Preparation and Characterization of some Transition Metal Complexes with di-2-Quinolinone Dibenzyldine Ligand and their Adducts with 1,10-Phenanthroline

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ABSTRACT

The present work includes the preparation with complexes of the general formula \([M_2L_2]Cl_4\) and \([M_2L_2(1,10-phen)_2]Cl_4\) were

\(M=\) Mn (II), Fe (II), Co (II), Ni (II), Cu (II) and Zn (II)

\(L=\) di-2- quinolinone dibenzyldine

\(1,10\text{-phen} = 1,10\text{phenanthroline}\)

The ligand was prepared by condensation reaction of N-aminoquinoline-2-one with terphaldehyde (2:1) and characterized by infrared and proton NMR.

The complexes number (1-6) prepared into (2:2) (M: L) molar ratio respectively while complex number (7-12) prepared into (2:2:2) (M: L: 1,10-phen) molar ratio respectively.

The IR spectra data suggest the involvement of nitrogen atom of azomethine group and oxygen atom of carbonyl group of the ligand in coordination to central metal ion.

The synthesized complexes were characterized by elemental analysis, molar conductance, magnetic susceptibility, and spectral measurements (UV – Vis, IR).

Elemental analysis data proposed 2:2 (metal: ligand) and 2:2:2 (1,10-phen). The molar conductance measurements showed 1:4 electrolytes complexes, Further more magnetic moment measurements and electronic spectra indicated that the complexes of the type \([M_2L_2]Cl_4\) possess a tetrahedral geometry while complexes of the type \([M_2L_2(1,10-phen)_2]Cl_4\) possess an octahedral geometry.

Keywords: di-2-quinolinonedibenzyldine, metal, complexes, 1,10 phenanthroline, dinuclear.

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INTRODUCTION

Ligands like Schiff bases with nitrogen or oxygen donor atoms are conceded to be a good category of organic compounds, that have the ability to bind with different metal ions that possess an existing non-medical and medical properties, which was very common in the last few years (Liu et al., 2018; Lashanizadegan et al., 2016). The synthesis of these ligands was conducted easily by the condensation of primary amines with ketones or aldehydes (Gerloch et al., 1968) Schiff base complexes with transition metals received a good attention due to their wide application in different areas since they have diverse role in metalo-organic, inorganic and biochemistry (Ganguly et al., 2008; Golcu et al., 2005). These compounds considered as a chelating ligands in the transition metals coordination chemistry; since they are stable in reductive and oxidative conditions (Al Zoubi and Ko., 2017).

These ligands interact with metal ions to give complexes with different geometries that possess more biological activities (Da Silva et al., 2011) like antibacterial, anticancer, antimalarial, antipyretic, antifungal, anti-inflammatory and antiviral properties (Afradi et al., 2017; Anitha et al., 2012; Raman et al., 2001).

A series of quinolones possess a wide spectrum of activity and bio availability (Zhang et al., 2018; Kocsis et al., 2016) which make them good candidates for the treatment of infectious diseases with different locations like: urinary, gastrointestinal, cutaneous, respiratory, and bone (Dhiman et al., 2019). The antibacterial mechanism of quinolones came from its ability to inhibit DNA replication and transcription in bacteria (Nagaraja et al., 2017; Charrier, 2017). A new trend in complex combination field of quinolones was represented by its chelation with lanthanide metal ion (Ln$^{3+}$) (Măciucă et al., 2020). Quinolone is a heterocyclic aromatic compound which is considered to be a cyclic amide that incorporated with the structure of different pharmaceuticals (Gümüş et al., 2010). Derivatives of 2-quinolone have a different biological activities like anti-depressant (Oshiro et al., 2000) antimalarial (Xiao et al., 2001) antiulcer (Banno et al., 1988) and antioxidant activity (Al-Omar et al., 2006). Furthermore, quinoline-2-one derivatives were found to be of great importance in chemotherapy as antitumor drugs (Abhishek et al., 2014). Synthesis of ligands that contains different donors is increased continuously and their importance increased when they possess biological activity (Govind and Rajesh, 1992; Kong et al., 2003). Quinolones studies revealed a metal-drug interaction. Ciprofloxacin, for instance, showed a decrease in absorption when co administered with magnesium, aluminum antacid (Reese et al., 2000). A dinuclear complexes for Cu (II), Ni (II), Co (II) and Zn (II) were prepared, and their antifungal and antibacterial properties against Escherichia coli were tested (Mruthyunjayswamy et al., 2005). Furthermore the dinuclear Zn (II) complexes revealed higher activity against bacterial strains (Krstic et al., 2019). In addition to the above observations, dinuclear complexes of platinum and copper showed an anticancer activity (Broomhead et al., 1993; Ahmad et al., 2021). Finally, complexes of Cu (II) and azomethane were screened for their fungicidal, antibacterial and protistocidal activities against colpoda steinii, Escherichia coli 078, Staphylococcus aureus P-209 and Penicillium italicum (Vlasenko et al., 2021).

In the present work, N-aminoquinoline-2-one has been synthesized through the reaction of coumarone and hydrazine hydrate. This compound was allowed to react with terphthalaldehyde in order to produce the ligand that reacted with different metal salts to give the dinuclear complexes General Scheme.
Preparation and Characterization

General Scheme: Synthesis of di-2-quinolinone dibenzylidine (2)

EXPERIMENTAL

Instrumentation

All chemicals used were reagent grade from B.D.H. of Fluka accompanies, used as supplied, Melting point were determined on a Stuart SMP30 advanced Digital Melting Point apparatus (UK), and they were uncorrected.

Infrared spectra were recorded on Shimadzu as KBr disk (400–4000 cm\(^{-1}\)) and Bruker Alpha FT-IR spectrophotometer (Germany).

The UV – Vis spectra (200 – 1100 nm) were recorded on a Shimadzu UV-1650 pc spectrophotometer using DMF as solvent.

Molar conductance was measured at room temperature using laboratory conductivity meter con 720 WTW/Germany (2004).

The magnetic susceptibilities were measured at 25 °C on the solid by Faraday method using Bruker BM6 instrument. Diamagnetic corrections were calculated using Pascal's constants.

Proton NMR spectra were recorded on Bruker Biospin 400 MHz, Germany, using TMS as internal reference, and DMSO - d6 as a solvent.

The C.H.N. elemental analyses were performed on euro EA 300 Instrument, The metal content of complexes were determined spectrophotometrically [Mn (II), Fe (II), Co (II) and Cu (II)] using Shimadzu AA670 atomic absorption spectrophotometer, zinc and nickel were determined volumetrically using standard EDTA and murexide as indicator.
Synthesis of compound

1. Synthesis of N-amino quinoline-2-one (1): (Al-Bayati and Radi, 2010).
   A mixture of coumarin (1.46g,0.01mol) and excess of hydrazine hydrate (99%) (3.2g,0.1mol) in absolute ethanol(25ml) was refluxed for 12 hrs., the mixture was then cooled and solid that formed was collected and recrystallized from chloroform, m.p (131-133 °C).

2. Synthesis of ligand (di-2-quinolinone dibenzylidine) (2):
   Terphthaldehyde (0.96g,0.01mol) was dissolved in (10ml) of absolute ethanol, (1-2 drops) of concentrated HCl was added to the solution. N-amino quinoline 2-one (3.2g, 0.02mol) was dissolved in (10-15ml) of absolute ethanol and this was added to the latter solution. The mixture refluxed for (9-10) hrs., and the orange precipitate was filtered and washed then dried under vacuum.

3. Preparation of complexes [ M2L2 ] Cl4:
   (1.672g,0.002mol) of ligand dissolved in (20ml) of absolute ethanol, then added to (0.002mol) of metal salt (MnCl2.5H2O, FeCl2.4H2O, CoCl2.6H2O, NiCl2.6H2O, CuCl2.2H2O, ZnCl2). The mixture was heated under reflux for 6 hrs. The precipitates were filtered and dried under vacuum.

4. Preparation of adducts [M2L2(1,10-phen)] Cl4:
   (0.36g,0.002mol) of 1,10-phenanthroline was added to a solution consist of (1.672g, 0.002mol) of ligand dissolved in (20ml) of absolute ethanol and (0.002 mol) of metal salts. The mixture refluxed for 6 hrs., filtered and the precipitate dried under vacuum.

RESULTS AND DISCUSSION

Elemental analysis
The experimental percentage and the calculated one for C.H.N. and M% for the prepared compounds were listed in (Table 2). We also recorded colors, melting points, percentage yield and molar conductivity in (Table 1).

Molar conductivity
Molar conductivity measurements are useful in the investigation of the existence of moving electrolytic species (ions) in the complex’s solutions in DMF at room temperature (25-30°C). Table (1) showed that the metal complexes possess high molar conductivity values in the range (242.5-336.5) ohm⁻¹.cm².mol⁻¹ which indicating 1:4 electrolytic nature of the inorganic compound (Geary,1971).

Table 1: Physical data for ligand and it's complexes

| No. | Formula                  | Color                  | m.p. °C or Decomposition | Yield % | \( \Lambda_m \) (DMF) |
|-----|--------------------------|------------------------|--------------------------|---------|-----------------------|
| 1   | (L) C_{26}H_{18}N_{2}O_{2} | Dark orange            | *280                     | 74.4    |                       |
| 1.  | [ Mn_{2}L_{2} ] Cl_{4}   | Orange                 | *270                     | 58.63   | 333                   |
| 2.  | [ Fe_{2}L_{2} ] Cl_{4}   | Dark red               | > 300                    | 60.5    | 287                   |
| 3.  | [ Co_{2}L_{2} ] Cl_{4}   | Green                  | *265                     | 76.6    | 287.5                 |
| 4.  | [ Ni_{2}L_{2} ] Cl_{4}   | Dark yellow mustard    | > 300                    | 57.4    | 330.5                 |
| 5.  | [ Cu_{2}L_{2} ] Cl_{4}   | Dark brown             | *262                     | 70.4    | 296.5                 |
| 6.  | [ Zn_{2}L_{2} ] Cl_{4}   | Dark orange            | > 300                    | 63.8    | 242.5                 |
| 7.  | [ Mn_{2}L_{2}(1,10-phen)_{2} ] Cl_{4} | Orange             | *250                     | 59.5    | 286.5                 |
| 8.  | [ Fe_{2}L_{2}(1,10-phen)_{2} ] Cl_{4} | Dark red       | > 300                    | 70.3    | 255.5                 |
| 9.  | [ Co_{2}L_{2}(1,10-phen)_{2} ] Cl_{4} | Green               | *265                     | 63.8    | 252.5                 |
| 10. | [ Ni_{2}L_{2}(1,10-phen)_{2} ] Cl_{4} | Orange           | > 300                    | 59.5    | 336.5                 |
| 11. | [ Cu_{2}L_{2}(1,10-phen)_{2} ] Cl_{4} | Green               | *245                     | 78      | 328.5                 |
| 12. | [ Zn_{2}L_{2}(1,10-phen)_{2} ] Cl_{4} | Dark orange       | > 300                    | 53.1    | 281.8                 |

* = decomposition
Table 2: Elemental micro analysis % for ligand and its complexes

| No. | Calculated (found) | Calculated (found) | Calculated (found) | Calculated (found) |
|-----|-------------------|-------------------|-------------------|-------------------|
|     | C                 | H                 | N                 | M                 |
|     | (74.64) (74.241)  | 4.30 (4.19)       | 13.39 (13.70)     | ----              |
| 1.  | 57.3 (57.00)      | 3.30 (2.70)       | 10.2 (9.90)       | 10.11 (9.40)      |
| 2.  | 57.2 (56.80)      | 3.30 (2.70)       | 10.2 (10.00)      | 10.2 (9.70)       |
| 3.  | 56.9 (56.50)      | 3.28 (3.80)       | 10.21 (10.20)     | 10.7 (10.00)      |
| 4.  | 56.9 (56.00)      | 3.2 (3.00)        | 10.2 (9.50)       | 10.7 (10.00)      |
| 5.  | 56.6 (55.50)      | 3.25 (3.90)       | 10.13 (10.70)     | 11.4 (10.80)      |
| 6.  | 56.3 (56.10)      | 3.24 (3.30)       | 10.1 (10.00)      | 11.7 (11.00)      |
| 7.  | 43.0 (43.10)      | 2.48 (1.80)       | 7.73 (6.80)       | 7.5 (7.10)        |
| 8.  | 43.0 (43.50)      | 2.48 (2.80)       | 7.72 (7.60)       | 7.72 (6.80)       |
| 9.  | 42.8 (41.50)      | 2.47 (2.00)       | 7.69 (6.00)       | 8.1 (7.90)        |
| 10. | 42.8 (41.90)      | 2.47 (2.60)       | 7.69 (7.66)       | 8.0 (7.10)        |
| 11. | 42.8 (41.90)      | 2.47 (3.00)       | 7.69 (7.66)       | 8.66 (8.40)       |
| 12. | 42.5 (41.70)      | 2.45 (1.80)       | 7.62 (7.00)       | 8.89 (8.70)       |

Electronic spectra and magnetic moment

The electronic spectra of the ligand showed band at (28248 cm\(^{-1}\)) which assigned to \(\pi\rightarrow\pi^*\) transition, and (37878 cm\(^{-1}\)) for \(\pi\rightarrow\pi^*\) transition. These bands were shifted to lower wave length in complexes at the regions (23148-27624 cm\(^{-1}\)) and (32654-36593 cm\(^{-1}\)) respectively suggesting the complexation of ligand with the metal. A new strong band for all complexes (1-12) appeared at the region (26315 - 31645 cm\(^{-1}\)) that related to the charge transfer.

Mn (II) complex (1) was paramagnetic and gave magnetic moment (5.5 B.M) which in correspondence with five unpaired electron. No band in electronic spectra for Mn (II) shown due to orbital forbidden and spin forbidden. Thus, magnetic moment suggests a tetrahedral structure (Lever,1984). While complex (7) gave magnetic moment (5 B.M) and electronic spectra of Mn (II) in octahedral geometry (Cotton,1999). (High-spin) are spin forbidden and orbital forbidden.

The magnetic moment of Fe (II) complex (2) was (4.7 B.M) indicative for a tetrahedral geometry and the electronic spectra showed two absorption bands at (11363 and 12345 cm\(^{-1}\)) respectively which correspond to \(^3T_2\rightarrow^3T_1\) transition in a tetrahedral geometry (Nicholls, 2013), while complex (8) of Fe (II) gave magnetic moment (4.9 B.M) and showed broad absorption band at (21459 cm\(^{-1}\)) which were assigned to \(5T_{2g}(D)\rightarrow5E_g(D)\) in octahedral (high-spin) geometry (Guzzi and El Alagi,2013).

The magnetic moment of Co(II) complex (3) was (4.20 B.M) and the electronic spectra showed a band at (14836 cm\(^{-1}\)) assigned to \(^4A_2(F)\rightarrow^4T_1\) (P) transition, \(\nu_1,\nu_2\) did not appear to fall outside the range of the device used for measurement these values suggest a tetrahedral geometry (Rakhi and Shelly, 2011;Saad E. Al-Mukhtar,2017), while in complex (9), the magnetic moment was (4.82 B.M) and electronic spectra of this complex showed two bands at (14970 and 17667 cm\(^{-1}\)) which assigned to
$^4T_{1g} (F) \rightarrow ^4A_{2g} (F) \nu_2$, $^4T_{1g} (F) \rightarrow ^4T_{2g} (P) \nu_3$ that related to $\nu_2$ and $\nu_3$ respectively, these values suggest (high-spin) octahedral geometry (Sönmez et al., 2003).

The magnetic moment of Ni (II) complex (4) was (3.3 B.M) and the electronic spectra showed band at (13,698 cm$^{-1}$) assigned to $^3T_1 (F) \rightarrow ^3T_1 (P) \nu_3$ this values suggests a tetrahedral geometry, while in complex (10) the magnetic moment (3.1 B.M) and the electronic spectra of complex showed three bands at (12468, 14513 and 24752 cm$^{-1}$) corresponded to three spin allowed transition $^3A_{2g} \rightarrow ^3T_{2g} (\nu_1)$, $^3A_{2g}(F) \rightarrow ^3T_{1g} (F) (\nu_2)$ and $^3A_{2g}(F) \rightarrow ^3T_{1g} (P) (\nu_3)$. This transition suggested octahedral geometry (Seleem et al., 2011).

The magnetic moment of Cu (II) complex (5) has been found (2.0 B.M), and the electronic spectra of this complex showed band at (11574 cm$^{-1}$) which assigned to $^2T_{2g}(D) \rightarrow ^2E_g(D)$ transition in tetrahedral environment, while the magnetic moment of complex (11) was found (2.0 B.M), and electronic spectra of this complex showed a broad band at (19011 cm$^{-1}$) assigned to $^3B_{1g} \rightarrow ^3B_{2g}$, because of the influence of Jan Teller, $^2B_{1g} \rightarrow ^2E_g$ transition in distorted octahedral structure around Cu (II) ions (Kulkarni et al., 2012; Mostafa, 2011).

Zn (II) complexes (6,12) were diamagnetic and the electronic spectra gives only charge transfer transition in (26315, 31318 cm$^{-1}$) respectively (Nabeel and Farah, 2012).

All of the above data were listed in (Table 3).

### Table 3: Magneticsusceptibility and electronic spectra of ligand and their complexes

| No. | $\mu_{eff}$ B.M. | Electronic transition | Absorption band cm$^{-1}$ |
|-----|------------------|----------------------|--------------------------|
| L.  | ----             | $n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$ | 28248, 37878             |
| 1.  | 5.5              | $^3E \rightarrow ^3T_2$ | 31645                    |
| 2.  | 4.7              | $^3A_2(F) \rightarrow ^3T_1 (P)$ | 11363, 12345             |
| 3.  | 4.2              | $^3T_1(F) \rightarrow ^3T_2 (P)$ | 14836                    |
| 4.  | 3.3              | $^3T_2g \rightarrow ^3Eg$ | 13698                    |
| 5.  | 2.0              | $n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$ | 11574                    |
| 6.  | ----             | $^3T_{2g} \rightarrow ^3Eg$ | 23584, 34211             |
| 7.  | 5.0              | ----                  | 37593                    |
| 8.  | 4.9              | $^3T_{2g} \rightarrow ^3Eg$ | 21459                    |
| 9.  | 4.82             | $^3T_{1g}(F) \rightarrow ^3A_{2g} (F)$ | 14970                    |
|     |                  | $^3T_{1g}(F) \rightarrow ^3T_{1g} (P)$ | 17667                    |
| 10. | 3.1              | $^3A_{2g} \rightarrow ^3T_{1g}$ | 12468                    |
|     |                  | $^3A_{2g}(F) \rightarrow ^3T_{1g} (F)$ | 14513                    |
|     |                  | $^3A_{2g}(F) \rightarrow ^3T_{1g} (P)$ | 24752                    |
| 11. | 2.0              | $^3B_{1g} \rightarrow ^3B_{2g}$ | 19011                    |
|     |                  | $^3B_{1g} \rightarrow ^3Eg$ | 26315, 31318             |

### Infrared spectra

The most important IR absorption bands for the ligand and its complexes are listed in (Table 4). The IR spectra for ligand showed characteristic absorption bands at (1685 cm$^{-1}$) that assigned for carbonyl group $\nu(C=O)$, while the azomethine group $\nu(C=N)$ gave a band at (1602 cm$^{-1}$), furthermore the $\nu(N-N)$ group gave a band at (947 cm$^{-1}$) and finally a band at (1213 cm$^{-1}$) that attributed to the $\nu(C-C=N)$ group. (Parikh, 1974). Fig. (1).

This spectra gave an indication for the formation of the complexes since there is a drop in both of carbonyl and azomethine frequencies which appears at (1600-1620 cm$^{-1}$) and (1491-1510 cm$^{-1}$) respectively that confirm complication through both of $\nu(C=O)$ and $\nu(C=N)$ (Despaigne et al., 2009; Prasad and Agarwal, 2006).

Furthermore, the $\nu(N-N)$ absorption frequencies for these complexes appear at higher values (950-958 cm$^{-1}$) then it was in the ligand and this will give further support for the coordination via azomethine nitrogen atom (Maurya et al., 2002). Figs. (2,3).
Moreover, complexes were also showed a band at (1211-1233) for $\nu$(C-N) function. It is worth noticing that, the $\nu$(M-O) and $\nu$(M-N) vibrational frequencies appear at low values, in which the $\nu$(M-O) showed absorption bands at (490-526 cm$^{-1}$) (Agarwal et al., 2006), while the $\nu$(M-N) band at (432-500 cm$^{-1}$) for azomethine group (Abd Al-Razaq et al., 2016), all of the above values indicate the formation of a tetrahedral complexes via the coordination of metal with the synthesized tetra dentate ligand, On the other hand complexes (7-12) showed another absorption band at (452-516 cm$^{-1}$) for $\nu$(M-N) function confirm the formation of octahedral complexes due to the coordination of the metal with the synthesized tetra dentate ligand and 1,10 phenathroline (Raya et al., 2006). Figs. (4,5).

Table 4: Infrared Spectra for ligand and its complexes

| No. | IR $\nu$ (cm$^{-1}$) |
|-----|-------------------|
|     | $\nu$(C=O) | $\nu$(C=N) | $\nu$(C-N) | $\nu$(N-N) | $\nu$(M-O) | $\nu$(M-N) with izomethin | $\nu$(M-N) with 1,10 phen. |
| 1   | 1685      | 1602      | 1213      | 947        | ---        | ---                | ---                  |
| 2   | 1618      | 1510      | 1211      | 958        | 526        | 440                | ---                  |
| 3   | 1611      | 1509      | 1216      | 955        | 520        | 439                | ---                  |
| 4   | 1600      | 1498      | 1216      | 953        | 516        | 470                | ---                  |
| 5   | 1607      | 1499      | 1233      | 952        | 523        | 432                | ---                  |
| 6   | 1607      | 1491      | 1222      | 951        | 518        | 440                | ---                  |
| 7   | 1620      | 1500      | 1220      | 950        | 520        | 500                | ---                  |
| 8   | 1618      | 1510      | 1211      | 958        | 490        | 454                | 510                  |
| 9   | 1620      | 1509      | 1216      | 955        | 520        | 470                | 516                  |
| 10  | 1608      | 1497      | 1215      | 956        | 523        | 424                | 477                  |
| 11  | 1604      | 1492      | 1222      | 950        | 518        | 490                | 452                  |
| 12  | 1610      | 1502      | 1215      | 951        | 520        | 500                | 470                  |

Fig. 1: IR Spectra for ligand
Fig. 2: IR Spectra for complex 2

Fig. 3: IR Spectra for complex 4
Fig. 4: IR Spectra for complex 8

Fig. 5: IR Spectra for complex 10
Proton NMR:

$^1$H-NMR spectra were recorded using d$_6$-DMSO as a solvent and TMS as an internal reference. Chemical shifts were reported in (ppm) and coupling constant were given in hertz (Hz). Only $^1$H-NMR spectrum for ligand was recorded due to the paramagnetic properties of the metal complexes the spectrum of the ligand showed characteristic bands as the following:

- $\delta$ (6.7 – 8.13) ppm (m, 16 H, Aromatic).
- $\delta$ (8.16) ppm (s, 2H, azomethine)
- Fig. 6 (a,b)
Conclusion Structure of Complexes:
On the basis of the elemental analysis, conductivity measurements, magnetic moment data, spectroscopic studies, the possible structure of complexes: Figs.(7,8)

Fig. 7: complexes of the type $[M_2L_2]Cl_4$
$M=Mn$ (II), $Fe$ (II), $Co$ (II), $Ni$ (II), $Cu$ (II), $Zn$ (II)

Fig. 8: complexes of the type $[M_2L_2\ (1,10\ phen_2)]Cl_4$
$M=Mn$ (II), $Fe$ (II), $Co$ (II), $Ni$ (II), $Cu$ (II), $Zn$ (II)

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Preparation and Characterization

Dinuclear copper complexes derived from N-{2-[(2-diethylamino (alkyl) imino)-methyl]-phenyl}-4-methyl-benzenesulfonamide. *Inorg. Chim. Acta.*, **523**, 120408.

Xiao, Z.; Waters, N.C.; Woodard, C. L.; Li, Z.; Li, P.K. (2001). Design and synthesis of Pfmrk inhibitors as potential antimalarial agents. *Bioorg. and Med. Chem. Lett.*, **11**(21), 2875-2878.

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**Preparation and Characterization**

Preparation and Characterization of Some Dicopper Complexes of 2-(Diethylamino (alkyl)imino)-4-methylbenzenesulfonamide. *Inorg. Chim. Acta.*, **523**, 120408.

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The focus of this study is the preparation of dicopper complexes of the general formula [M2L2(1,10-phen)2]Cl4, where M = Zn(II) and Cu(II), Ni(II), Co(II), Fe(II), Mn(II), and L = 2-(diethylamino (alkyl)imino)-methylphenyl.

The complexes were prepared by reaction of N-aminoquinoline-6 and formaldehyde in a 1:6 ratio with the ligand. The complexes were characterized using IR (IR) and NMR (1HNMR) spectroscopy. The IR spectra showed a band at 1700 cm⁻¹ for the carbonyl group of the complex.

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