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## Evaluation on synthesis and application of Schiff base and its transition metal complexes

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### Abstract

Schiff base ligands are easily prepared by the condensation between aldehydes and amines. These compounds are also known as anils, imines or azomethines. Lone pair of nitrogen atom of the azomethine group is of considerable chemical and biological importance. Schiff base ligands are able to coordinate with various transition metal and to stabilize them in various oxidation states. The present study focuses the diverse importance of Schiff bases complexes in many fields like co-ordination chemistry, catalysis, pharmaceutical, food industry, dye industry, analytical chemistry and in biological processes.

**Keywords:** Schiff base, metal complexes, compounds etc.

### Introduction

Interest in the synthesis and characterization of transition metal complexes of Schiff bases containing nitrogen and oxygen donor atoms has increased manifold in the recent past [1, 2]. The Schiff base ligands are considered to be good chelating agents [3], especially when –OH functional group is close to the azomethine group [4]. Schiff bases are a special class of ligands with a variety of donor atoms exhibiting interesting coordination modes towards transition metals [5], and azomethine linkage is responsible for the biological activities [6]. The Schiff bases derived from various amines have been widely investigated [7] and find applications in biomimetic catalytic reactions, materials chemistry and industry [8]. Schiff base complexes have also gained attention as stereochemical models in transition metal coordination chemistry due to their structural variety [9]. A number of transition metal Schiff's base complexes have been studied extensively that show variable coordination geometry and flexible oxidation states with ligating system as varied as bidentate, tridentate, tetradentate and multidentate [10-11]. Some of them are key points in the development of inorganic biochemistry, catalysis and industrial purpose. Copper is a biologically essential element and more than a dozen enzymes depend on copper for their activity [12]. Because of its biological relevance, coordination chemistry of copper attracts much attention. A considerable number of Schiff's base copper complexes have potential biological interest and are being used as successful models of biological systems [13-14] and supramolecules and helical assemblies [15, 16].

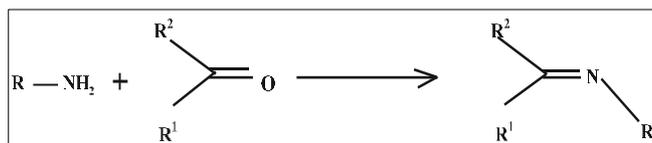
### Preparation of Schiff bases

The first preparation of imines was reported in the 19th century by Hugo Schiff (1864). Since then a variety of methods for the synthesis of imines have been described [17]. The classical synthesis reported by Schiff involves the condensation of a carbonyl compound with an amine under azeotropic distillation. Molecular sieves are then used to completely remove water formed in the system [18]. In the 1990s an *in situ* method for water elimination was developed, using dehydrating solvents such as tetramethyl orthosilicate or trimethyl orthoformate [19]. Chakraborti *et al.* [20] demonstrated that the efficiency of these methods is dependent on the use of highly electrophilic carbonyl compounds and strongly nucleophilic amines. Because of the relative ease of preparation, synthetic flexibility, and the special property of C=N group, Schiff bases are generally excellent chelating agents, especially when a functional group like –OH or –SH are present close to the azomethine group so as to form a five or six membered ring with the metal ion.

### Correspondence

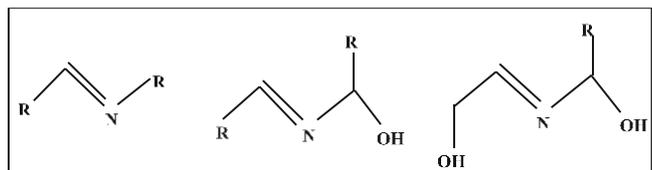
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The general formation of schiff base is as follow:



### Denticity and Basicity of Schiff base

The schiff base ligands are classified according to the number of donor atoms are named as uni, di, tri, tetradenate ligands, Schiff base primarily possess nitrogen donor atom.



### Schiff Base with varying Denticity

In general the donor nature of the ligand depends both on the type of aldehyde/ketone used and the nature of primary amine/diamine. The basicity of the schiff base also play a key role in the formation and stabilization of the complexes. The -OH group present in the Schiff base can induce tautomerism in the compound, which leads to compound with different structures. A large number of schiff base compound show keto-enol tautomerism. Also the deprotonation of alcoholic and phenolic groups are favored due to the stabilization of varies oxidation state of different metal ions.

### Coordination with Transition Metal

Schiff base metal complexes are prepared in situ by producing a reaction between the schiff base and well-defined metal. This approach is clearly simple and suitable for catalytic applications. Different complexes can be present in different concentrations, as a function of the equilibrium constant. However, the introduction of a bulky group in the schiff bases can control the identity and homogeneity of the complex, by shifting the equilibrium towards the formation of a single species. The stability of the complexes is regulated by the equilibrium constant, and a disproportionation between Schiff base metal complexes and the metal alkoxides can occur.

Schiff base ligands are able to coordinate many different metals with various oxidation states, enabling the use of schiff base metal complexes for a large variety of useful catalytic transformations. Schiff-base ligands containing imidazole groups have potentially donor and acceptor character in the formation of a coordination bond and function as a ligand-complex or as a self-complementary building block for the construction of the assembly structure due to the formation of a coordination bond with Cu (II) ions [21, 22]. Versatility of Schiff base ligands and their biological, analytical and industrial applications of their complexes have promoted further investigations in this area. The importance of Schiff base complexes for bioinorganic chemistry, biomedical applications, supramolecular chemistry, catalysis and material science, separation and encapsulation processes, and formation of compounds with unusual properties and structures has been well recognized and reviewed. A large number of Schiff bases and their

complexes are of significant attention because of their biological activity including anti-tumor, antibacterial, fungicidal and anti-carcinogenic properties and catalytic activity [23, 24].

### Application of schiff base complexes

#### Catalysis

The Schiff base transition metal complexes are a family of attractive oxidation catalysts for a variety of organic substrates because of their cheap and easy synthesis and their chemical and thermal stability [25]. Important oxidation reactions include the transformation of alcohols to either the corresponding carbonyl compounds or carboxylic acids, the oxidation of sulfides to sulfoxides, alkenes to epoxides and diols, and the activation of hydrocarbons etc. The catalytic activities of the Mn (II), Fe (III), Co (II) and Cu (II) complexes are observed for their activity towards phenol hydroxylation reaction. All the complexes show good activity. The activities of these cobalt complexes are slightly lower than that of copper (II), iron (II) and manganese (II) analogues of the investigated Schiff bases [26, 27]. The major product of the reaction was found to be catechol [28]. The cobalt (II) complex is found to be inactive, which may be due to the dimer formation. So that it is unable to bind with the oxygen to form the intermediate. The copper complex was found to be the most active catalyst.

#### Biological activity

Schiff bases have also been shown to exhibit a broad range of biological activities, including antifungal, antibacterial, antimalarial, anti-proliferative, anti-inflammatory, antiviral, and antipyretic properties [29]. Imine or azomethine groups are present in various natural, natural-derived, and non-natural compounds. The imine group present in such compounds has been shown to be critical to their biological activities [30].

Schiff bases have been shown to be interesting moieties for the design of antimalarial agents. Schiff base was the most effective antimalarial agent among the synthesised 5-nitroisquinoline derivatives. Ancistrocladidine is a secondary metabolite produced by plants from the families Ancistrocladaceae and Dioncophyllaceae that present an imine group in its molecular scaffold. Rathelot *et al.* [31] described the synthesis of schiff base functionalised 5-nitroisquinolines and investigated the *in vitro* activity of these compounds.

Isatin-derived schiff bases have also been reported to possess antibacterial activity. Other isatin derivative schiff bases also have antibacterial activities [32, 33]. The natural or non-natural origin that are platforms for the synthesis of Schiff bases for antibacterial activities include amino acids, coumarins, sulfonamides, or resacetophenone, aminothiazolyl bromocoumarins, crown ethers, o-phthalaldehyde, or 2-aminophenol and 1, 2,4-triazoles [34].

Kumar *et al.* [35] reported a series of 3-(benzylideneamino)-2-phenylquinazoline-4(3H)-one and evaluated their cytotoxicity and antiviral activity. Compounds having 2-hydroxy substitution showed better anti-viral activity. Some bis-schiff bases of isatin, benzylisatin, and 5-fluoroisatin, were reported by Jarrahpour *et al.* [33] as antiviral agents.

Sashidhara *et al.* [36] presented a series of schiff's bases of benzocoumarin and evaluated *in vitro* for their anti-oxidant activity and *in vivo* for their antidyslipidemic activity. During antioxidant screening, compound exhibited

significant activity and significant lipid lowering activity. Li *et al.* [37] reported antioxidant capacities of ferrocenyl Schiff bases including o-(1 ferrocenylethylidene amino) phenol (OFP), m-(1ferrocenyl ethylidene amino) phenol (MFP), and p-(1-ferrocenylethylideneamino) phenol (PFP) were evaluated. OFP, MFP and PFP possessed similar activities to trap DPPH and ABTS+. The introduction of ferrocenyl group to Schiff base increased the antioxidant effectiveness more remarkably than benzene related schiff bases.

### Conclusion

Schiff bases have been widely explored for industrial applications and in various organic transformations. However, the biological activity of this class of compounds deserves further investigation. This becomes clear when plant pathogens are considered. Although the research on this subject is incipient, a number of reports disclosing the effects of the schiff bases on the pathogens of clinical interest have recently been increasing. Schiff base compounds have been shown to be promising leads for the design of more efficient antimicrobial agents. Advances in this field will require analyses of the structure–activity relationships of the schiff bases as well as the mechanism of action of these compounds.

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