td>Ampicill/Sulbactam</td>
<td>Resist</td>
<td>Resist</td>
<td>Resist</td>
</tr>
</tbody>
</table>

4. Conclusion.

This study indicates that the bonding of the metals ionic with Glycine is bi dentate through nitrogen and oxygen atoms. This was confirmed by Characterization of IR, UV Spectra and Magnetic Susceptibility.

Antibacterial activity effect of the Glycine on the type of bacteria *Esherichia Coli* but we find that bacteria *Streptococcus* are more effective from the bacteria *Easy domonas* and complexes but found type only one effected on Co(II) complex is *Easy domonas*. Also effect of some antibiotics on the growth of laboratory bacteria find of the effect *Esherichia Coli*, *Streptococcus* and *Easy domonas* bacteria is *Chloramphenicol* and also effect CLINDAMYCIN on *Streptococcus* only.
References


