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Synthesis, Spectroscopic and Antibacterial Studies of N(٢-amino phenyl)-N-((pyridine-٢-yl)methyl)Benzene-١,٢-Diamine Complexes

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Abstract

N(٢-amino phenyl)-N-((pyridine-٢-yl)methyl) benzene-١,٢-diamine (L) was prepared from the reaction of ortho amino phyenylthiol with N(٢-amino methyl pyridyl) phenyl diamine in mole ratio (١:١). It was characterized by elemental analysis (CHN),^{١}H, ^{١٣}C-NMR, IR and Uv-Vis. The complexes of the bivalent inos (Co (II), Ni (II), Cu (II), Pd (II), Cd (II) and Hg (II)) and the trivalent (Cr (III)) have been prepared and characterized too. The structural were established by elemental analysis (CHN), IR, Uv-Vis spectra, conductivity measurements, atomic absorption and magnetic susceptibility. The complexes showed characteristic behavior of octahedral geometry around the metal ions except with Cu and Pd complexes showed square planer, other parameters for complexes were estimated. The study of biological activity of the ligand (L) and its metal complexes showed various activity toward *staphylococcus aureus* and *E. coli*.

Keywords**:** Synthesis, characterization, complexes, benzene, pyridine, biological study.

Introduction

The chemistry of transition metal complexes has received consideration attention largely due to their catalytic of bioinorganic relevance. Such complexes are also important due to their potential biological activities such as antibacterial, antiviral, antifungal, antimalarial and antitumor [١].

Recently complexes containing macrocyclic ligand type $N_{٣}$ donor atoms play a very important role in biological system such as Ca^{II}, Fe^{II} and Pd^{II} complexes [٢] and high stable complexes of this type ligand with Tc, Re are used for radio pharmaceuticals application [٣,٤] and in magnetic resonance imaging [٥], also with Ni^{II} for used as catalyst for division DNA molecules and Fe^{II} complex with porphyrin as a model for biological proteins such as hemoglobin in blood[٦]. In this paper reports the synthesis and characteriazation of new ligand derived from the reaction of ortho amino phenyl thiol with N(٢-amino pyridyl) phenyl diamine, the new ligand complexes with (Cr^{III}, Co^{II}, Ni^{II}, Cu^{II}, Pd^{II}, Cd^{II} and Hg^{II}) were prepared too.

Experimental

a- Chemicals; All reagents were Analar or chemistry pure grade by British Drug Houses (BDH), Merk and Fluka.

Materials: orthoamino phenyl thiol ($C_{٦}H_{٧}NS$), N(٢-amino methyl pyrideyl) phenyl diamine ($C_{١٢}H_{١٣}N_{٣}$), chromium trichloridehexahydrate ($CrCl_{٣}.٦H_{٢}O$), Cobalt chloride hexahydrate ($CoCl_{٢}.٦H_{٢}O$), Nickel chloride hexahydrate ($NiCl_{٢}.٦H_{٢}O$), Copper chloride dihydrate ($CuCl_{٢}.٢H_{٢}O$), Mercury chloride ($HgCl_{٢}$), Ethanol ٩٩٪ ($CH_{٣}CH_{٢}OH$), Dimethyl fromamide ٩٩,٥٪ (DMF), Dimethyl sulphoxide ٩٩,٥٪ (DMSO), carbon tetra chloride ٩٩,٥٪ ($CCl_{٤}$), Chloroform ٩٩٪ ($CHCl_{٣}$), Toluene ٩٩٪ ($C_{٧}H_{٨}$).

b- Instruments

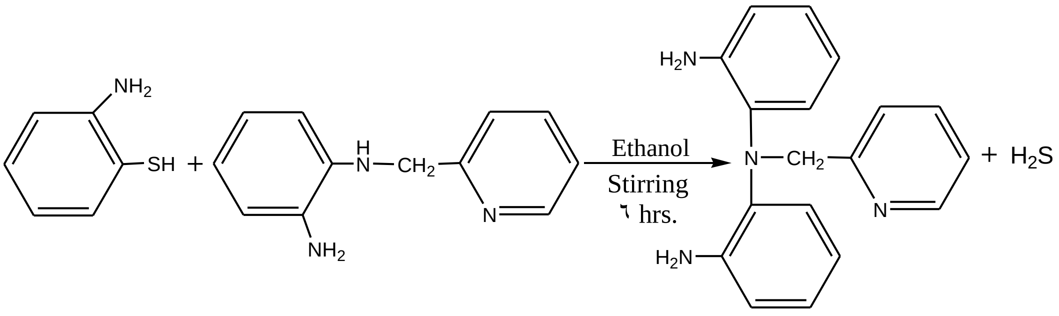
Elemental analysis for the new ligand (L) and complexes were determined by Calibration type; Linear Regression Euro EA Elemental analysis were mode in Al- Kufa University. Melting points were determined by Gallen-Kamp apparatus.^{١}H, ^{١٣}C-NMR spectra were recorded in DMSO using Bruker model; Ultrashield٣٠٠ MHz origin, Switzerland (Jordan) in $CH_{٣}OD$ using TMS as an internal standard.IR spectra were recorded as KBr discs in the range (٤٠٠٠-٤٠٠) cm$^{-١}$ using shimadzu- FTIR.UV- Visible spectra were recorded by shimadzu- UV- Vis- ١٦٠A ultra violet spectra photometer at ٢٥°C, using ١ cm quartz cell and etamind at the range of (٢٠٠-١١٠٠) nm at $١٠^{-٣}$ M in DMSO. Atomic Absorption (A.A) technique have been measured suing ashimadzu AA ٦٨٠G atomic absorption spectrophoto meter were made in center of Ibn-Cina. Molar conductivity of the complexes were measured on pw ٩٥٢٦ digital conductivity in DMSO at $١٠^{-٣}$ M. Magnetic susceptibility were recorded by magnetic susceptibility blance, model, Ms B-MK$_1$ and made in Al- Nahrain University.

Preparation

Synthesis of N (٢-aminophenyl)-N-((pyridine-٢-yl) methyl) benzene-١,٢-diamine (L).

Orthoaminophenylthiol (٠,١٢٥ gm. ١,٠٠ mmol) and N-pyridin-٢-ylmethyl) benzene-١,٢-diamine (٠,١٩٩ gm. ١,٠٠mmol) in ethanol (١٥ml) was stirred for ٦ hours. The precipitate was filtered and recrystallized from hot absolute ethanol, fine yellow crystals were obtained, m.p. ٧٧°C, yield ٨٠٪ and it is soluble in most organic solvents as shown in Table (١).

The ligand was obtained by the reaction of one mole of orthoaminophenylthiol and one mole of N-pyridin-٢-ylmethyl-benzene-١,٢-diamine, as shown below;



orthoamino phenylthiol

N-pyridin-2-ylmethyl-benzene-1,2-diamine

N(2-amino phenyl)-N-((pyridin-2-yl)methyl)bezene-1,2-diamine

Synthesis of the metal complexes

An ethanolic solution of the following metal salts $CrCl_{٣}.٦H_{٢}O$ (٠,٢٦ gm. ١,٠٠mmol), $CoCl_{٢}.٦H_{٢}O$ (٠,٢٤gm. ١,٠٠mmol), $NiCl_{٢}.٦H_{٢}O$ (٠,٢٤ gm. ١,٠٠ mmol), $CuCl_{٢}.٢H_{٢}O$ (٠,١٠ gm. ١,٠٠ mmol), $PdCl_{٢}$ (٠,١٧ gm. ١,٠٠ mmol), $CdCl_{٢}.٢H_{٢}O$ (٠,٢٢ gm. ١,٠٠ mmol) and $HgCl_{٢}$ (٠,٢٧ gm. ١,٠٠ mmol) were added to a solution of the ligand (L) (٠,٢٩ gm. ١,٠٠ mmol) in ethanol. The mixture was stirred of ٥٠ min. the precipitate formed was filtered, washed with distilled water and dried under vacuum. Color, melting point, yield, metal analysis and solubility of the ligand and its metal complexes are given in Table (١).

Table (١)

Some physical properties for theligand (L) and its metal complexes.

NO	Compound	no. of mole and gm	Color	m.p. °C	Yield %	Elemental analysis Found (calculateed)				
						C%	H %	N %	M %	Cl%
١	(L)$C_{١٨}H_{١٨}N_{٤}$	١,٠٠ ٠,٢٩	Yellow	٧٧-٧٩	٨٠	٧٤,٤٦ (٧٤,٤٨)	٦,٢٢ (٦,٢٠)	١٩,٣٠ (١٩,٣١)	-	-
٢	$LCrCl_{٣}$	١,٠٠ ٠,٢٦	Dark Green	١٥٢-١٥٤	٦٢	٤٨,١٦ (٤٨,١٦)	٤,٠١ (٤,٠١)	١٢,٤٨ (١٢,٤٨)	١١,٥٩ (١١,٥٩)	٢٣,٥٠ (٢٣,٥٧)
٣	$LCoCl_{٢}.H_{٢}O$	١,٠٠ ٠,٢٤	Dark blue	١٨٢-١٨٤	٧٤	٤٩,٣١ (٤٩,٣١)	٤,٥٦ (٤,٥٦)	١٢,٧٨ (١٢,٧٨)	١٣,٤٦ (١٣,٤٧)	١٦,١١ (١٦,٢١)
٤	$LNiCl_{٢}.H_{٢}O$	١,٠٠ ٠,٢٤	Light green	١٧٠-١٧٢	٦٠	٤٣,٩٥ (٤٣,٩٥)	٤,٠٩ (٤,٠٧)	١١,٣٩ (١١,٣٩)	٢٢,٨٧ (٢٢,٨٧)	١٦,٢٠ (١٦,٢٢)
٥	$LCuCl_{٢}$	١,٠٠ ٠,١٧	Brown	١٦٨-١٧٠	٥٨	٥٠,٨٨ (٥٠,٨٨)	٤,٢٣ (٤,٢٤)	١٣,١٩ (١٣,١٩)	١٤,٩٥ (١٤,٩٥)	١٦,٧١ (١٦,٧٢)
٦	$LPdCl_{٢}$	١,٠٠ ٠,١٧	Brown	١٥٦-١٥٨	٦٣	٤٦,٢١ (٤٦,٢١)	٤,٢٧ (٤,٢٧)	١١,٩٨ (١١,٩٨)	٢٢,٧٦ (٢٢,٧٦)	٢٦,٥٤ (٢٦,٥٥)
٧	$LCdCl_{٢}.H_{٢}O$	١,٠٠ ٠,٢٢	Light yellow	٢١٤(dec)	٨١	٤٣,٩٥ (٤٣,٩٥)	٤,٠٦ (٤,٠٧)	١١,٣٩ (١١,٣٩)	٢٢,٨٧ (٢٢,٨٧)	١٤,٤٣ (١٤,٤٤)
٨	$LHgCl_{٢}.H_{٢}O$	١,٠٠ ٠,٣٣	Light yellow	٢١٧(dec)	٨٧	٣٧,٢٧ (٣٧,٢٧)	٣,٤٥ (٣,٤٥)	٩,٦٦ (٩,٦٦)	٣٤,٥٩ (٣٤,٥٩)	٢٥,٤٠ (٢٥,٤٠)

dec.=Decomposition

Results and Discussion

١- ^{١}H-NMR spectrum for the ligand (L).

The^{١}H-NMR spectrum of the ligand (L) in DMSO-^{٦}d solvent are summarized amultiplet signal at (δ=٧,٠٥, ٧,٠٤, ٧,٠٦, ٧,٠٩ and ٧,١١ ppm) and a doublet, triplet signal at (δ= ٦,٧٣٧, ٦,٧٦٣), (δ= ٦,٤١, ٦,٤٤, and ٦,٤٦ ppm) which are due to aromatic hydrogen and carbon respectively of ligand (L) and a singlet signal at (δ= ٥,٤١ ppm) equivalent to protons assigned to (N–H) group, the chemical shift at (δ= ٣,٣٤ ppm) is due to solvent, while the chemical shift at (δ= ٢,٥٠ ppm) belongs to the methylene protons[٧].

٢- ^{١٣}C-NMR spectrum for the ligand (L)

^{١٣}C-NMR of the free ligand shows the signals of the C aromatic Carbon of the benzene ring that do not bear hydrogens were observed at (١٥٠,١٦, ١٣٥,٨٧ and ١٣١,٥٨ ppm) and signals at (δ ١١٧,٠٦, ١١٦,٥ and ١١٥,٣١ ppm) assigned to the carbon have one hydrogen. The methylene group ($H_{٢}$ —C —N$<$) appear at ٤٠,٠٦ppm [٨].

٣- The infrared spectrum of the ligand (L) and complexes

Infrared spectra of the ligand exhibit several absorption in common the bands at approximately (٣٣٧٩)cm$^{-١}$, (٣٣٠٠) cm$^{-١}$, (١٥٨٣) cm$^{-١}$ and (١٣٠٩) cm$^{-١}$ have been assigned to the υ(N–H)[٩]. In (٢٦٠٠-٢٥٠٠) cm$^{-١}$ region disappearance of absorption band due to SH in ortho amino phenyl thiol [١٠].

The spectra of all complexes showed, the amulti bands in the range (٣٤٢١-٣٢١٩) cm$^{-١}$ and splite or broader band at (١٦٠٤-١٥٤٦) cm$^{-١}$ and (١٣٠١) cm$^{-١}$ with the formation nitrogen atom. (M–N) in the region (٥٢٠-٥٠٩) cm$^{-١}$ suggesting the coordination through nitrogen atom.

The bands characteristic of coordinated water and (M–O) are seen in some complexes in the region (٨٨٢-٨٢٩) cm$^{-١}$and (٤٧٠-٤٥٥) cm$^{-١}$[١١]. Table (٢) characteristic some stretching vibration frequencies (cm$^{-١}$) for the ligand and its metal complexes.

Table (٢)
Characteristic stretching vibration frequencies ($cm^{-١}$) for the ligand and its metal complexes.

No.	Compound	υ(N-H) $cm^{-١}$	υ(C-H) $cm^{-١}$ Ar.	υ(C-H) $cm^{-١}$ Ali.	υ(M-N) $cm^{-١}$	υ(M-O) $cm^{-١}$ $\upsilon(OH_{٢})$aq.$cm^{-١}$
١	$(L)C_{١٨}H_{١٨}N_{٤}$	٣٣٧٩(asym)s.s ٣٣٠٠(sym)s.s ١٦١٤(S.S),١٥٨٣(s.s) ١٣٠٩,١٣٠١(m.s),١٢٤٧(s.s)	٣١٨٢(m.s) ٣٠٧٠(m.s)	٢٩٧٠(asym)m.s ٢٨٥٠(sym)m.s ١٤٧٣,١٤٤٦(s.s)	–	–
٢	$LCrCl_{٣}$	٣٤٠٤(asym)(m.br) ٣٢٤٢(sym)(s.s) ١٥٨٥(s.s),١٥٤٤(s.s) ١٣١٠(w.w),١٢٦٥(s.s)	٣١٦٥(w.s) ٣٠٩١(m.br)	٢٩٦٠(asym)(w.s) ٢٨١٥(sym)(w.s) ١٤٦٥(s.s) ١٤٣٥(s.s)	٥١٠(m.s)	–
٣	$LCoCl_{٢}.H_{٢}O$	٣٣٧٧(asym)(m.br) ٣٣٣٤(sym)(m.br) ١٦١٠(s.s),١٥٨٠(sh) ١٥٧٥(sh),١٣٠٧(s.s),١٢٤٧(s.s)	٣١٦٠(w.s) ٣٠٦٤(m.br)	٢٩٦٥(asym)(w.s) ٢٨١٠(sym)(m.br) ١٤٧٠(s.s),١٤٤٠(s.s)	٥٢٠(m.s)	٨٨٢(m.s) ٤٥٥(m.s)
٤	$LNiCl_{٢}.H_{٢}O$	٣٣٨٠(asym)(m.br) ٣٢٤٨(sym)(m.s) ١٥٩٣(s.s),١٥٤٦(s.s), ١٣١٧(s.s),١٢٧٨(s.s)	٣١٢٦(s.s) ٣٠٩٠(m.s)	٢٩٦٥(asym)(m.br) ٢٨٢٥(sym)(m.br) ١٤٧٣(s.s),١٤٤٢(s.s)	٥١٠(m.s)	٨٢٩(s.s) ٤٦٠(s.s)
٥	$LCuCl_{٢}$	٣٤٢١(asym)(m.br) ٣٣٤٦(sym)(m.br) ١٦١٠(m.s),١٥٧٧(m.s) ١٣٩٤(m.s), ١٣٠٧(m.s) ١٢٥٠(m.s)	٣١٤٣(m.s) ٣٠٧٠(m.s)	٢٩٧٤(asym)(m.s) ٢٨٥٥(sym)(m.s) ١٤٥٤(s.s),١٤٤٦(s.s)	٥١٥(m.s)	–
٦	$LPdCl_{٢}$	٣٤١٤(asym)(m.br) ٣٣٥٠(sym)(m.br) ١٣٠٧(m.s)١٦٠٤(s.s), ١٥٥٨(m.s)١٣٩٦(w.s)	٣١٨٢(m.br) ٣٠٥٥(m.br)	٢٩٧٠(w.s) ٢٨٦٠(w.s) ١٤٧٣(s.s),١٤٤٢(s.s)	٥١٠(m.s)	–
٧	$LCdCl_{٢}.H_{٢}O$	٣٤١٠(m.s),٣٢٨٤(m.s) ١٦١٢(sh),١٥٩٣(s.s), ١٥٤٦(s.s),١٣١٥(m.s),١٢٧٦(s.s)	٣١٢٠(s.s) ٣٠٦٢(s.s)	٢٩٥٠(m.s) ٢٨١٥(m.s) ١٤٧٣(s.s),١٤٤٢(s.s)	٥٠٩(m.s)	٨٧٥(m.s) ٤٦٥(m.s)
٨	$LHgCl_{٢}.H_{٢}O$	٣٣٢٣(asym)(s.s) ٣٢١٩(sym)(s.s) ١٦١٤(sh),١٥٩١(s.s), ١٣٠٧(m.s),١٢٨٢(m.s) ١٢٣٠(m.s)	٣١٣٢(m.s) ٣٠٥٧(m.s)	٢٩٢٤(m.s) ٢٨٥٤(m.s) ١٤٧٣(s.s),١٤٤٠(s.s)	٥١٠(m.s)	٨٥٥(s.s) ٤٧٠(m.s)

Ar = aromatic, asym = asymmetric, sym = symmetric, sh = shoulder
br=broad, m=medium, s=strong, w=weak

٤- The Uv-visible spectra of the ligand (L) and complexes

The Uv-visible spectra of the ligand (L) in DMSO solution exhibited strong absorption bands at (٢٦٦ nm, ٣٧٥٩٣ $cm^{-١}$) and (٣٤٨ nm, ٢٨٧٣٥ $cm^{-١}$), (٣٥٣ nm, ٢٨٣٢٨ $cm^{-١}$) this may attributed to the π-$\pi^{*}$and n-π^{*} transition respectively[١٢].

The UV-visible spectrum for Cr(III) complex showed one band in the region (٥٤٦ nm, ١٨٣١٥ $cm^{-١}$) is due to${}^{٤}A_{٢}g \rightarrow {}^{٤}T_{٢}g$[١٣].

The UV-visible spectrum for Co(II) complex showed three bands in the region (٨٠٠ nm, ١٢٥٠٠ $cm^{-١}$) due to ${}^{٤}T_{١}g \rightarrow {}^{٤}T_{٢}g_{(F)}$ (٦٦٠ nm, ١٥١٥١ $cm^{-١}$) due to ${}^{٤}T_{١}g \rightarrow {}^{٤}A_{٢}g$ and (٥٢٠ nm, ١٩٢٣٠ $cm^{-١}$) due to ${}^{٤}T_{١}g_{(F)} \rightarrow {}^{٤}T_{١}g_{(P)}$[١٤].

The ratio of ١٩٢٣٠$cm^{-١}$ to ١٢٥٠٠ $cm^{-١}$ is ١,٥٤ which fits with Tanabe- Sugano $d^{٧}$ E/B= ٢٦ and $\Delta_{٠}$/ B\= ١٦,$\Delta_{٠}$=١٢٥٠٠$cm^{-١}$, B\ complex= ١٢٥٠٠/١٦= ٧٨١ $cm^{-١}$B for free Co(II)= ٩٧١ $cm^{-١}$$\beta$ (nephelaveticeffecit)=B\ complex/B Co(II)=٧٨١/ ٩٧١ = ٠,٨٠٤.

Which indicates of d-electron delocalization on the ligand hence a significant covalent character in the complex [١٥].

The UV-visible spectrum for Ni(II) showed one band at (٨٤٠ nm, ١١٩٠٤ $cm^{-١}$) which is due to ${}^{٣}A_{٢}g \rightarrow {}^{٣}T_{١}g$, Cu(II) complex appeared band at(٤٧٧ nm, ٢٠٩٦٤ $cm^{-١}$) is due to${}^{٢}B_{١}g \rightarrow {}^{٢}B_{٢}g$. The brown palladium complex exhibited astrong band at (٤٠٠ nm,٢٥٠٠٠$cm^{-١}$) due to ${}^{١}A_{١}g \rightarrow {}^{١}B_{١}g$ transition[١٦]. The UV-visible spectrum for Cd (II) and Hg (II) complexes showed shifted bands compared with free ligand (L) are due to charge- transfer.

The molar conductance of all complexes in DMSO were found to be low values which suggested coordination of anion to the metal [١٧].

The magnetic moments of Cr(III) complexes was indicative of three unpaired electron for Cr(III) ion suggesting consistency with their octahedral environment. The magnetic moments measurements for the solid Co (II) complex is also indicative of three unpaired electrons per Co (II) ion suggesting consistency with their Octahedral environment. Ni (II) complex showed the magnetic moment value of (٢,٨–٣,٥) B.M (octahedral range) suggesting consistency with their octahedral environment. The magnetic susceptibility measurements of Cu (II) complex is ١,٩٢ B.M, which suggests the presence of one unpaired electron with square- planer configuration [١٨]. Electronic spectra conductance in (DMSO) magnetic moment (B.M) of the ligand and its metal complexes are given in Table (٣).

Table [٣]

Electronic spectra (DMSO), Conductance in DMSO, Magnetic moment (B.M) for the ligand (L) and its metal complexes.

NO	*Compound*	*λ (nm) cm⁻¹*	*Assignment Bands*	*Λ s. cm⁻¹ DMSO (١٠⁻٣ M)*	*μ_{eff} (B.M)*	*Suggested structure*
١	$(L)C_{١٨}H_{١٨}N_{٤}$	٣٧٥٩٣(٢٦٦) ٢٨٧٣٥(٣٤٨) ٢٨٣٢٨(٣٥٣)	$\pi \rightarrow \pi^*$ $n\rightarrow \pi^*$	–	–	–
٢	$LCrCl_٣$	١٨٣١٥(٥٤٦)	$^٤A_٢g \rightarrow {}^٤T_٢g$	٨,٢٥	٣,٨١	octahedral
٣	$LCoCl_٢.H_٢O$	١٩٢٣٠(٥٢٠) ١٥١٥١(٦٦٠) ١٢٥٠٠(٨٠٠)	$^٤T_١g_{(F)}\rightarrow {}^٤T_١g_{(P)}$ $^٤T_١g \rightarrow {}^٤A_٢g$ $^٤T_١g \rightarrow {}^٤T_٢g_{(F)}$	١٢,٥٦	٣,٨٢	octahedral
٤	$LNiCl_٢.H_٢O$	١١٩٠٤(٨٤٠)	$^٣A_٢g \rightarrow {}^٣T_١g$	١٧,٣٤	٢,٨٣	octahedral
٥	$LCuCl_٢$	٢٠٩٦٤(٤٧٧)	$^٢B_١g \rightarrow {}^٢B_٢g$	١٠,٨٥	١,٩٢	Square planer
٦	$LPdCl_٢$	٢٥٠٠٠(٤٠٠)	$^١A_١g \rightarrow {}^١B_١g$	٢٠,٢٠	–	Square planer
٧	$LCdCl_٢.H_٢O$	٢٧١٧٣(٣٦٨)	Charge– Transfer	١٠,٢٥	–	octahedral
٨	$LHgCl_٢.H_٢O$	٣٠٥٨١٠(٣٢٧)	Charge– Transfer	٢٠,٢٠	–	octahedral

B. M = Bohr Magneton.

Calculation of Cr (III), Co(II), Ni (II) and Cu (II) metal complexes formation in solution

The complexes of the ligand (L) with selected metal ions (Cr(III), Co(II), Ni(II) and Cu(II)) were studied in solution using ethanol as solvent, in order to determine (M:L) ratio in the prepared complexes, following molar ratio method [١٩]. A series of solutions were prepared having a constant concentration (C) ١٠⁻٣ M of the hydrated metal salts and the ligand (L). The (M:L) ratio was determined from the relationship between the absorption of the observed light and the mole ratio (M:L) found to be (١:١) for all metal complexes.

The stability constant (K_f) was evaluated using the following equations:

$K_f=١-\alpha/\alpha^٢C$ .... (١)

$\alpha=A_m-As/A_m$ .... (٢)

(α) is the degree of the dissociation, (C) is the concentration of the complex (١٠⁻٣M). (As) and (Am) are the absorbance value of the partially and fully formed complex respectively Table (٤).

The absorbance of the solution were measured at (λ_{max}) of the maximum absorption. The molar absorptivity (ε_{max}) (eq.٣) has been calculated using equation;

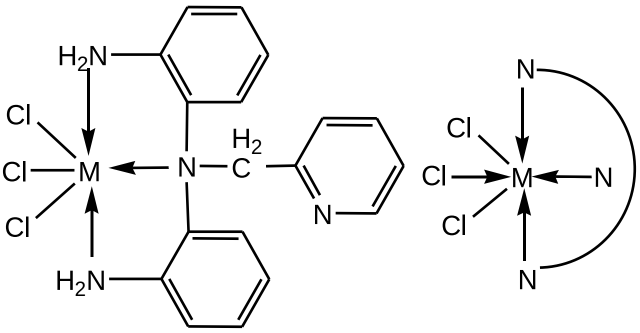
$A= \varepsilon_{max}.b.c$ .... (٣)

(A) is the average of three measurement of the absorption containing the same amount of metal ion and three fold excess of ligand, (b) is the depth of the quartz cell usually equal ١ cm.

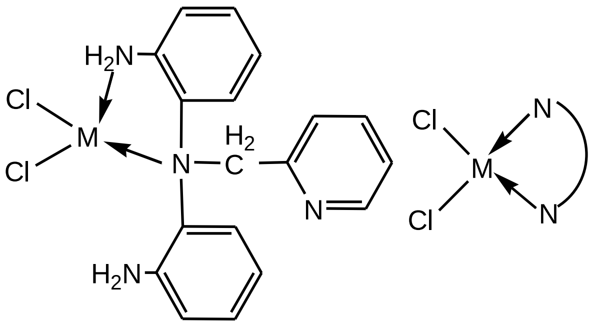
Table (٤)

As, Am, K_f, ε_{max} and λ_{max} of the Cr(III), Co(II), Ni(II) and Cu(II) complexes.

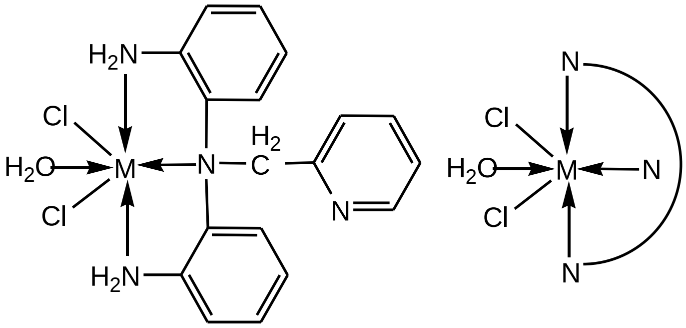
No.	*Compound*	*As*	*Am*	*α*	*Formation constant (Kf)*	*Molar absorptivity ε_{max}L.mol$^{-١}$.cm$^{-١}$*	*λ_{max} (nm)*
١	Cr-complex	١,٥٠	١,٥٢	٠,٠١٣	٥,٨٤٠×١٠^{٦}	١٢٦٨	٣٤١
٢	Co-complex	١,٢٠	١,٢٢	٠,٠١٦	٣,٨٤٣×١٠^{٦}	١٤٩٣	٣٤٨
٣	Ni-complex	٠,٨٠	٠,٨٣	٠,٠٣٦١	٧,٣٧٨×١٠^{٥}	٢٩٩٦	٣٤٨
٤	Cu-complex	١,٦٠	١,٦٢	٠,٠٢٠	٢,٤٥٠×١٠^{٦}	٢٠٣٠	٣٦٨



M=Cr(III)(1)



M=Cu(II) and Pd(II)(2)



M=Co(II), Ni(II), Cd(II) and Hg(II)(3)

Fig.(١) Suggested structures of the metal complexes of the ligand (L).

Atomicabsorption analysis Table (١) and spectroscopic data of the metal complexes indicate that the metal ions are coordinated to the nitrogen, nitrogen and nitrogen atoms and the data support the proposed structures of the ligand (L) have a ١:١ metal to ligand ratio.

Antibacterial activity study

The antibacterial activity of the prepared ligand and its complexes were studied against selected types of microorganisms which include gram positive bacteria like *staphylococcus aureues* and gram negative bacterial like *E.coli* in agar diffusion method [٢٠], which is used (DMSO) as a solvent. Agar diffusion method involves the exposure of the zone of inhibition toward the diffusion of microorganisms on agar plate. The plates were incubated for (٢٤) hrs. at (٣٧°C), the zone of inhibition of bacterial growth around the disc was observed. Table (٥).

Table [٥]
Effect of ligend and its metal complexes on gram positive and gram negative bacteria.

No.	***Compound***	***Diameter of inhibition zone (mm) at concentration ١mg/ml***	***Diameter of inhibition zone (mm) at concentration ٥mg/ml***	***Diameter of inhibition zone (mm) at concentration ١mg/ml***	***Diameter of inhibition zone (mm) at concentration ٥mg/ml***
		Staphylococcus aureus		***E. Coli***	
١	Amoxicillin	٢٧,٤	٢٧	٢٩,٢	٢٨,٦
٢	(L)$C_{١٨}H_{١٨}N_{٤}$	١٦,٤	١٦,٢	١٧,٠	١٦,٩
٣	L$CrCl_{٣}$	١٢,٥	١٢	١٣,٤	١٤,٢
٤	L$CoCl_{٢}.H_{٢}O$	١٤,٨	١٤	١٥,٦	١٤,٢
٥	L$NiCl_{٢}.H_{٢}O$	١٤,٨	١٤,٦	١٥,٦	١٤,٦
٦	L$CuCl_{٢}$	١٨	١٧,٨	١٨,٢	١٧,٦
٧	L$PdCl_{٢}$	١٥	١٤,٨	١٥,٢	١٦

Conclusion

A series of complexes of Cr(III), Co(II), Ni(II), Cu(II), Pd(II), Cd(II), and Hg(II) with N(٢-aminophenyl)-N-((pyridine-٢-yl)methyl) benzene-١, ٢-diamine (L) have been prepared and characterized. The tridentate ligand (L) (N,N,N) is binding metal ion forming octahedral structure except with Cu(II) and Pd(II) are forming square planer.

Antibacterial effects of the ligand and its metal complexes indicated that the ligand and its metal complexes exhibited antibacterial activity against both gram positive and gram negative bacteria.

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الخلاصة

حضر الليكاند (L) N(٢- أمينو فنيل)- N-((بريدين-٢- يل) مثيل) بنزين-١،٢- ثنائي امين من تفاعل اورثو أمينو فنيل ثايول مع N-(٢- امينو مثيل بريديل) فنيل ثنائي امين وبنسبة ١:١ وشخص بواسطة التحليل الدقيق للعناصر (N, H, C)، طيف الرنين النووي المغناطيسي، الاشعة تحت الحمراء والاشعة فوق البنفسجية – المرئية كما حضرت وشخصت معقدات املاح بعض ايونات العناصر الثنائية التكافؤ (Co، Ni، Cu، Pd، Cd و Hg) وثلاثي التكافؤ (Cr). استخدمت تقنيات تحليل العناصر (N, H, C) الاشعة تحت الحمراء، الاشعة فوق البنفسجية – المرئية، التوصيلية الكهربائية، الامتصاصية الذرية والخواص المغناطيسية واستنتج من التحاليل ان المعقدات لها شكل ثماني السطوح حول ايون الفلز مع الليكاند (L) ما عدا الـ Cu و Pd معطياً الشكل مربع مستوي وقد تم حساب قيم α، K_f، ε_{max} للمعقدات، كما تم دراسة الفعالية البايولوجية لليكاند ومعقداته وقد أظهرت النتائج امتلاكها فعالية متفاوتة تجاه أنواع البكتريا *E. Coli* و *Staphylococcus laureus*.