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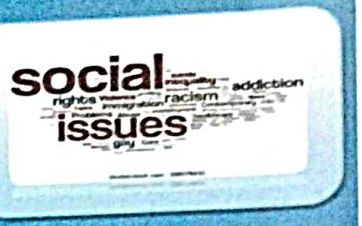

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April 2022 Volume-13 Issue-17

Chief Editor

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Applications of Schiff Bases and their Metal Complexes: A Review

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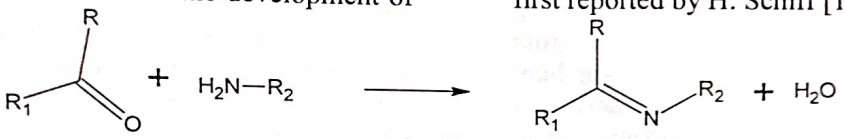
Abstract: Schiff bases are formed by the condensation of amines with active carbonyl compounds. Schiff bases are commonly named as imines, anils, azomethines, oximes, hydrazones, semicarbozones, thiosemicarbozones and allied derivatives continue to provide the most interesting side in the field of coordination chemistry as evident from some excellent reviews. They contain azomethine (>C=N-) group as a functional group and hence can act as effective ligand stereogenic centers or other elements of chirality can be introduced in the synthetic design. The coordination chemistry of Schiff bases with transition metals has been widely investigated due to their biological activities, such as anticancer, antitumor, leprosy, antibacterial, antifungal, mental disorders, antioxident and interesting bonding patterns with metal ions. The present review discusses the various applications of Schiff bases and their metal complexes.

Introduction:

Schiff bases and their metal complexes have played a central role in the development of coordination chemistry. The name ' Schiff base ' is given to this class of compounds as they were first reported by H. Schiff [1].



Carbonyl Compound Amine Schiff Base

Metal complexes of Schiff bases have played an important role in the development of coordination chemistry. Azomethine group (>C=N-) in Schiff base metal complexes shows considerable biological significance and found to be responsible for biological activity such as insecticidal and fungicidal [3]. To be an effective chelating agent, a Schiff base must possess an additional ligating group such as -OH, -COOH, -NH_2, -SH etc. besides azomethine nitrogen (>C=N-) so that atleast five or six membered ring can be formed upon complexation with a metal ion. Chelating ligands with O and N donor atoms show broad biological activity and are of special interest because of the number of ways in which they are bonded to metal ions. This chelating behavior of the Schiff bases associated with the ease of preparation and flexibility in varying the chemical environment about the C=N group makes it an interesting ligand in coordination chemistry. Schiff bases have shown a special feature as chelating ligands in main group and transition metal coordination chemistry because of their stability under a variety of redox conditions and because imine ligands are borderline Lewis bases. The important physical and biological properties of Schiff bases are directly related to the intramolecular hydrogen bonding and proton transfer equlibria. Schiff bases also present opportunities for inducing substrate chirality tuning metal centered electronic factors and enhancing the solubility and stability of homogeneous and heterogeneous catalysis. The coordination chemistry of Schiff bases with transition metals has been widely investigated due to their biological activities [4-7], such as anticancer, antitumor, leprosy, antibacterial, antifungal, mental disorders, antioxident and interesting bonding patterns with metal ions [8].

Applications of Schiff Bases and their Metal Complexes:

Schiff bases find an important character in inorganic chemistry as they have ability to easily form stable complexes with most transition metal ions in the periodic table. It has been recognized that many of these complexes may serve as models for catalysis, polymers, dyes and biological systems besides they can be used as antifertility and enzymatic agents.

1) **Catalysis:**

Catalytic activity of Schiff bases or their metal complexes has been reported in literature [9]. Aromatic Schiff bases and their metal complexes catalyze reactions on oxygenation [10,11], hydrolysis [12] andelectro-reduction [13]. Coordination compounds having multimetal centres with magnetic interaction are of considerable interest in the domain of metalloenzymes and homogeneous catalysis [14]. Some polymer bound Schiff base metal complexes exhibit catalytic activity on

decomposition of hydrogen peroxide and oxidation of ascorbic acid [15]. The Cu(II) complexes of Schiff base have been used for allylic oxidation of cyclohexene [16].

2) **Polymers:**

Photochemical degradation of natural rubber yield amine terminated liquid natural rubber (ATNR) when carried out in solution, in presence of ethylene diamine. ATNR on reaction with glyoxal yield Schiff base which improves aging resistance [17]. The titanium and zirconium complexes derived from thiophene diamide Schiff base ligands exhibited the activity for ethylene and styrene polymerization [18]. Organocobalt complexes with tridentate Schiff base act as initiator of emulsion polymerization and co-polymerization of dienyl and vinyl monomers [19].

3) **Dyes:**

Metal complexes having azo groups are used for dying cellulose polyester fibres [20, 21]. Cobalt complex of a Schiff base derived from salicylaldehyde and diamine has excellent light resistance and storage ability and does not degrade even in acidic gases (CO_2). Tetradentate Schiff base acts as a chromogenic reagent for determination of Ni in some food samples [22].

4) **Biological activity:**

a) **Antibacterial activity:**

VO(II), Co(II), Ni(II) and Cu(II) complexes with the Schiff bases derived from 3-chloro-4-floroaniline and 2-pyridinecarboxaldehyde with 4-aminoantipyrine show a good activity against the bacteria; *S. aureus*, *E. coli* and *S.fecalis* [23]. Metal complexes of isatinic Schiff base gave a fair inhibitor effect on growth of the microorganisms and were more potent as bacteriostatic agents [24]. Metal complexes with an asymmetric tetradentate Schiff base ligands derived from dehydroacetic acid, 4-methyl-*o*-phenylenediamine and salicylic aldehyde show good antibacterial activity against *S. aurus* and *E. coli* [25].

b) **Antifungal activity:**

Metal complexes of Fe(III) and Co(III) with Schiff bases derived from 3-substituted-4-amino-5-mercapto-1,2,4-triazole and pyridine-2-carboxaldehyde or thiophene-2-carboxaldehyde show that *the* complexes show antifungal activity against *A. niger* and *F. solani* [26]. Schiff base and their metal complexes possess effective antifungal activities against *Aspergillus* sp., *Stemphylium* sp. and *Trichoderma* [27].

c) **Antiviral activity:**

Silver complexes of Schiff base with salicylaldehyde and glycine showed considerable effect towards *C. mosaic* virus [28]. High antiviral activity of Schiff bases is reported in literature [29].

d) **Antitumor and cytotoxic activity :**

Schiff bases derived from condensation of salicylaldehyde, 2,4-dihydroxybenzaldehyde with glycine and L-alanine and their metal complexes show antitumor activity [30]. Diorgano-tin (IV) complexes of Schiff base show antitumour activities in vitro and inhibit interaction to tumor cell lines [31].

e) **Plant growth regulator:**

Schiff base of ester and carboxylic acid show remarkable activity as plant growth hormone [126]. Effective activities have been shown by Schiff bases on plant hormone such as auxins and root growth [32, 33].

f) **Synergistic action on insecticides:**

Schiff base derived from sulfane thiadizole and salicylaldeyde or thiophine-2-aldehyde and their complexes have shown toxicity against insects [34]. α-amino acid acts as intermediate in synthesis of photostable pyrthriod insecticides [35].

g) **Chemotherapy:**

Schiff bases used in chemotherapy are now attracting the attention of biochemists [36, 37]. Some drugs showed increased activity when administrated as metal complexes rather than as organic compounds [38, 39].

h) **Other therapeutic activities:**

Several Schiff bases possess anti-inflammatory, allergic inhibitors reducing activity, radical scavenging, analgesic and anti-oxidative action [40-42].

5) **Antifertility and enzymatic activity:**

Schiff bases of hydrazine carboxomide and hydrazine and Mo(IV) and Mn(II) might alter reproductive physiology [43]. Schiff base linkage with pyridoxal 5 phosphate from lysine to alanine or histidine abolishes enzyme activity in protein [44].

6) **Analytical Applications:**

Schiff bases react with metal ions and form colored precipitates or solutions. Hence they are extensively used as analytical reagents. They have been used for the spectrophotometric determination of metal ions [45-47]. Few researchers considered Schiff bases as spectrofluorimetric reagents also [48-49].

7) **Other:**

In some cases, it is found that Schiff bases with sulphur donor atom are more selecting to form more intense color and stable chelates with certain metal ions than the Schiff bases with oxygen donor [50]. A number of Schiff bases used for the qualitative and

quantitative analysis. Duke estimated copper gravimetrically in brass and bronze with salicylaldimine [51]. Mehta and Sexena reported the use of N-salylidene-β-alanine Schiff base as a gravimetric reagent for copper [52]. Schiff bases derived from salicyldehyde and mono and diamines were used by Terent'ev et.al. [53-55] in developing the qualitative tests for Cu(II), Ni(II), Co(II), Fe(II), Cd(II), Zn(II) and Pb(II). Mukharjee [56, 57] used Schiff base derived from ethylenediamine-bis-sulphosalicylaldehyde and salicylaldehyde glycine hydroxamic acid.

Nair et al. [58] have synthesized some new oxomolybdenum(IV) complexes with a Schiff base derived from 3-methylsalicyldehyde and isonicotinoyl hydrazide. The ligand, $[MoO(L)Cl_2]$ and $[MoO_2(L)Cl]$ have been screened for their anticancer and antibacterial activity. The complex $[MoO(L)Cl_2]$ showed higher activity than the ligand and its dioxocomplex. Reddy et al. [59] have described the synthesis and analytical application of 2-hydroxy-3-methoxy benzaldehyde thiosemicarbazone. The ligand used to determine nickel in aluminium based steel, drinking water, plant samples and vegetable oil. A series of Cu(II) complexes of mixed ligands with Schiff bases derived from 2-aminophenol/2-aminobenzoic acid with substituted benzaldehyde and 1-10 phenanthroline synthesized by Raman and Raja [60]. The complexes show higher antibacterial activity than the free ligand.

Schiff bases and their compounds are being used in clinical [61] and biological implications [62, 63]. A number of Schiff bases have been reported for their bactericidal, antipyretic [64-66], fungicidal [67], antitumor [68], antitubercular [69], stress inhibitory [70] activities and anticancer activities [71-74].

Conclusion:

During the past few decades Schiff bases have drawn great attention of researchers due to their various applications. Schiff bases have been playing a major role as chelating ligand for large variety of metal ions. An attempt has been made through this present review paper to discuss this role of Schiff bases and their metal complexes in various aspects.

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