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Synthesis, Characterization and Antibacterial Activities of Schiff Base Complexes of Co (II) and Ni (II) Derived From 2-Hydroxy-1-Naphthaldehyde and 4-Aminophenol

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Original Research Article

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Abstract: A new series of transition metal complexes of Co (II) and Ni (II) were synthesized from the Schiff base ligand derived from 2-hydroxy-1-naphthaldehyde and 4-aminophenol which gives (1-[(4-Hydroxy-phenylimino)-methyl]- naphthalen-2-ol) as the ligand They were characterized using different analytical techniques like IR, magnetic susceptibility, melting point and molar conductivity. The IR results revealed bands at 1616cm-1 indicating the formation of azomethine (C=N) confirming the formation of Schiff base, 441cm-1for (M-O) and 657cm-1 for (M-N) bands in the spectra of the complex supporting coordination of Schiff base with respective metal . The Schiff base and its metal (II) complexes were colored with Sharp melting point. An octahedral geometry was suggested on the basis of magnetic moment data. The molar conductance values indicated that the complexes are non-electrolytes. The schiff base and its metal complexes have been tested in vitro against (Staphylococcus aureus and Escherichia Coli) in order to assess their antibacterial activities.
Keywords: 4-aminophenol, 2-hydroxy-1-naphthaldehyde, schiff base, antibacterial.

INTRODUCTION

The microbial resistant properties shown by microbes have further complicated the world's challenge in health sector [1].Therefore to build a strong health sector in any nation; major advances towards the improvement of antimicrobial drugs have to be a continuous process. These discoveries coupled with continuing developments for better antibiotics will be of Very great achievement in modern science and technology [2].

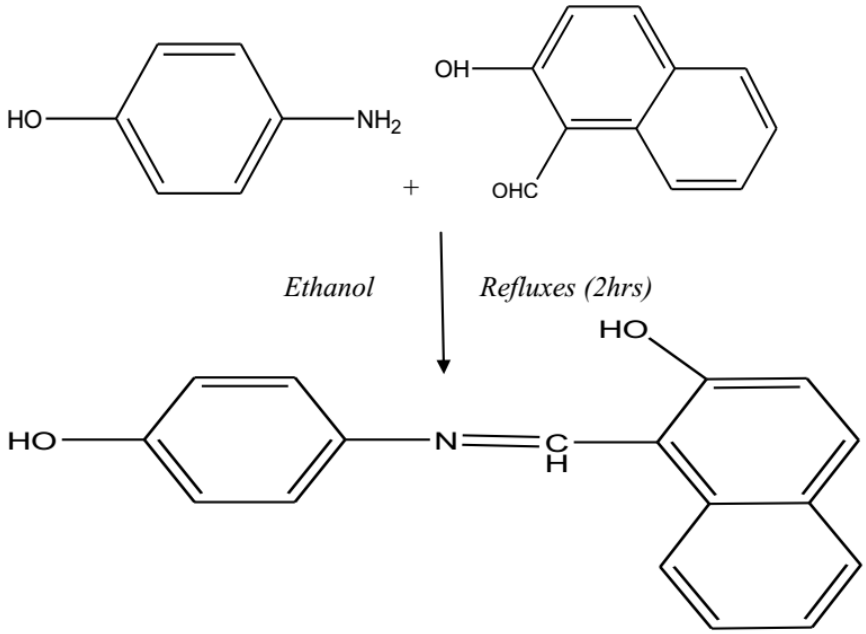
In order to achieve this, several research works have been done and a lot more are still going on, all gearing towards the design of novel compounds that will serve as more potent antimicrobial drugs. Such efforts have been extended to cover plant extracts and synthetic materials [3].The potentials of metal complexes in therapeutic applications have also been reported by various authors [4]. In bioinorganic chemistry the study of coordination chemistry of biologically important metal ions with ligands is creating great impact in this area [5]. Schiff base is one of the compounds reported to possess remarkable antibacterial, antifungal, anticancer and antimalarial activities [6].

MATERIALS AND METHODS

All reagents and solvents used for this research were of analytical grade and were purchased from sigma Aldrich and Merck and were used without further purification the melting point was recorded on hot stage Gallen Kamp melting point apparatus. The infrared spectra were recorded using Agilent carry 630 FTIR spectrometer in the frequency range of 400-4000cm^{-1}. The magnetic susceptibility was obtained at room temperature using magnetic susceptibility balance MK1 Sherwood. Conductivity measurement was carried out using Jenway conductivity meter 4010.

Synthesis of Schiff Base

Exactly 0.01mol (1.722g) of 2-hydroxy-1-nephthaldehyde was mixed with 0.01mol (1.0913g) of 4-Aminophenol in 25 cm^3 of ethanol. The resulted mixture was heated under reflux for 2hours and the solid product formed was separated by filtration, purified by recrystallization from ethanol, washed with ethanol, and then dried in desiccators over phosphorus pentaoxide(P_2O_5) for 72hrs [7].



Synthesis of Cobalt (II) Complexes

An aqueous solution of a hydrated copper (II) chloride (0.01mol, 2.3793g) in 10cm^3 ethanol was added to an ethanolic solution of the prepared Schiff base ligand (0.02mol, 5.26g) the mixture was refluxed for 2hours. The precipitated complex formed was separated by filtration recrystallised and washed with ethanol and dried in a dessicator over phosphorus pentaoxide (P_2O_5) for 72hrs [8].

Synthesis of Nickel (II) Complexes

An aqueous solution of a hydrated copper (II) chloride (0.01mol, 2.3769g) in 10cm^3 ethanol was added to an ethanolic solution of the prepared Schiff base ligand (0.02mol, 5.26g) the mixture was refluxed for 2hours. The precipitated complex formed was separated by filtration recrystallised and washed with ethanol and dried in a dessicator over phosphoruspentaoxide (P_2O_5) for 72hrs [8].

RESULT AND DISSCUSION

Table-1: Physical Properties and Analytical Data of Schiff Base and its Metal (II) Complexes

Compound	Colour	B.M μ eff	Decomposition Temperature (^{O}C)	Melting point	Percentage Yield
Ligand	Orange yellow	-	-	220	83
[NiL_2].2H_2O	Pale yellow	4.4	250	-	67
[CoL_2].2H_2O	Brown	4.5	335	-	66

The interaction between 2-hydroxy-1-naphthaldehyde and 4-aminophenol gives a orange yellow Schiff base and its metal complexes of Co (II), Ni (II), exhibit various colour ranging brown and pale yellow respectively. This is typical for transition metal complexes due to d-d electrons transition. They are non-hygroscopic solids and are air and photo stable. The purity of the schiff base and metal complexes was established by the observance of sharp melting/decomposition temperature and for schiff base and metal complexes were 220ºC,250ºC ,335ºC respectively [9] The percentage yield of schiff base and complexes were 83%, 67%, 69%, and 66% respectively. As shown in Table 1 magnetic moments of the complexes are tabulated in Table 1. The Co (II) complex possesses magnetic moment of 4.5 B.M. It is reported that an octahedral geometry can be assigned to Co(II) complexes, if the measured μeff value is in the range of 4.3-5.2 B.M [10] Ni(II) complex exhibited magnetic moment values of 4.4 B.M which suggests an octahedral arrangement around the metal ion[11].

Table-2: **The Infrared Spectral Data of Schiff Base and Its Metal (II) Complexes**

Compound	v(OH) cm^{-1}	v(C=N) cm^{-1}	v(M-N) cm^{-1}	v(M-O) cm^{-1}
Ligand	3335	1620	-	-
$[NiL_2].2H_2O$	3332	1616	672	441
$[CoL_2].2H_2O$	3312	1616	661	413

The IR analysis carried out for Schiff base showed an absorption band at 3335cm^{-1} which could be attributed to *v*(O-H) vibration frequency. The band shifted to different frequency of 3332cm^{-1}, 3295cm^{-1}, and 3315cm^{-1} for Ni (II), Co (II), and Cu (II) Complexes of Schiff base respectively. The appearances of such spectral bands suggest the coordination of Schiff base to the respective metals. The band at 1620cm^{-1} could be due to v(C=N) this band is observable in the spectra of the three complexes 1616$cm^{-1,}$ 1616cm^{-1} 1620cm^{-1}respectively, confirming coordination of Schiff base to the respective metal [12]. The strong band in the region in the range 661-672$cm^{-1}$and 413-441$cm^{-1}$of the complexes could be due to *v*(M-N) and (M-O)stretching frequencies, supporting coordination of the Schiff base to respective metal ion[13].

Table-3: Conductivity Measurement of Complexes in DMSO Solution (1x10 ^{3}moldm^{-3})

Compound	Specific conductance $Ohm^{-1}cm^{-1}$	Molar conductance $Ohm^{-1}cm^{2}$ mol^{-1}
$[NiL_2].2H_2O$	$10.50x10^{-6}$	10.50
$[CoL_2].2H_2O$	$11.32x10^{-6}$	11.32

The ∧m values determined for the complexes in DMSO are reported in table 3. Analysis of the results show that Co (II) and Ni (II) chelates of the Schiff base ligand have ∧m values ranging from (10-18 $Ohm^{-1}cm^{2}$ mol^{-1}) showing that they behave as non-electrolytes in nature [14]

Antibacterial screening

The sterilized [15] (autoclaved at 121^{o}C for 15 min) medium was inoculated with the suspension of ($5x10^{-5}$ cfu/ml) of the microorganism (matched to McFarland turbidity standard) and poured into a petridish to give a depth of 3–4 mm. Three wells were made containing different concentrations of (250, 500 and 1000 ppm in dimethylsulfuroxide) of both Schiff base and its metal (II) complexes. . The plates were pre-incubated for 1 hr at room temperature and incubated at 37^{o}C for 24 antibacterial activities, streptomycin (100 ppm) was used as standard. After the incubation period, the plates were observed for zones of inhibition in (mm) [16].

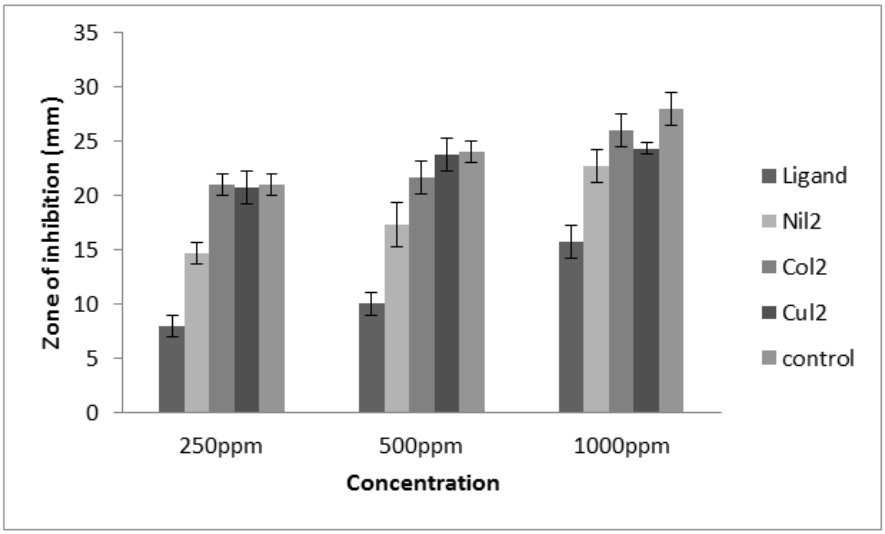


Fig-1: **Sensitivity test for antibacterial activity of Schiff base and its Metal (II) Complexes against clinical isolate (*Staphylococcus aureus*) using Well diffusion method**

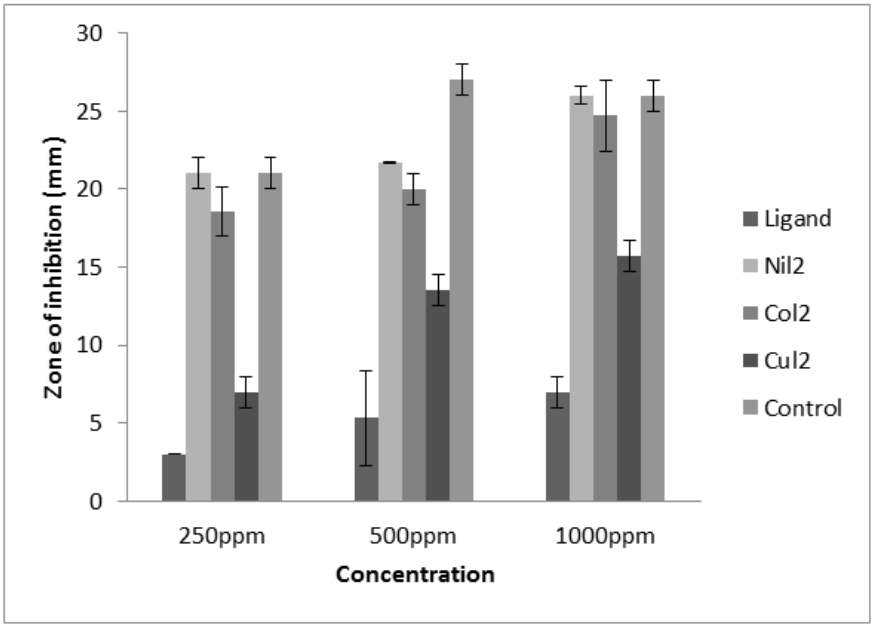


Fig-2: Sensitivity test for antibacterial activity of Schiff base and its Metal (II) Complexes against clinical isolate (*Escherichia Coli)* using Well diffusion method.

Antibacterial activity of schiff base and its metal (II) complexes showed activity on *Staphylococcus aureus*, *Escherichia coli* but the activity is higher on *Staphylococcus aureus* compared to that of *Escherichia coli with inhibitory zone of 7mm-15mm and 15mm-24mm ligand to metal complex respectively*. The metal complexes on the other hand showed higher activities compared to Schiff base because of chelation and π-electron delocalization, which increase the lipophilic character, favoring its permeation into the bacterial membrane, causing the death of the organisms [17]**.** The activities of both schiff base and its metal (II) complexes increase as the concentration increases as shown in figure 1 and 2

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CONCLUSION

In this paper we have reported the co-ordination chemistry of complexes from derived Schiff base ligand obtained from the reaction of **2**-hydroxy-**1**-naphthaldehyde and **4**-aminophenol with Co (II), and Ni (II) .The structures of the complexes were confirmed by IR, molar conductance, and magnetic susceptibility. The Schiff base coordinates through its azomethine nitrogen and the carbonyl group to the central metal atom. The Schiff base behaves as a bidentate ligand. The molar conductance measurements suggest the presence of anion inside the coordination sphere .The metals, forms **1:2** complexeswith the Schiff base ligand. The magnetic susceptibility data of the complexes suggest an octahedral geometry for the all complexes. .The in vitro antimicrobial screening of schiff base and its metal complexes showed that they are potential antimicrobial agents against the tested microorganisms.

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