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Preparation, Characterization and Antimicrobial Studies of Cu (II) and Mn (II) Complexes with Schiff Base Derived from Benzaldehyde and 2,4-Dinitrophenylhydrazine

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ABSTRACT

Two series of Cu(II) and Mn(II) of complexes were prepared by refluxing ethanolic solution of their salts with Schiff base obtained from benzaldehyde and 2,4-dinitrophenylhydrazine into 1:2 ratio. The prepared compounds were characterized by solubility, molar conductance and infrared analysis. The complexes show low molar conductance values suggesting non-electrolytic nature. The Schiff ligand and its metal (II) complexes were found to be active against four isolates of bacteria (Salmonella bongori, Streptococcus pyogenes, Staphylococcus aureus and Shingella dysenteriae).

Key words: *Schiff base, Benzaldehyde, 2,4-Dinitrophenylhydrazine, Antimicrobial activities.*

1.0 INTRODUCTION

The chemistry of Schiff base-metal complexes has fascinated several chemists in different parts of the globe in search of promising chemotherapeutic agents for disease control [1].The ease with which the Schiff base ligands are designed and synthesized have made them to be referred to as 'fortunate ligands', possessing azomethine derivatives, the C=N linkage that is essential for biological activity, including: antibacterial, antifungal, antioxidant, anticancer and diuretic activities. A variety of Schiff bases and its complexes studied as model molecules for analytical, biological and industrial applications for instance many research have shown that Schiff bases and their transition metal complexes played vital role in the areas like free radical chains termination, as antileishmanial agents, radiotracers in nuclear medicine, anti-inflammatory, plant growth hormone regulator/ booster and cytotoxic activity [2-4]. Co(II), Ni(II) and Zn(II) complexes of Schiff bases derived from condensation of 4-anisaldehyde with 2,4 dinitrophenylhydrazine were found to be active against pathogenic bacteria such as *Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis* and *Staphylococcus aureus* [5].This paper reports the preparation and characterizations of two new metals (Cu(II) and Mn(II)) complexes and Schiff base derived from benzaldehyde and 2,4-dinitrophenylhydrazine.

2.0 MATERIALS AND METHOD

The solvents and chemicals used in this work were of Analar grade. All the glasswares used were washed thoroughly with distilled water and dried in an oven. Weighing was carried out on electric metler balance, model AB 54. Infrared spectral analyses were recorded using Fourier Transformed IR, Genesis series model in Agilent within 400-4000 cm-1. Electrical conductivity measurements were carried out using conductivity meter model Jenway 4010.

2.1 METHODOLOGY

2.1.1 Preparation of Schiff Base

1.39 cm^3 of benzaldehyde was mixed with 2,4-dinitrophenylhydrazine (3.96g, 0.014 mol) in ethanol (25 cm^3) and then refluxed on a hotplate with stirring for 3hrs. The orange crystalline solid obtained was filtered, washed with ethanol and then recrystallized from methanol and dried in a desiccator over calcium chloride ($CaCl_2$) for three days [6].

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2.1.2 Preparation of Metal Complexes

(1.42 g, 3 mmol) of $CuCl_2$ or (1.51 g, 3 mmol) of $MnCl_2$ in hot ethanol (25 cm^3) was added to (1.72 g, 6 mmol) of the Schiff base in ethanol (25cm^3) in dropwise whilestirring.The mixture was refluxed for 3 hrs. The product obtained was filtered, washed with ethanol and dried in a desiccator over ($CaCl_2$). [6-7].

2.2 Solubility Test

The solubility of both synthesized Schiff base ligand and its metal (II) complexes are determined with some common solvents such as acetone, chloroform and dimethylsulfoxide.

2.3 Conductivity Test

The conductivity test was carried out using conductivity meter,10^{-3}M are assumed to be the concentration of complexes and both were dissolve in 10ml of ethanol.

2.4 Infra-red Analysis

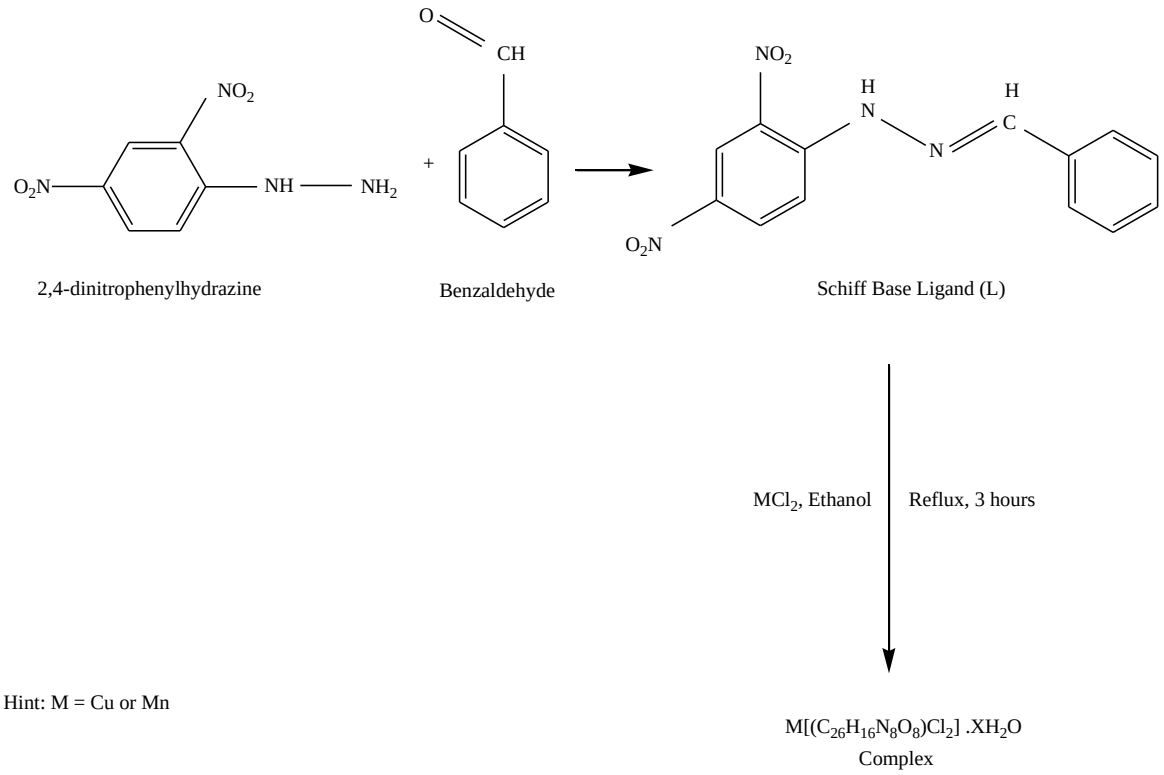
The IR of both the Schiff base ligand and the complexes were run on FTIR machine and the spectra obtained.

2.5 Anti-microbial Activity

A stock solution of the antibiotic to be tested was prepared using dimethylsulfoxide (DMSO). Five (5) test tubes ware arranged each containing 4ml of the sterile Mueller Hinton Broth and serially dilute the stock solution of the prepared antibiotic from test tube 1 to test tube 4, 0.1 ml of standardized inoculums of the test organisms were added to each test tube from test tube 1 to test tube 5 and incubated. The test tubes were observed after Incubation for the presence of growth. The minimum concentrations that Inhibit the growth of the tasted Organism is the minimum inhibitory concentration (MIC) of the given antibiotic. Using a Sterile wire loop sub culture was used all the test tubes that show no viable growth on the prepared Mueller Hinton Agar Petri dish plates and incubated for 24 hours at 37^0C. The Zone Inhibitory Concentrations (ZIC) was observed and compared it with gentamacin for bacteria standard [8-9].

3.0 RESULT AND DISCUSSION

The Schiff base ligand and its metal complexes were prepared, and they were found to be orange in color. (Scheme 1).



Scheme1: Synthesis of metal complexes.

3.1 The Solubility Test

The Solubility tests of the ligand and complexes were carried out in various solvents. The result shows that the ligand was soluble in acetone, chloroform and ethanol while slightly soluble in aqueous ammonia and dimethylsulfoxide (DMSO) but insoluble in

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water. The metal complexes were also soluble in acetone, chloroform and ethanol. However, they were found to be slightly soluble in aqueous ammonia, distilled water and dimethylsulfoxide (DMSO). The result is summarized in table 1.

Table 1: Solubility Test of Schiff Base and its Metal Complexes

Solvent	Schiff base	Copper (II) Complex	Manganese(II)Complex
Acetone	S	S	S
Aqueous Ammonia	SS	SS	SS
Chloroform	S	S	S
Distilled Water	IS	SS	SS
DMSO	SS	SS	SS
Ethanol	S	S	S

Key:

S = Soluble

SS = Slightly Soluble

IS = Insoluble

3.3 The Conductivity Test

The conductivity test of the metal complexes were carried out using ethanol as the solvent, and the result was found that is in range of 17-19$cm^{-1}mol^{-1}$ showing that they are non-electrolyte due to their lower value [10].

Table 2: Conductivity Measurement of Complexes,

Compound	Schiff Base	Cu (II) Complex	Mn (II) Complex
Molar Conductance ($cm^{-1}mol^{-1}$)	-	17	19
% yield	83	76	71

3.3 IR Spectroscopy

The IR spectra analysis of the free ligand shows broad band at 3283cm^{-1}assigned to υ(O-H) stretching vibration. The strong peak at 1618 cm^{-1} is attributed to azomethine υ(C=N) group. This band was shifted to high wave number in the complexes around 1622-1626cm^{-1} which indicate the participation of the azomethine nitrogen in coordination to the metal ions[11]. The appearance of unchanged band at 3283cm^{-1} in the metal complexes suggests presence of water molecule [10].The formation of new absorption band in the range of 592-596 cm^{-1} in the metal (II) complexes indicates the formation of M-N bonds confirming coordination of the ligand to the metal (II) ions [12] as shown in the Table 3.

Table 3: IR Spectra data of Schiff base and its metal complexes

Compound	υ(C=N) cm^{-1}	υ(O-H) cm^{-1}	υ(M-N) cm^{-1}
Ligand	1618	3283	-
Cu (II) Complex	1622	3283	592
Mn (II) Complex	1625	3283	595

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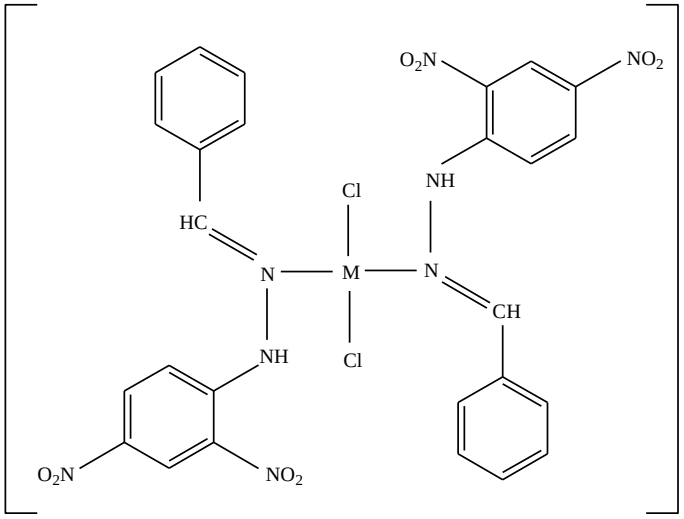

Scheme 2: the Proposed structure of the metal complexes

3.4 The Antimicrobial Activity of Schiff base and Metal Complexes

The synthesized ligands and its metal (II) complexes were screened for their antibacterial activity against four isolates bacterial (*Salmonella bongori, Streptococcus pyogenes, Staphylococcus aureus and Shingella dysenteriae*). The results of this study revealed that all the complexes and the ligand showed significant antibacterial potency. However, The Schiff base ligand was found to be less active against the tasted bacteria than the complexes this may due to the present of lipophilic nature of complexes which is explained by Overtone`s concept and Tweedy`s chelation theory [13]. The results are summarized in Table 4–5.

Table 4: Antibacterial Activity of Schiff base ligand

Test Organism	100 µml	50 µml	25 µml	12.5 µml
Salmonellabongori	++	+	-	-
Streptococcus pyogenes	++	++	-	-
Staphylococcus aureus	++	+	+	-
Shingelladysenteriae	++	+	-	-

Table 5: Antibacterial Activity of Cu (II) Complex

Test Organisms	100 µml	50 µml	25 µml	12.5 µml
Salmonellabongori	+++	+++	++	+
Streptococcus pyogenes	+++	++	+	-
Staphylococcus aureus	++	++	-	
Shingella dysenteriae	+++	+	-	-

Key:

+++= Highly Active (Inhibition zone > 12mm)

++ = Moderately active (Inhibition zone > 9 – 12mm)

+ = Slightly active (Inhibition zone > 6 – 9mm)

- = Inactive (Inhibition zone < 6mm)

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4. CONCLUSION

The Schiff base ligand and its metal complexes have been prepared by using appropriate method and they were found to be soluble in some organic solvents such as dimethylsulfuroxide and chloroform but insoluble in water. The conductivity measurement value of the metal complexes shows that they are non-electrolyte.The synthesized ligand and the metal complexes were to found active against;*Salmonella bongori, Streptococcus pyogenes, Staphylococcus aureus and Shingella dysenteriae.*

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