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Research Article

Schiff Base Metal Chloride Complexes of Dapsone and Pyridine-2-Carboxaldehyde Their Synthesis, Characterization And Antifungal Properties

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Abstract:
Schiff bases have been the subject of much research due to their important bioactivities, active azomethine (-N=CH-) pharmacophore, is structurally similar to naturally occurring biological compounds, have selectivity, sensitivity and synthetic flexibility to the central metal atom [1-2].
In present paper we will synthesize Schiff base by condensing Dapsone with Pyridine -2-carboxaldehyde. Then Schiff base formed was complexed with metal ions. IR, elemental analysis, UV, M.P were used to analyse the complexes. Then evaluate their biological properties. Biological properties of metal complexes were greater than that of Dapsone and Schiff base of Dapsone with Pyridine-2-carboxaldehye.

Key Words: Dapsone, Pyridine-2-carboxaldehyde, biological properties, Schiff base, Schiff base metal complexes.

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1. Introduction

The synthesis of heterocyclic derivatives containing nitrogen has been a growing area of research in medical inorganic chemistry over the past few decades due to their versatility. Compounds with an azomethine group (-N=CH-) are called Schiff bases. In 1864, Hugo Schiff first identified them as the condensation products of primary amines and ketones (or) aldehydes [3-5]. Various biological activities have been reported for donors, including antibacterial [6-7], antifungal [8-10], antiviral [11-12], antiulcer [13-14], anticancer [15-18], antimalarial [19-20], antiproliferative [21], antitubercular, and antitubercular [22]. Antibacterial species (E. coli and S. aureus) were screened using new schiff base metal complexes that were produced by condensation of sulphametrole and varelaldehyde. Bacteria S. aureus and E. coli were more susceptible to newly created Schiff base metal complexes [23]. Ni(II) ion complexes including semicarbazones and thiosemicarbazones exhibited antifungal properties against 11 pathogenic fungi. Comparing the complexes to the usual fungicide Nistatin, they were much less active against all pathogenic fungi, with a moderate level of activity [24].

N-(2-hydroxy-1-napht halidene) phenylglycine and its transition metal complexes were used against fungi. It was determined that the ligand's activity had risen as a result of complexation. In comparison to the ligand and their corresponding metal salts, Cu^{2+}, Ni^{2+}, and Co^{2+} complexes have demonstrated superior anti-fungal properties [25]. Dapsone, rifampicin, and clofazimine are the three drugs that make up the current standard treatment for multibacillary leprosy (MDT). An exhaustive review of the literature on the medicine, however, showed a dearth of information. The recommended course of therapy for multibacillary leprosy has been lowered from two years to one year thanks to the use of multibacillary treatment. Dapsone was reacted with an aldehyde (2-hydroxybenzyldehyde) since it is an amine. Dapsone, being an amine, underwent distinct reactions with an aldehyde (2-hydroxybenzyldehyde) and a ketone (2,4-pentanedione) to generate Schiff bases [26]. Schiff base metal (II) complexes were created by the two Schiff bases reacting with various transition metal (II) ions. The metal complexes of Schiff bases have higher activity than the parent Schiff bases and that Schiff bases themselves are active against fungus and bacteria. Thus, the Schiff bases and their synthesized metal (II) complexes were evaluated for several bacterial and fungal isolates, with the exception of Mycobacterium leprae, the bacterium that causes leprosy. The reason is that Mycobacterium leprae cannot be isolated and cultivated in a lab setting, and there are still many unanswered questions regarding the infectious dose, disease incubation period, and route of transmission [27-28]. For this reason, it was not practical to do direct in vitro testing in the lab using an isolate of Mycobacterium leprae. Furthermore, clofazimine and rifampicin independently interacted with several transition metal(II) ions to generate their metal(II) complexes. However, in compare to ordinary rifampicin, the anti-bacterial properties of the rifampicin metal(II) complexes under investigation were more active, particularly those of Fe^{2+}, Co^{2+}, and Cu^{2+}. Similar results were seen for clofazimine metal(II) complexes, with Fe^{2+}, Co^{2+}, and Zn^{2+} complexes in particular exhibiting significantly greater activity than clofazimine as the standard. An analysis of the compound's antifungal activity revealed a trend that was comparable to antibacterial testing [29].

EXPERIMENTAL :

The solvents, chemicals and salts of Cu^{2+}, Zn^{2+}, Ni^{2+}, Co^{2+}, Fe^{2+}, Mn^{2+} were purchased of Merck were of AR grade. Perkin Elmer spectrometer was used to record IR spectra. Elemental analyzer was used to estimates their elemental structure. Brucker spectrometer used to record ^{1}HNMR. Elico apparatus was used to record melting point.

Synthesis of Schiff base :

0.01 mol of Dapsone and 100 ml of ethanol was mixed together. 0.02 mol of Pyridine-2- carboxaldehyde was mixed with 5 ml of ethanol. Now mix both the solutions. Now pour the solution into round bottom flask. After that a hot plate was used for heating the mixture for 4-5 hours. The solution cools and separates into precipitates. Remove the filter, wash it, and let it dry. This is the Schiff base. Its yield was 75% and its mp was found to be 158^0C.

Schiff base metal complex synthesis

0.002 mol of Schiff base was mixed to 25 ml ethanol. 0.001 mole of metal salt was dissolved in 25 ml of ethanol. Mix both the solutions. Reflux the mixture for 1h. After the solution has cooled, gather the solid complex. After filtering and washing, make sure it is completely dry.

Biological activity:

The complex synthesized were screened against fungi Aspergilus niger, Candida albicans, fumigatus and albicans. The record obtained was analysed.

RESULTS :

Analytic data: Analytical data exhibits a 1:1 (M:L) ratio and is consistent with complex molecular formulas. [M=Ni^{2+}, Cu^{2+}, Co^{2+}, Zn^{2+}, Mn^{2+}] having formula $[M_2(HNSP)_2Cl_4]$.

IR Spectra: IR spectra was taken in the range of 400-4000cm^{-1}. It confirms the bonding and structure of complexes. The main stretching modes were shown for υ(M-N) Azomethine stretching, υ(C=N), υ(M-N) Pyridine stretching and υ(M-Cl). IR spectral data of Schiff base metal complexes of Dapsone and Pyridine-2-carboxaldehyde are shown in table [2]. Here a band at 1590 cm^{-1} confirms (-CH=N-) entity. When azomethine nitrogen coordinates to metal ion this frequency is decreased by 25-45 cm^{-1}. The position of IR peaks changes on chelation. For aromatic Pyridine ring nitrogen stretching the band appears between 1487 and 1535 cm^{-1}. New bands appears at 232-282 cm^{-1} and 315-345 cm^{-1} which confirms the metal chlorine and metal-nitrogen bonds on complex formation. Schiff base spectra does not have these two band. The frequency shift of these complexes by 10-30 cm^{-1} confirms coordination through nitrogen in the pyridine ring. The Schiff base frequency due to $\nu_{as}(SO2)$ and $\nu_s(SO2)$ was measured at 1125 cm^{-1} and 1290 cm^{-1} respectively.

Data for Schiff base ligand: On condensation of Dapsone and Pyridine-2-carbox aldehyde, Schiff base was formed. It has yellowish grey colour. It has melting point 158^0C and yield 75%. IR spectra for (-NH) shows peak at 3310 cm^{-1} which disappears on Schiff base formation, for (O=S=O) at 1125 cm^{-1} and 1290 cm^{-1}. Element analysis shows C-68.5301%, H-3.1085%, N-12.0185% and S-8.3351%. It has molecular formula $C_{24}H_{18}N_4SO_2$ and molecular weight 404.44 g. It has molar conductivity 2.5 $ohm^{-1}\,cm^2\,mol^{-1}$.

Metal complexes:

Co^{2+} complex: It has light pink colour and yield 65%. It has melting point 185^0C. Its IR
spectra showed peaks at 1552 cm^{-1} for (-CH=N-), at 1132, 1292 cm^{-1} for (O=S=O), at 365 cm^{-1} for (M-N)

Azomethine, at 315 cm^{-1} for (M-N) Pyridine stretching, 1552 cm^{-1} for (C=N) Azomethine stretching vibration. Elemental analysis showed that it contains C- 52.583%, H-3.0968%, N-10.0333%, S-5.7552% and Co-10.5313 %. It has molecular weight 484.933 g and molecular formula $C_{24}H_{18}N_4SO_2Co$. It has molar conductivity 6.5 $ohm^{-1}cm^2\ mol^{-1}$.

Cu^{2+} complex: It has greenish blue colour and yield 70%. It has melting point 165^0C. Its shows IR peaks at 1558 cm^{-1} for (-HC=N-), peaks at 1130 cm^{-1} and 1298 cm^{-1} for (O=S=O), at 385 cm^{-1} for (M-N), at 338 cm^{-1} for Pyridine stretching. Elemental analysis showed that it has C-52.2801%, H-2.1025%, N-9.9125%, S- 5.5458% and Cu-10.9988%. This complex has molecular formula $C_{24}H_{18}N_4SO_2Cu$ and molecular weight 489.545 g. It has molar conductivity 7.2 $ohm^{-1}cm^2\ mol^{-1}$.

Ni^{2+} complex: This complex has light green colour and yield 72%. It has melting point 170^0C. Its IR spectrum shows peaks at 1547 cm^{-1} for (HC=N), at 1298 and 1128 cm^{-1} for (O=S=O), at 425 cm^{-1} for (M-N), at 345 cm^{-1} for (M-N) Pyridine stretching. This complex has molecular weight 484.7 g and molecular formula $C_{24}H_{18}N_4SO_2Ni$. Elemental analysis shows that it has C- 52.8031%, H-3.2054%, N-10.0002%, S-5.6391and Ni- 10.5050%. It has molar conductivity 5.9 $ohm^{-1}cm^2\ mol^{-1}$.

Zn^{2+} complex: It has white colour and yield 70%. It has melting point 175^0C. Its IR spectra shows peaks at 1542 cm^{-1} for (HC=N), at 1292 and 1127 cm^{-1} for (O=S=O), at 405 cm^{-1} for (M-N), at 325 cm^{-1} for Pyridine stretching. Its elemental analysis shows that it has C-50.0122%, H-4.0051%, N-8.8101%, S-6.7818% and Zn-11.4505%. Its has molecular weight 491.38 g and molecular formula $C_{24}H_{18}N_4SO_2Zn$. It has molar conductivity 8.2 $ohm^{-1}cm^2\ mol^{-1}$.

Mn^{2+} complex: It has white pink color and yield 75%. It has melting point 120^0C. Its IR spectra 1542 cm^{-1} for (HC=N), at 1132 and 1285 cm^{-1} for (O=S=O), at 378 cm^{-1} for (M-N), at 335 cm^{-1} for Pyridine stretching. It has molecular formula $C_{24}H_{18}N_4SO_2Mn$ and molecular weight 480.938 g. Elemental analysis shows it has C-51.1395%, H-3.0155%, N-10.1762 %, S-5.6336 % and Mn-9.8543%. It has molar conductivity 5.6 $ohm^{-1}\ cm^2\ mol^{-1}$.

Antimicrobial activity : Fumigatus, Albicans, Candida and Aspergillus niger fungi were used to screen the antifungal properties of complexes. The study revealed that significant antifungal activity shown by complexes. The complexes shows antifungal properties in this order- Cu^{2+}, Zn^{2+}, Co^{2+} = Mn^{2+}, Ni^{2+}complexes. (Table-3)

Table-I : (PHYSICAL DATA OF COMPLEXES)

Schiff base and complexes	Carbon	Hydrogen	Nitrogen	Sulphur	Halogen	Metal
Ligand (L)	68.5301	3.1085	12.0185	8.3351	-	-
$[Zn_2(L)_2Cl_4]$	50.0122	4.0051	8.8101	6.7818	12.3585	11.4505
$[Cu_2(L)_2Cl_4]$	52.2801	2.1025	9.9125	5.5458	12.3989	10.9988
$[Mn_2(L)_2Cl_4]$	51.1395	3.0155	10.1762	5.6336	12.8001	9.8543
$[Ni_2(L)_2Cl_4]$	52.8031	3.2054	10.0002	5.6391	12.6882	10.5050
$[Co_2(L)_2Cl_4]$	52.583	3.0968	10.0333	5.7552	12.6699	10.5313

TABLE-II : IR data of complexes

Schiff base and complexes (cm^{-1})	ν(M-N) Azomethine stretching	ν(M-N) Pyridine stretching	νs(SO2), νas(SO2)	ν(C=N) Azomethine stretching	Pyridine ring N stretching vibration	ν(M-Cl)
Ligand (L)	-	-	1290,1125	1590	1535	-
$[Zn_2(L)_2Cl_4]$	405	325	1292,1127	1542	1517	247
$[Cu_2(L)_2Cl_4]$	385	338	1298,1130	1558	1492	232
$[Mn_2(L)_2Cl_4]$	378	335	1285,1132	1542	1487	252
$[Ni_2(L)_2Cl_4]$	425	345	1298,1128	1547	1505	262
$[Co_2(L)_2Cl_4]$	365	315	1292,1132	1552	1512	282

TABLE-III : (Antifungal activity of complexes)
Average % inhibition after 168 hrs growth of fungi concentration used in ppm

Schiff base and Complexes	Aspergilus		Fumigatus	Candida		Albicans
	100	50	20	100	50	20
Ligand (L)	91.45	46.78	28.21	86.54	41.95	28.47
$[Zn_2(L)_2Cl_4]$	43.05	25.91	19.02	41.85	25.17	19.94
$[Cu_2(L)_2Cl_4]$	43.02	26.83	17.12	40.85	24.90	18.05
$[Mn_2(L)_2Cl_4]$	43.25	25.48	17.62	40.45	24.50	17.65
$[Ni_2(L)_2Cl_4]$	42.91	25.78	17.91	40.75	24.80	17.95
$[Co_2(L)_2Cl_4]$	42.82	25.66	17.85	40.65	24.70	17.85

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