Review on Synthesis, Characterization and Biological Activities of Schiff bases and Metal Complexes

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Abstract
Schiff bases shows biological activities such as antimicrobial, anti-inflammatory, and antiproliferative properties. Schiff base having presence of azomethine are condensation products of primary amine with a carbonyl compound in which the carbonyl group has been replaced by an imine or azomethine group. The imine group of Schiff base is an important structural part which is found in various natural compounds of biological importance. All Schiff bases and metal complexes were characterized on the basis of elemental analysis and by using various spectroscopic techniques such as elemental analysis, UV-Visible, IR, ^{1}H NMR, ^{13}C NMR, Mass, X-ray Diffraction, SEM, TEM, Thermogravimetric analysis and Magnetic Properties. Biological activities are determined by screening against wide range of micro-organism.

Keyword : Schiff Bases, Metal Complexes, Synthesis, Characterization, Biological Activity.

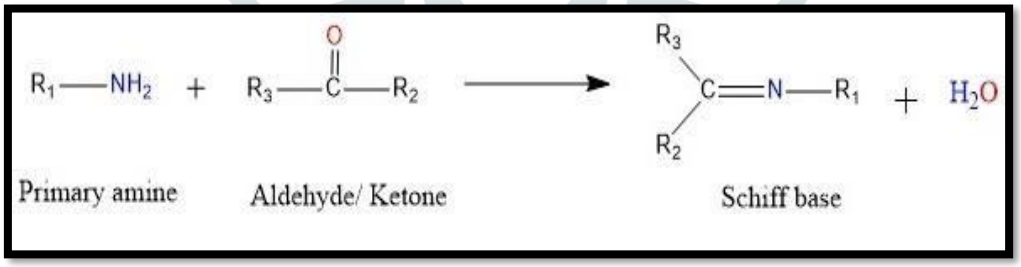
Introduction

Schiff base name after Hugo Schiff, a German chemist who first prepared it in 1864 by reacting an aldehyde with an amine in the presence of an acid catalyst [*1*]. Imines, known even as azomethines or Schiff bases are compounds that are represented by the general formula $R_3R_2C{=}NR_1$, involves the formation of an imine functional group (-C=N-) by the condensation of the carbonyl group of the aldehyde with the amino group of the amine.

Schiff base is a nitrogen analogue of aldehyde or ketone in which the carbonyl group (C=O) has been replaced by an imine or azomethine group (-C=N-). In Schiff bases, (-C=N-) group shows a specific purpose in producing these molecules with extensive biological actions on varying R_1, R_2 or R_3 group which can be an H /aryl /alkyl/ heteroaryl group [*2*]. Schiff bases that contain aryl substituents are more stable and readily synthesized, while those which contain alkyl substituent are comparatively unstable.

Structural variation in Schiff base allows the researcher to explore its potential application. This is evident from the number of reviews published on the synthesis, structure and application of Schiff base [*3-4*].

The imine group (CH=N) of Schiff base is a key structural part which is found in various natural compounds of biological significance. Schiff bases shows prominent biological activities such as anti-inflammatory [*5*], antimicrobial [*6*]and antiproliferative [*7*] properties. The general method of preparation of Schiff base is as given below.



Where R_1, R_2 and R_3 will be an alkyl or aryl groups

Result and Discussion

A Schiff bases are typically formed by the condensation of a primary amine with an aldehyde or ketone. In which >C=O group is replaced by >C=N-R group. The resultant compound, $R_1R_2C{=}NR_3$, is called a Schiff base. Some of worked on it are summarize below.

Jeewoth, et al., [*8*] have reported Schiff bases derived from 2,3-diaminopyridine (DAPY) with pyrrole-2-carboxaldehyde (Pyrr) and 2-hydroxy-1-naphthaldehyde (NaphH), and complexes with Cu (II), Fe (III), Ni (II), Ru (II) and Zn (II) and the bis-condensed Schiff base of 2,3-diaminopyridine and salicylaldehyde (SalH) were synthesized. All were characterized by a elemental analyses, magnetic susceptibility measurements, IR and NMR spectra. Schiff bases and some of the metal complexes show antibacterial activity. Fe (III) and Ru (II) complexes shows catalytic activity in the oxidation of alcohols in the presence of N-methylmorpholine-N-oxide as co-oxidant.

Cozzi [*9*] in this review reported Schiff base ligands are easily prepared by the condensation between aldehydes and amines. Elements of chirality (planes, axes) can be introduced in the synthetic design. Schiff base ligands are able to coordinate different metals, and to stabilize them in different oxidation states, enabling the use of Schiff base metal complexes for a large variety of useful catalytic transformations.

Radecka-Paryzek, et al., [*10*] have focuses on the design, template synthesis and characterization of the Schiff base mono- and homo- or heterodinuclear polyaza and polyoxaaza macrocyclic complexes. In this review the factors which prove to be of much importance in directing the synthetic pathway in these systems are discussed.

Gupta and Sutar [*11*] have reported complexes of Many Schiff base complexes of metal ions Co (II), Fe (II) ions with pyridyl bis(imide) and pyridine bis(imine) have been used as catalysts in the polymerization of ethylene and propylene. show high catalytic activity. Chiral Schiff base complexes are more selective in various reactions such as oxidation, hydroxylation, aldol condensation and epoxidation. The catalytic activity of metal complexes of binaphthyl, binaphthol and their combinations with salen Schiff base is presented in this review.

Justin Dhanaraj and Sivasankaran Nair [*12*] have reported preparation of Neutral complexes of Co (II), Ni (II), Cu (II), and Zn (II) have been synthesized from the Schiff bases derived from 3-nitrobenzylidene-4-aminoantipyrine and aniline p-nitro aniline p-methoxy aniline in the molar ratio 1: 1. All have been characterized from microanalytical, IR, UV-Vis, ^{1}H-NMR, mass, and ESR spectral data. The Cu (II) complexes are square planar, while Co (II), Ni (II), and Zn (II) complexes are tetrahedral. Magnetic susceptibility measurements and molar conductance data provide evidence for the monomeric and neutral nature of the complexes. The X-band ESR spectrum of Cu (II) complexes at 300 and 77 K were recorded. The electrochemical behavior of the complexes in MeCN at 298 K was studied. The biological screening effects of the investigated compounds were tested against the bacterial species Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Proteus vulgaris, and Pseudomonas aeruginosa and fungal species Aspergillus niger, Rhizopus stolonifer, Aspergillus flavus, Rhizoctonia bataicola, and Candida albicans by the well-diffusion method. Comparison of the inhibition values of the Schiff bases and their complexes indicate that the complexes exhibit higher antimicrobial activity.

Neelakantan,et al.,[*13*] have reported synthesis of mixed ligand complexes (1-5) of type ML'B (M(II)=Mn(II), Co(II), Ni(II), Cu(II) and Zn(II); HL'= o-vanillidene-2-aminobenzothiazole; B= 1,10-phenanthroline) and Schiff base metal complexes of types (ML_2") (6-10) and (M_2L") (11-15) (HL"= *o*-vanillidene-2-amino-N-(2-pyridyl)-benzene sulfonamide) were synthesized and characterized by elemental analysis and spectral (IR, ^{1}H NMR and ^{13}C NMR) studies. The free ligands and their metal complexes have been screened for their *in vitro* biological activities against bacteria, fungi and yeast. The metal complexes show more potent activities compared with Schiff base ligand

Jouad, et al., [*14*] have reported Schiff base metal complexes of Co (II), Ni (II), Cu (II) and Cd (II) with 5 - methyl - 2-furanaldehyde thiosemicarbazone. Prepared metal complexes were characterized spectrally by IR, ^{1}H NMR, Electronic spectra and XRD techniques.

Mohamad, et al., [*15*] have reported metal complexes of Co (II), Zn (II) and UO_2 (II) with Schiff bases derived from 2-furancarboxaldehde and o-phenylenediamine, 2-thiophenecarboxaldehyde and 2-aminothiophenol. The prepared metal complexes were characterized by elemental analysis, IR, ^{1}H NMR, solid reflectance, magnetic moment, molar conductance and thermal analysis (TGA). Antimicrobial and antifungal activities screening study indicates that metal complexes exhibit greater antimicrobial activities as compare to Schiff bases against wide range of bacteria and fungi.

Srivastava, et al., [*16*] have reported complexes of Co (II), Ni (II) and Cu (II) with the Schiff base prepared by condensation of p-chloroaniline and 2-furfuraldehyde. Analyzed and characterized with the help of microanalytical data, UV-visible and IR, conductance and magnetic susceptibility measurements. The complexes have general formula ML2(H20)2 S04.nH20. Complexes were screened for their antimicrobial activities against various bacteria's.

Gaballa, et al., [*17*] have reported metal complexes of Pt (II) with Schiff base derived from salicylaldehyde, 2 - furaldehyde with o and p-phenylenediamine. Prepared metal complexes were characterized on the basis of elemental analysis, IR, UV-Visible spectroscopy and TGA techniques. The antimicrobial data shows that Pt (II) metal complex exhibit higher antimicrobial activities than Schiff bases.

Rajavel, et al., [*18*] have reported metal complexes of Cu (II), Ni (II), Zn (II) and VO_2 (IV) with Schiff base ligand [bis-(2-aminobenzaldehyde)] malonoyl dihydrazone]. All metal complexes were characterized by using spectroscopic tools.

Suresh and Prakash [*19*] have reported synthesis of Schiff bases derived furfural, 4-aminoantipyrine, furfural and o-phenylenediamine and complexes of Mn (II), Co (II), Cu (II), Ni (II) and Zn (II). All Schiff bases and metal complexes were analysed by elemental analyses, IR, UV-visible, NMR, thermal gravimetric analyses, ESR spectral analyses and conductivity measurements. The data of the complexes suggested square planar geometry for the metals with primary valency two. MIC values of antimicrobial activities of the Schiff base and its metal complexes shows that the metal complexes exhibit greater antibacterial activity than the free ligand.

Saxena, [*20*] have reported metal complexes of Co (III), Ti (III), V (III), Mn (III) and Ru (III) derived from the Schiff base ligand prepared from furfuraldehyde with 4-amino-5-mercapto-5- triazole. All prepared metal complexes and Schiff basses were characterized by elemental analyses, molar conductance, magnetic measurements, 1H NMR and electronic spectral data, on the basis of these data octahedral structures have been assigned to these complexes.

Ali,[*21*] have reported metal complexes of Zn (II) with Schiff bases derived from 2-furanaldehyde with 4, 5-dimethyl-1, 2-phenylendiamine and 4, 5-dichloro-1, 2-phenylendiamine. Prepared complexes were characterized by elemental analysis, magnetic measurement, molar conductance, IR, ^{1}H NMR, UV–Visible and thermal analysis techniques. It was observed that Zn (II) complexes shows corrosion inhibitory behaviour.

Dong, et al., [*22*] have reported hexa coordinated metal complexes of Zn (II) with 4, 4 -dibromo-6, 6-dichloro-2, 2- [ethylenedioxybis (nitrilomethylidyne)] diphenol. Metal complexes were analysed by elemental analysis and confirmed spectrally by using spectroscopic tools such as UV-Visible, IR, TGA analysis and XRD. Spectroscopic study indicates slightly distorted octahedral geometry shown by Zn (II) complexes.

Jayaseelan, et al., [*23*] have reported metal complexes of metal salt with tetradentate binucleating ligand obtained by condensation of 3, 3′-diaminobenzidine with o-hydroxyacetophenone, the reaction of the ligand with metal salt yielded bimolecular complexes. Ligand and metal complexes were characterized by elemental analysis, conductivity measurement, magnetic measurement, UV-Visible, IR, ^{1}H NMR and ^{13}C NMR.

Al Zoubi and Ko [*24*] reported Schiff bases were compounds synthesized from the reaction of a primary amino compound with aldehydes or ketones and used for industrial purposes and shows catalytic oxidation in the oxidation of organic compounds and polymers. Schiff bases were versatile compounds synthesized from the condensation of a primary amino compound with aldehydes or ketones and widely used for industrial purposes and also exhibit catalytic oxidation in the oxidation of organic compounds and polymers. Recent researches of Schiff bases and metal complexes in oxidation catalysis had addressed on metal catalyzed oxidation of organic compounds.

Saravana Mani and Narayanaswamy [*25*] have reported Schiff base metal complexes by reacting Schiff base derived from reacting 4-nitro-o-phenylenediamine with 2-furanaldehyde, metal salt of Cu (II), Co (II), Ni (II), Mn (II) and 2, 2-bipyridyl. It was observed that complexes show greater antimicrobial and antifungal activities as compare to Schiff bases.

Araujo, et al.,[*26*] have reported Schiff bases by the reaction of biopolymer chitosan with salicylaldehyde, 5-methoxysalicylaldehyde and 5-nitrosalicylaldehyde. Transition metal complexes of Cu (II), Ni (II) and Zn (II) with Schiff bases were prepared in stoichiometric ratio. Complexes were characterized by ^{1}H NMR and FTIR techniques. Cytotoxicity test was performed by MTT assay.

Conclusion

Schiff bases are very important compound due to its easy method of preparation and its ability to formed complexes with metal ions and presence of important pharmacophore azomethine shows important biological properties such as antimicrobial, antifungal, anti-inflammatory, antiproliferative activities and its versatile application in industries as yellow pigment and in energetics. But still there is needs to explore biological properties of already synthesized Schiff bases and its metal complexes and to synthesize new Schiff bases and metal complexes with transition, lanthanides and actinides metal ions.

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