Antibacterial activity of binuclear Cu(II) and Ni (II) complexes and Schiff base ligand such as N, N^1-Bis(4-diethylaminobenzylidene) benzene – 1, 3 – diamine.

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Abstract :-

A new Schiff base ligand. N,N^1 Bis (4-diethylaminobenzylidene) benzene-1,3-diamine has been synthesized by condensation reaction of 4-diethylaminobenzaldehyde and 1,3 – Phenylenediamine. Treatment of this Schiff base ligand with Cu(II) nitrate and Ni(II) nitrate in ethanol medium afforded the corresponding metal complexes. The synthesized ligand and complexes were characterized by their UV-VIS, FT-IR and ^{1}H-NMR spectral data and elemental analysis. The spectral data suggested a distorted octahedral geometry for these complexes. The complexes showed better antibacterial activity in comparison with that of the free ligand against selective bacteria due to chelation.

Key Words: -

Schiff base ligand, 4-diethylaminobenzaldehyde, Cu(II), Ni(II) complexes, antibacterial activity.

1. Introduction

Due to changes in human habits and climate changes, bacterial infections have been a major cause of death. Antibiotics are essential to treat infections caused by bacteria. To overcome this serious medical problem the discovery of new types of antibiotics is a very important and challanging issue. The development of new antibacterial agents with novel and more efficient mechanism of action is definitely an urgent medical need. In recent years research has been focused on developing new drugs, which may act through structural changes to solve the problem of bacterial drug resistant. The developement of resistance of microorganism to antibiotics may be due to the reasons of intrinsic or natural whereby there is no site for the drugs to bind there or permeability against the drug is low, So the drug cannot effect the microorganism.

Schiff base complexes are effective metal chelates that can be used as antibacterial agents against Bacillus subtilis, Escherichia coli. Structurally when the carbonyl group of an aldehyde or ketone is replaced with an imine or azemethine group the compound is called a Schiff base. Schiff base ligands are readily synthesized and they form complexes with some metal ion that are used as catalyst in different reaction such as oxidation reaction, Polymerization, reduction of ketone, biological activity of Schiff bases are due to the

azeomethine linkage. Complexes with metal ion such as Cu(II), Ni(II) with octahedral coordination have exhibited significant Physico chemical and biological properties.

I report here the synthesis of new bidentate ligands by a simple condensation of 4-diethylaminobenzaldenyde and 1,3-Phenylenediamine to yield N,N^{-} – bis (4-diethylamino benzylidene) benzene -1,3-diamine as new Schiff base ligand and the corresponding complex with Cu(II) and Ni(II) ions. The ligand and complexes are characterized by their FT-IR, UV-VIS and H^{1} - NMR spectral data and elemental analysis.

2- Experimental

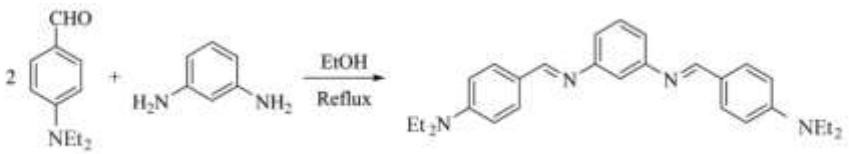
2.1 – Materials and method :-

All reagents and chemical Purchased from Aldrich – sigma were of analytical / spectroscopic grade and were used without further Purification. Chemical and solvents used for the preparation of Schiff base ligand. The FT-IR analysis were conducted with Nexus 670, Thermo Ni colet (USA model), FT-IR Spectrometer. The UV – VIS spectra were obtained with a UK model UV – VIS Spectrophotometer. UV – VIS electronic absorption spectrum were measured in the 200-800 nm Wavelength range. The melting point of compounds was measured by electothermal melting point apparatus model BUCHI 510.

2.2 – Synthesis of N-N^{1} – bis (4-diethylamino benzylidene) benzene – 1, 3 – diamine as new Schiff base ligand

108 mg (1 mmol) of 1,3-phenylendiamine in ethanol (20 mL) was added to a stirring solution of 4-diethylaminobenzaldehyde (326mg, 2 mmol) in hot ethanol (20 mL.) The resulatant mixture was heated under reflux for 24 h with continuous stirring and consequently, a yellow precipitate was formed (Scheme 1). The purity of the ligand was confirmed by TLC (using Ethylacetate: hexane / 3:2 as eluents, R_f = 0.57). The obtained precipitate was filered, rinsed with distilled water, ethanol and dried at room temperature.

The physical properties of ligand are shown in Table 1 which are closely matching with the amounts calculated by the suggested formula. Moreover, the melting points calculated are sharp which indicate the purity of the synthesized ligand.



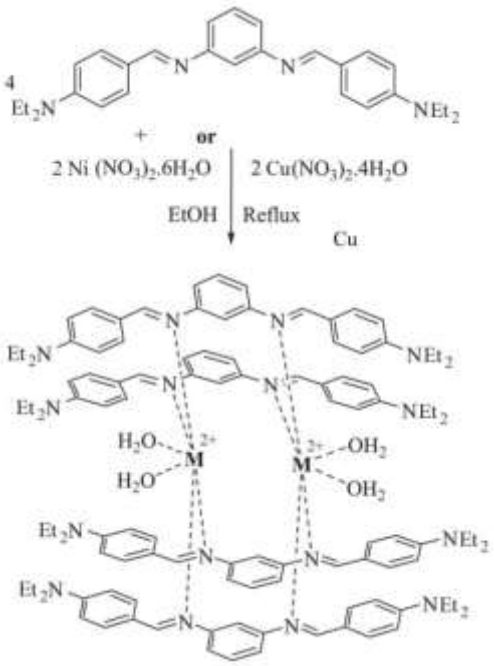
Scheme 1
Synthesis route of new Schiff base ligand.

Table 1 Physical data of the prepared ligand.

Molecular formula	Molecular weight /g mol^{-1}	Yield/%	Colour	M.p./°C	Elemental analysis found (Calcd.)		
					C /%	H/%	N/%
$C_{28}H_{34}N_4$	426	67	Yellow	148	78.87	7.98	13.14

2.3 – Synthesis of Schiff Base Complexes with Ni(II) Cu(II) lons

A mixture of the Schiff base (2 mmol) under investigation in 25 mL ethanol and the same amount of the same solvent of metal salt ($Ni(NO_3)_26H_2O$ and $Cu(NO_3)_24H_2O$, 1 mmol) were refluxed for 3 h on a waterbath. The purity of the complex was confirmed by TLC. The obtained solution was left to cool to room temperature, then the precipitate was filtered, washed many times with ethanol and then left to get dry at room temperature (Scheme 2). The physical properties of complexes is tabulated in Table 2. Endeavours to grow appropriate crystals for single crystal diffraction investigation were not successful.



M = Ni or Cu

Scheme 2

Physical data of the prepared complexes.

Table 2 Physical data of the prepared complexes.

Molecular formula	Molecular weight /g mol^{-1}	Yield/%	Colour	M.p./°C	R_f*	Elemental analysis found (Calcd.)		
						C/%	H/%	N/%
$[Ni(C_{28}H_{34}N_4)_2(H_2O)_2].(NO_3)_2$	1071	81	Dark brown	278 (Dec.)	0.67	62.74	6.72	13.07
$[Cu(C_{28}H_{34}N_4)_2(H_2O)_2].(NO_3)_2$	1075.5	80	Brown	297 (Dec.)	0.79	62.48	6.69	13.01

Table – 2

2.4 – Investigation of antibacterial activity.

The diffusion method is a simple method that is commonly used in hospital laboratories to determine the antibacterial activity of various components that was used in this paper as well. In this method, some disks in the agar medium containing 2% of glucose are used which the diameter of inhibited zone is visually read 18 h after incubation at temperature of 37ºC. Consequently, antibacterial activity is estimated by investigating the size of the zone of inhibition formed around the paper disks on the seeded agar plates. Ampicillin was used as a positive control.

3- Result and discussion :-

3.1 – FT – IR Spectra

In the absence of powerful technique such as x – ray crystallography, IR technique such as x-ray crystallography, IR spectrum is the most suitable technique to obtain information is order to be able to elucidate the nature of bonding of the ligand to the metal ion. In the FT-IR spectra of ligand, a band at 1600 cm^{-1} is due to the C=N stretching vibration. There is no peak related to unreacted primary amines or carbonyl groups. On complex formation the IR band due to azomethine group shifs to the lower wave number 1614 Cm^{-1} for Ni (II) complex and 1617 cm^{-1} for Cu(II) complex which indicates that the nitrogen atom of azomethine groups are coordinate to the metal atom. However the band appearing at 471 and 473 cm^{-1} are due to M-N vibration in Ni (II), Cu(II) complexes respectively.

3.2 - Magnetic moments and electronic spectra data

The electronic absorption spectra of metal complex were recorded in Dinso Solvent. The electronic spectrum of cu(II) complex display 3 Prominent bands a low intensity band at 16760 cm^{-1} is assignable to $^2E_g \rightarrow {}^2T_{2g}$ transition. Another high intensity band in the region 25000-32300 cm^{-1} is due to symmetry forbidden LMCT and sharp bands observed at 38510 which is due to ligand bands. The magnetic momentum of cu(II) complex was seen at 1.62 B.M. Corresponding to one unpaired electron will a slight orbital contribution to the spin only value and absence of spin spin interaction on the basis of electronic spectra and magnetic succeptibility measurement a distorted octahedral geometry around cu(II) is suggested.

The electronic spectrum of Ni (II) complex showed 3 band at 16085 cm^{-1}, 26191 cm^{-1} and 32380 cm^{-1} corresponding to the transition $^3A_{2g} \rightarrow {}^3T_{2g}$, and $^3A_{2g} \rightarrow {}^3T_{1g}$ (P). The magnetic moment of Ni (II) was seen at 3.32 BM which suggest octahedral geometry.

3.3 - Antibactrial activity of Ligand and complex in Agar medium –

Ampicillin was used as a standard to study the antibacterial activity of prepared complex. The result are shown in Table 3.

Antibacterial activity of ligand, Ni(II) and Cu(II) complexes

Compound (5 mg L^{-1})	*Escherichia coli* Mean ± RSD*	*Staphylococcus aureus* Mean ± RSD*	*Bacillus subtilis* Mean ± RSD*
Ligand	11.6 ± 0.028 mm	12.6 ± 0.018 mm	15.2 ± 0.021 mm
Ni(II) complex (Zone of inhibition diameter)	18.4 ± 0.017 mm	18.2 ± 0.024 mm	20.5 ± 0.019 mm
Cu(II) complex (Zone of inhibition diameter)	16.2 ± 0.014 mm	20.3 ± 0.020 mm	23.4 ± 0.018 mm
Ampicillin	20.5 ± 0.031 mm	22.8 ± 0.029 mm	30.3 ± 0.027 mm

*RSD (relative standard deviation).

Table - 3

The Schiff base complexes exhibited different antibacterial effects on the growth of the bacterial species. The activities of the metal complexs are found to be more as compared to the ligand that it may be related to the effect of the metal ion in the normal cellular process. Therefore, the complexes may be used as a potential drugs with antibacterial activity after carrying out further researches on them.

3.4 Mass spectra of the compound :-

The ESI – mass spectra were measured to confirm the composition and the purity of the complexes and ligands under investigation (Table -4). The obtained mass spectra shwed molecular ion peaks which were matching with the expected values.

Mass spectral data of Schiff base ligands and their metal complexes.

Peak assigned	Obtained mass	Cal. mass	Compound
$[M]^+$	426	426	Ligand
$[M+1]^+$	1071	1071	Ni(II)
$[M]^+$	1075	1075	Cu(II)

Table – 4

Conclusions :-

In this paper, new Schiff base ligand obtained by condensation reaction of 4- diethylaminobenzaldehyde N,N^1-bis(4-diethylaminobenzylidene) benzene – 1, 3 – diamine which is characterized by the spectral analysis. The reaction of the ligand with hydrated nitrate salt of Cu(II) and Ni (II) give the respective metal complexes in almost quantitative yields. From the spectral and analytical data, the ligand is found the coordinate to the metal ions through nitrogen atoms and acts as a bidentate ligand. According to the elemental analysis and analytical data an octahedral geometry has been proposed for the complexes. Also the ligand and complexes were tested in order to investigate their antibacterial effect on some hazardous bacterial such as Escherichia coli and Bacillus subtilis. The complex exhibited sufficient biological activity which confirms that these compounds possess antibacterial effects.

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