Synthesis and Characterization of Nickel, Palladium, Platinum and Cupper with New Oxazipine Ring

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Abstract
Via cycloaddition reaction new seven membered Oxazipine ring was prepared by reaction of Schiff base with phthalic anhydride. Then we use the Oxazipine ring as ligand in this research and complexation with four transition metals Nickel, Palladium, Platinum and Cupper. Many techniques were used to identify the produced compound such as Melting Point, FT-IR, $^1$H NMR and UV-Vis. Finally and by evidences we conclude the geometry and hybridization of all prepared complexes.

Keywords: Oxazipine ring, Oxazipine complexes, thiosemicarbazide, tridentate ligand.

1. Introduction
Oxazepine is non-homologous seven member ring that contains two heteroatom (Oxygen and Nitrogen). Oxazepine and their derivatives have some important biological pharmacological activities [1] such as enzyme inhibitors [2], analgesic [3], antidepressant [4], and psychoactive drugs [5] Amoxapine is a group of drugs called tricyclic antidepressants. It is used to treat symptoms of depression, anxiety and agitation [6].

Oxazepine derivatives showed various biological activities, such as antibacterial[7], Antimicrobial and anticonvulsant activity[8], as telomerase inhibitors[9], as Potent agonists of the human TRPA1 receptor[10], inhibitors for some enzymes action[11], Some of oxazepine derivatives are used in another applied fields[12].

The usual method for preparing 1,3-oxazepine ring are limited[13] cycloaddition reaction (2+5→7) was used for many studies to the synthesis of different 1,3-oxazepine ring [14]. In this type of cycloaddition, two atoms of imine group as two-membered component was added to five-membered component such as phthalic anhydrides to give a seven-membered ring [15].

In this paper, The intermediate Schiff base used in this reaction which is synthesized by the usual condensation reaction in which an 4-chlorobenzaldehydes with a primary amine which is synthesized be nucleophilic substitution reaction of ethyl 4-aminobenzamide with thiosemicarbazide to produce an imine compound[16].

2. Materials and Method
2.1 Materials
The chemical materials which are used in this research were obtained from sigma Aldrich company [glacial acetic acid and H$_2$SO$_4$] Fluka, [CuSO$_4$.5H$_2$O, NiCl$_2$.6H$_2$O, PtCl$_4$ and PdCl$_2$], GCC [4-chlorobezaldehyde, phthalic anhydride and thiosemicarbazide], and Merck [4-aminobenzoic and ethanol] also it used without purification. FT-IR spectra were taken on SHIMADZU FTIR-8400S with of KBr discs. of .The prepared compounds also have been characterized by $^1$H NMR spectra worked out on NMR spectrometer, Bruker 2009 spectrometer at 400MHz in DMSO-d$_6$ as solvent. Electronic spectra of our compounds were tested on
SHIMADZU UV-1800 photometer. Electro thermal apparatus Stuart SMP 30 was used to determine the Melting points of compounds.

2.2 Ligand synthesize

Ethyl 4-aminobenzoate

The Ester compound was prepared by the reaction of 4-aminobenzoic acid 0.001 mole [0.2 gm] with absolute ethanol[50 mL], 2 mLH₂SO₄ was added to the mixture and then reflux under 70 o C with reflux on the water bath for 2h. The produced ester was filtered after cooling and then washed by ethanol and dried at oven [17] then characterized by melting point and FT-IR spectroscopy, the yield was 85%.

2-(4-aminobenzoyl)hydrazinecarbothioamide

The Amide compound was prepared by addition of dissolved thiosemicarbazide 0.001 mole [0.1gm] to an prepared ester 0.001 mole [0.18 gm] in the first step in presence of ethanol as solvent the reaction refluxed to 71º C, after 3h cooling the mixture and the brownish precipitate was filtered and washed by ether [17] then characterized by melting point and FT-IR spectroscopy, the yield was 90%.

2-(4-aminobenzoyl)-N-(4-chlorobenzylidene)hydrazinecarbothioamide

The Schiff base produced from the reaction of prepared amide 0.0002 mole [0.05 gm] with 4-chlorobenzaldehyde 0.0002 mole [0.035gm] in presence of ethanol as solvent and 1mL of glacial acetic acid as catalyst the reaction is progress under continuous stirring and heating to 70º C, after 1.5 h. the mixture was cooled and filtering the formed Schiff base then washed by ethanol [18]. Schiff base compound also characterized by melting point, ¹H NMR spectroscopy and FT-IR spectroscopy, the yield was 79%.

4-amino-N'-(3-(4-chlorophenyl)-1,5-dioxo-1,3,4,5-tetrahydrobenzo[e][1,3]oxazepine-4 carbonothioyl)benzohydrazide

The Oxazipine compound was prepared as final product and consider the ligand of this research, as shown in previous study [15] A mixture of an prepared Schiff base 0.0001 mole [0.003 gm] and phthalic anhydride 0.0001 mole [0.015 gm] in dry benzene [20 mL] were refluxed on the water bath at 70 ºC for 6 h. The mixture allowed to cool and the product was filtered and dried in oven washed by methanol and characterized by melting point, ¹H NMR spectroscopy and FT-IR spectroscopy, the yield was 75%.

2.3 Complexes synthesize

our complexes were prepared As shown in the study [19] by the addition of heated solution of the metals salt [CuSO₄·5H₂O , NiCl₂·6H₂O, PtCl₄ and PdCl₂ ] , [0.01mole] in appropriate amount of Methanol [10 mL]to the stirred and heated solution [65 ºC] of the Oxazipine [ 0.01 mole] previously dissolved in the Methanol. All the complex were characterized by melting point, FT-IR, ¹H NMR and UV-visible spectrum. All the steps of the preparation of ligand and complexes were involved in the below flowchart.
3. Results and Discussion

3.1 Identification of ester

Melting point of first prepared compound was 205°C while for starting material [4-amino benzoic] equal to 187°C [20]. The yellowish ester also identified by FT-IR spectroscopy and show specified bands at: 3414-3342, 1731 and 1584 cm⁻¹ belong to stretching of \(-\text{NH}_2\), C=O carboxyl group and C=C in aromatic ring respectively[21] as shown in fig. 3.1

![Fig 3.1 FT-IR spectra of ester compound](image)
3.2 Identification of Amide
Melting point of second prepared compound was 145-143°C and its color was orange. The amide compound also identified by FT-IR spectroscopy and show the specified bands: abroad and strong band at 3171-3200 cm\(^{-1}\) belong to interaction of absorption bands of \(-\text{NH}_2\) and two \(-\text{NH}\) groups, a bands at 1668, 1600, and 1519 cm\(^{-1}\) belong to stretching of amidic C=O group, C=S and C=C in aromatic ring respectively[21] as shown in fig. 3.2

![Fig 3.2 FT-IR spectra of amide compound](image)

3.3 Identification of Schiff Base
Melting point of third prepared compound was 180°C and its color was red. The Schiff base compound also identified by FT-IR and \(^1\)HNMR spectroscopy

**FT-IR**
The FTIR spectra of Schiff base compound showed the specified bands at 3212 – 3169, 2972, 1670, 1666, 1599, 1518 cm\(^{-1}\) belong to stretching of, -NH\(_2\), aromatic C-H, C=O amide group, C=N imine group, C=S and C=C in aromatic ring respectively[22] as shown in fig. 3.3.

![Fig 3.3 FT-IR spectra of Schiff base compound](image)
**1H NMR**
The $^1$H NMR spectrum was recorded for Schiff base and showed the chemical shifts; singlet at 2.3 ppm and singlet at 2.5 belong to protons at N-H group attached directly with C=O and C=S respectively, two chemical shifts at 6.2-6.5 ppm and 8 ppm are belong to two aromatic ring finally the singlet chemical shift at 8.3 ppm is attributed to proton is attached with C=N group[23] fig 3.4.

![Fig 3.4 $^1$H NMR spectra of Schiff base compound](image)

3.4 identification of Oxazipine
Melting point of ligand was 220° C and its color was brown. The Oxazipine compound also identified by FT-IR and $^1$HNMR spectroscopy.

**FT-IR**
In the FTIR spectra of Oxazipine compound we noticed disappearing absorption band of C=N bond and showed the specified bands at 3383 – 3351 , 2972, 1697- 1685 1589 and 1558 cm$^{-1}$ belong to stretching of, -NH$_2$, aromatic C-H, three groups of C=O amide group, C=S and C=C in aromatic ring respectively as shown in [22] fig. 3.5.

**$^1$H NMR**
The taken $^1$H NMR spectrum for ligand didn’t show additional specified chemical shifts than those found in the $^1$H NMR spectrum for Schiff base compound since they chemically similar from environment of protons; singlet at 2.1 ppm and singlet at 3.5 belong to protons at N-H group attached directly with C=S and C=O respectively, multiple signal chemical shifts at 7-7.5 ppm belong to two aromatic ring finally the singlet chemical shift at 9 ppm is attributed to proton is attached with C=N group [24] fig 3.6.

**Electronic spectra**
Electronic spectra of the ligand was recorded in DMSO solutions in the region 190 – 1100nm [UV - Vis] and given the bands showed in fig 3.7 UV-vis. The electronic spectrum of ligand show two bands at 200 nm and 250 nm attributed to transition $\pi\rightarrow\pi^*$ in aromatic ring and n$\rightarrow\pi^*$ C=S, C=O, ph-NH$_2$ and ph-Cl) transitions[25].
Fig 3.5 FT-IR spectra of Oxazipine compound

Fig 3.6 $^1$H NMR spectra of Ligand
3.5 identification of complexes

The physical properties of the prepared complexes were recorded in the below table:

| Product                | Color         | Melting point °C |
|------------------------|---------------|------------------|
| Complex of Nickel      | Green         | 216              |
| Complex of Copper      | Violet        | 235              |
| Complex of Palladium   | Brownish red  | 228              |
| Complex of Platinum    | Dark brown    | 210              |
| Original Ligand        | Brown         | 220              |

The complexes were identified by $^1$H NMR and UV-Vis spectroscopies. The same chemical shifts in the $^1$H NMR spectrum of ligand were showed at spectra of all ligand as expected result because all the protons in a ligand and complexes are environmentally similar that also consider an evidence of stability of ligand at the temperature of reaction. The appeared signals are: ; singlet at 2.2-2.5 ppm and singlet at 3.1-3.7 belong to protons at N-H group attached directly with C=O and C=S respectively, multiple signal chemical shifts at 6.5-8 ppm belong to protons in two aromatic ring finally the singlet chemical shift at 8.5 – 9.2 ppm is attributed to proton is attached with C=N group[24], figures 3.7 – 3.10.
Fig 3.8 $^1$H NMR spectra of copper complex

Fig 3.9 $^1$H NMR spectra of platinum complex
Electronic spectra

By comparison of two broad bands appeared in UV-Vis. spectra of ligand as we noted above and we attributed it to $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transitions with the obtained bands of complexes which is caused by d→d transitions as detailed: the UV-Vis chart of cupper II complex show a broad band at approximately 200nm caused by Eg→T$_2g$ transition according to Orgel d$^9$ diagram. It also show a small shoulder at 250nm caused by Jan-teller distortion[26] fig3.10.

The Electronic spectra of Nickel II complex show two bands at 250nm and 300nm may be due to absorption of transition: A$_{2g} \rightarrow$T$_{1g}$ and T$_2 \rightarrow$T$_1$ respectively according diagram of tanabe-sugano. Fig 3.11
Palladium II complex also tested by UV-Vis spectroscopy and show bands are approximately similar to those of nickel complex and this is expected because the electronic configuration of d orbital at Ni\(^{+2}\) and Pd\(^{+2}\) are similar. Two a broad absorption bands at 255nm and 310nm may be due to absorption of transition: \(A_2 \rightarrow T_1\) and \(T_2 \rightarrow T_1\) respectively[27]. Fig 3.12

![Fig 3.12 UV-Vis spectra of Cu\(^{+2}\) complex](image1)

![Fig 3.13 UV-Vis spectra of Cu\(^{+2}\) complex](image2)
Fig 3.14 UV-Vis spectra of Pd$^{2+}$ complex
4. Conclusion
The esterification of 4-amino benzoic acid by ethanol carried out at 70 °C to 2h in presence of sulfuric acid as catalyst. The produced ester reacted at next step with thiosemicarbazide at reflux reaction continued to 3h at 71°C to produce amide compound. The terminal NH$_2$ was condensed with CHO at chlorobenzoic acid at third step, the condensation reaction was progressed under reflux reaction for 1.5h awhile in presence of glacial acetic acid to formation of Schiff base compound. Synthesis of ligand [Oxazipine ring] has take placed according to 2+5 cycloaddition reaction since the imine group of Schiff base was added to phthalic anhydride to produce a final product in ligand synthesis reaction.

Complexation reaction was carried out of synthesized ligand with chloride salts of Nickel II, Cupper II, Palladium II and Platinum IV. The resulting complexes were characterized by $^1$HNMR and UV-Vis spectroscopy. Appearing of bands in UV-Vis spectrum of complexes belong to d→d transitions and disappearing of bands belong to π→π* and n→π* in ligand consider indicator of successful of complexation reaction as the analogous of $^1$H NMR charts of both ligands and complexes. The matching of UV-Vis spectrum of complexes with the diagrams of tanabe-sugana and orgel prove that the geometry of all complexes is an octahedral with six coordinate number come from two moiety of ligand that is mean three coordinating bond from our ligand which is donating an electron pair from three position [M(L)$_2$]. The geometry and hybridization of complex as we suggested:

| Complex of : | geometry  | hybridization |
|--------------|-----------|--------------|
| Cu$^{2+}$    | Octahedral| $\text{Sp}^3d^2$ |
| Ni$^{2+}$    | Octahedral| $\text{Sp}^3d^2$ |
| Pd$^{2+}$    | Octahedral| $\text{Sp}^3d^2$ |
| Pt$^{4+}$    | Octahedral| d$^2$Sp$^3$   |

Geometry of complex as we suggested n=2 in complexes of Cu, Ni and Pd ; n=4 in complex of Pt
5. References

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