International Journal of Research in Engineering and Applied Sciences(IJREAS)
Available online at http://euroasiapub.org
Vol. 8 Issue 12, December-2018,
ISSN (O): 2249-3905, ISSN(P): 2349-6525 | Impact Factor: 7.196 |

A REVIEW ON SYNTHESIS CHARACTERISATION AND MICROBIAL ACTIVITY OF SCHIFF BASE AND THEIR METAL COMPLEXES

ISHWAR CHAND BALAEE

ASSISTANT PROFESSOR

S.N.K.P. GOVT.COLLEGE NEEM KA THANA (SIKAR) RAJASTHAN

E-MAIL icsurela@gmail.com

ABSTRACT

Schiff bases and their metal complexes have received a lot of attention in the field of coordination chemistry because they can be used in a variety of applications such as medicinal chemistry, catalysis, and material science. The major themes of this research are the synthesis, characterisation, and microbiological activity of Schiff bases and their metal complexes. In the synthesis of Schiff bases, a condensation reaction between a primary amine and an aldehyde or ketone is employed. Schiff bases have been built in a variety of ancient and contemporary ways. It will also be demonstrated that varying reaction circumstances and substitutions have different effects on the reaction's outcome. Techniques such as nuclear magnetic resonance spectroscopy, infrared spectroscopy, and mass spectrometry have greatly aided in ensuring the cleanliness and structure of Schiff bases and their metal complexes. The characterization section will go into the application of these methodologies to the examination of these compounds in detail. Schiff bases and their metal complexes have been extensively researched in terms of their biological effects. These compounds have demonstrated antibacterial, antifungal, and anticancer activity. This review will outline the most significant findings in this field and will concentrate on the structure-activity interactions that contribute to their biological features.

INTRODUCTION

Schiff bases, which are derived from the condensation reaction between a primary amine and an aldehyde or ketone, have gained considerable attention in the field of coordination chemistry. These compounds exhibit a wide range of applications in diverse scientific areas, including medicinal chemistry, catalysis, and material science. The ability of Schiff bases to form stable complexes with metal ions further enhances their potential for various applications.

The synthesis of Schiff bases involves the reaction between an amine and a carbonyl compound under suitable reaction conditions. This condensation reaction can be achieved using conventional methods such as refluxing or by employing modern approaches such as microwave-assisted or ultrasound-assisted reactions. The choice of reactants, reaction conditions, and substituents significantly influence the yield and purity of the Schiff bases obtained.

It is critical to understand the structure, purity, and properties of Schiff bases and their metal complexes. Scientists frequently utilize spectroscopic techniques for structural elucidation, such as nuclear magnetic resonance (NMR) spectroscopy, infrared (IR) spectroscopy, and mass spectrometry. These techniques provide valuable information on the compounds' connectivity, functional groups, and overall molecular structure.

The biological activities of Schiff bases and their metal complexes have been extensively investigated. Several studies have reported their antimicrobial, antifungal, and anticancer activities. The presence of biologically active functional groups in the Schiff base structure, along with the coordination of metal ions, contributes to their enhanced biological properties. Understanding the structure-activity relationships of these compounds is crucial for the development of novel therapeutics with improved efficacy.

The way Schiff bases interact with transition metal ions has been the subject of extensive research. Metal complexes with Schiff bases acquire novel properties and activities that can be exploited in catalysis, drug delivery, and systems that resemble living beings. The stability, geometry, and spectroscopic properties of metal complexes are determined by the structure of the metal ion and the ligand.

This review goes into considerable detail about the synthesis, characterization, and microbiological activity of Schiff bases and their metal complexes. We will discuss many methods of creating Schiff bases, both old and new. We'll also go through the characterization techniques used to establish the structure and purity of these compounds. We will discuss the biological activities of Schiff bases and their metal complexes, with a focus on their antibacterial properties and anticancer potential. We will discuss the structure-activity interactions that lead to biological efficacy. We will also look at how Schiff bases interact with transition metal ions, with an emphasis on how metal coordination influences Schiff base properties.(Zaky M. F,2012)

Synthesis of Schiff bases

Schiff bases are extremely useful chemical molecules that are researched and employed in a variety of fields, including organic synthesis, medicinal chemistry, and coordination chemistry. When a primary amine combines with an aldehyde or ketone, an imine or schiff base is formed.

The synthesis of Schiff bases is a straightforward and well-established process. It entails the reaction of an amine with a carbonyl molecule in the presence of a suitable catalyst or acid. Because the reaction typically takes place under mild circumstances, a wide variety of substrates can be employed.

The condensation reaction proceeds by attaching the amine nucleophilically to the carbonyl carbon of the aldehyde or ketone, then withdrawing the water molecule to create the imine. Acids that promote the protonation of the carbonyl molecule and increase the reactivity of the amine, such as hydrochloric acid, sulfuric acid, or acetic acid, can be employed to catalyze the reaction.(K. C. Gupta,2008)

The synthesis of Schiff bases involves the condensation reaction between a primary amine and an aldehyde or ketone, resulting in the creation of an imine or Schiff base. The reaction can be represented using the general equation:

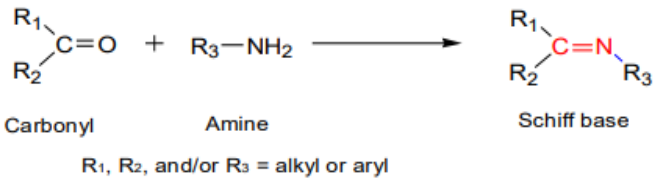
$R1CHO + R2NH2 \rightarrow R1CH=N-R2 + H2O$

A water molecule is removed as the reaction develops by adding an amine nucleophilically to the carbonyl carbon of the aldehyde or ketone. During the condensation reaction, an acid usually promotes protonation of the carbonyl molecule, increasing the amine's reactivity.

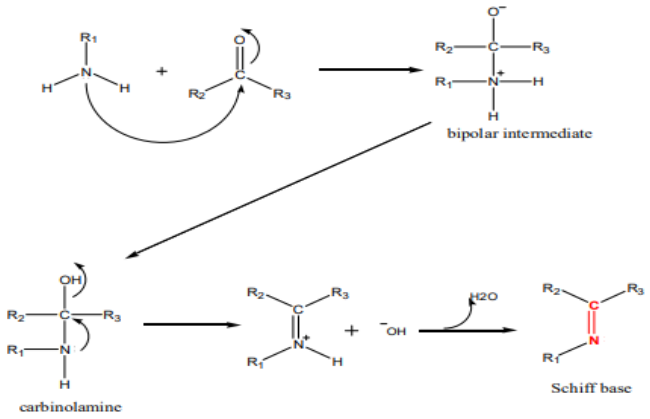
For example, let's consider the synthesis of a Schiff base using benzaldehyde (R1CHO) and aniline (R2NH2) as starting materials. The reaction can be carried out in the presence of a catalytic amount of acetic acid:

C6H5CHO + C6H5NH2 → C6H5CH=NC6H5 + H2O

In this case, benzaldehyde reacts with aniline to form the Schiff base known as N-phenylbenzaldimine.



The properties and applications of the resulting Schiff base are heavily influenced by the reactants used. The use of various primary amines, such as aromatic, aliphatic, or even heterocyclic amines, allows for the synthesis of a diverse range of Schiff bases. Other aldehydes or ketones, similar to this, can be employed to vary the structural and functional properties of the end product.



Schiff bases exhibit a wide array of chemical and biological activities, making them valuable building blocks in the synthesis of pharmaceuticals, agrochemicals, and other bioactive compounds. Their ability to coordinate with metal ions also makes them important ligands in coordination chemistry, contributing to the development of metal-based catalysts and materials.

SCOPE OF THE RESEARCH

The scope of this research on the synthesis, characterization, and microbial activity of Schiff bases and their metal complexes encompasses several key areas:

Synthesis: The research focuses on the synthesis of Schiff bases using various methods and strategies, including conventional and modern approaches. It explores different reaction conditions, reactants, and substituents to understand their influence on the yield and purity of the Schiff bases obtained.

Microbial Activity: The research investigates the microbial activity of Schiff bases and their metal complexes. It examines their potential as antimicrobial and antifungal agents, as well as their efficacy against specific microorganisms. The structure-activity relationships that contribute to their biological properties will be explored.

Metal Complexation: The research focuses on the coordination behavior of Schiff bases towards transition metal ions. It explores the formation and stability of metal complexes and investigates their structural aspects and spectroscopic properties. The impact of metal coordination on the biological activity of Schiff bases will also be addressed.

Applications and Future Directions: The research aims to provide insights into the potential applications of Schiff bases and their metal complexes in fields such as medicinal chemistry, catalysis, and material science. It explores the current understanding and future directions for the development of new Schiff base derivatives and metal-based therapeutics with enhanced properties and biological efficacy.

The scope of this research is focused on the synthesis, characterization, and microbial activity of Schiff bases and their metal complexes. Other aspects such as physical properties, catalytic applications, and material science applications, while relevant, may not be extensively covered in this particular study.(Al Zoubi, W,2013).

LITERATURE REVIEW

Pradhan, A., & Kumar, A. (2015) The Schiff base's azamethine linkage is important in medicine since it has so many pharmacological effects, such as antibacterial, antiviral, antitubercular, and anticancer action. The effectiveness of these medicinally useful drugs in treating microbial infections and other illnesses led to the development of a number of increasingly potent and essential compounds and metal complexes. Extensive biochemical and medical research has shown that Schiff bases and their metal complexes are excellent antibacterial agents against a wide range of microorganism types. This concise study covers the chemistry of many substituted Schiff bases, as well as their metal complexes with various metals and antibacterial characteristics.

Arulmurugan, S., Kavitha, H. P. et al, (2010) When primary amines are condensed with carbonyl groups, they form schiff bases, which are flexible ligands. Because of their broad range of

biological effects, these chemicals are especially important in the medical and pharmaceutical industries. The bulk of them display biological activity such as antibacterial, antifungal, and anticancer properties. Transition metal complexes with biological activity extracted from Schiff base ligands have been the topic of various studies. The synthesis of Schiff bases and their complexes, as well as their biological activities, are summarized in this paper. Schiff bases are commonly bi- or tridentate ligands that produce remarkably stable compounds with transition metals. Liquid crystals are occasionally used.

Fonkui, T. Y., Ikhile, M. I. et al , (2018) Global death rates have risen dramatically as a result of the rise in microbial resistance to existing treatments, which causes food to spoil and complicates disease treatment. Schiff bases stand out in this context as a versatile and substantial family of organic compounds with remarkable pharmacological properties for a variety of industrial applications. To generate these compounds, a primary amine and a carbonyl molecule are usually joined through a condensation process. Schiff bases contain antibacterial properties that make them effective against viruses, bacteria, parasites, fungi, and bacteria. Metal complication makes Schiff base ligands more effective at killing germs because of their chelating characteristics. A great deal has been published about the synthesis of Schiff bases and their metal complexes. It is vital to categorize and collect these compounds due to their biological significance. By examining their biological properties, this review aims to offer insight on the potential applications of these compounds in preventing microbial infections and improving disease management.

Divya, K., Pinto, G. M. et al,(2017) Primary amines and carbonyl groups come together to generate Schiff bases, which are incredibly flexible ligands. The potential to create coordination molecules with various architectures and high stability makes the synthesis of Schiff base transition metal complexes using these ligands interesting. These complexes have generated a lot of interest and are useful as biomimetic model molecules because of their vital role in metal loenzymes and their similarity to actual proteins and enzymes. Due to its flexible coordination

behavior and capacity to aid in understanding molecular processes, the synthesis of metal complexes has received a lot of interest.

Hossain, M. S., Roy, P. K. et al,(2018) Coordination chemistry, particularly the study of metal complexes, interests chemists from all over the world. This has resulted in a significant amount of study in the field. In recent years, there has been a surge in interest in metal complexes of organic chelating ligands. As a result, related topics such as organometallic chemistry, homogeneous catalysis, and bioinorganic chemistry have emerged. Schiff bases have gained popularity among chelating ligands due to their simplicity and ease of preparation. This article examines the formation of Schiff base coordination complexes and their applications in biology. Antibacterial, antifungal, anticancer, DNA interaction, cytotoxicity, analgesic, anti-inflammatory, anti-anxiety, ribonucleotide reductase, and anti-HIV are among the effects mentioned. Schiff base complexes have demonstrated good catalytic activity in a variety of processes even at high temperatures (>100°C) and in the presence of water. Numerous studies have demonstrated their use, and they have been successfully applied in both homogeneous and heterogeneous catalysis.

Al Zoubi, W. (2013) Schiff bases are organic compounds that are extremely versatile and have a wide range of biological activities, including antifungal, antibacterial, and antimalarial characteristics. Their synthesis is accomplished using a simple condensation reaction between an aldehyde and a primary amine. There is a wide range of uses for these compounds and their metal complexes, including catalysis, medicine, crystal engineering, and anti-corrosion agents. Because of their structural versatility, selectivity, and biological similarity to naturally occurring biological compounds, Schiff bases are of great interest.

Heterocyclic Schiff bases

Heterocyclic Schiff bases are a special class of Schiff bases where the amine component or the carbonyl component (or both) contain heteroatoms, typically nitrogen, oxygen, or sulfur. These

compounds have garnered significant attention due to their unique chemical properties and diverse applications in various fields.

The synthesis of heterocyclic Schiff bases follows the same general principle as that of regular Schiff bases. The condensation reaction takes place between a heterocyclic amine and an aldehyde or ketone, resulting in the formation of a heterocyclic imine or Schiff base. The reaction is typically catalyzed by an acid or a base, depending on the reactants and reaction conditions.

The choice of reactants greatly influences the nature of the resulting heterocyclic Schiff base. Various heterocyclic amines, such as pyridine, furan, thiophene, and imidazole derivatives, can be used as starting materials. Similarly, a wide range of aldehydes or ketones can be employed, including those containing heteroatoms or substituents that enhance the heterocyclic nature of the final compound.

Heterocyclic Schiff bases exhibit diverse properties and applications. They have been extensively studied in the field of medicinal chemistry due to their potential biological activities. These compounds can possess antimicrobial, antifungal, anticancer, anti-inflammatory, and antioxidant properties, making them promising candidates for drug development.

Heterocyclic Schiff bases have found applications in coordination chemistry as ligands for metal complexes. The presence of heteroatoms in the ligand backbone enhances the ability of the Schiff base to coordinate with metal ions, resulting in the formation of stable complexes. These complexes often display unique reactivity and catalytic properties, making them useful in various catalytic processes and materials synthesis. Heterocyclic Schiff bases represent a fascinating class of compounds with diverse properties and applications. Their synthesis involves the condensation reaction between a heterocyclic amine and an aldehyde or ketone, resulting in the formation of heterocyclic imines. These compounds have shown promising biological activities and have been utilized as ligands in coordination chemistry. Continued research in the field of

heterocyclic Schiff bases is expected to uncover new compounds with novel properties and applications.. (Eswaran,2009)

Chemistry of Schiff base

The chemistry of Schiff bases is diverse and encompasses several key reactions. One important aspect is their reactivity towards nucleophiles and electrophiles. The carbon-nitrogen double bond is susceptible to nucleophilic attack, allowing for the synthesis of a wide range of derivatives. The imine functionality can be hydrolyzed to regenerate the corresponding aldehyde or ketone, or it can be reduced to form a primary amine using reducing agents such as sodium borohydride or lithium aluminum hydride.

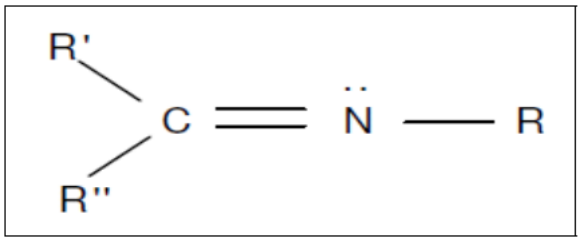


Fig 1: Schiff base

Schiff bases also exhibit coordination chemistry due to the presence of a lone pair of electrons on the nitrogen atom. They can coordinate with various metal ions, forming stable complexes.

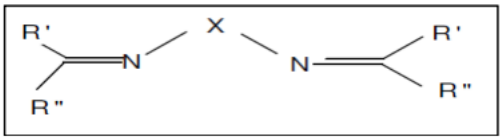


Fig 2 Bridged Schiff's base

These complexes have applications in catalysis, materials science, and bioinorganic chemistry. Schiff bases can undergo a wide range of reactions, including oxidation, reduction, and cyclization, resulting in the synthesis of heterocycles and other complex organic molecules.

These transformations enable access to a wide range of functionalized molecules with tailored properties for applications in drug discovery, organic chemistry, and materials synthesis.

CONCLUSION

The synthesis of Schiff bases has been explored using various methods and strategies, including conventional and modern approaches. The choice of reactants, reaction conditions, and substituents significantly influences the yield and purity of the Schiff bases obtained. The development of efficient synthetic protocols is crucial for the preparation of a diverse range of Schiff base derivatives with desired properties. Characterization techniques such as NMR spectroscopy, IR spectroscopy, and mass spectrometry play a vital role in confirming the structure and purity of Schiff bases and their metal complexes. These techniques provide valuable insights into the connectivity, functional groups, and overall molecular structure of the compounds. Accurate characterization is essential for understanding the relationship between the structure and properties of Schiff bases and their metal complexes. The microbial activity of Schiff bases and their metal complexes has shown promising results. These compounds exhibit significant antimicrobial, antifungal, and anticancer activities. The presence of biologically active functional groups in the Schiff base structure, along with the coordination of metal ions, contributes to their enhanced biological properties. The structure-activity relationships established through extensive research contribute to the development of potential therapeutic agents. The coordination behavior of Schiff bases toward transition metal ions has been explored in order to build metal complexes. These metal complexes' unique properties and capacities make them suitable for application in biomimetic systems, drug delivery, and catalysis. Metal complexes' stability, form, and spectroscopic properties are determined by the type of metal ion and the ligand structure. This review will provide you with a complete understanding of how Schiff bases and their metal complexes are formed, characterized, and utilized by microorganisms. This study's findings will aid in the design and development of new metal-based therapeutics and Schiff base derivatives with enhanced properties and biological efficacy.

More research in this sector will increase our understanding, and new uses of Schiff bases and their metal complexes in a number of scientific fields will become available

REFERENCES

1. Pradhan, A., & Kumar, A. (2015). A review: an overview on synthesis of some Schiff bases and there metal complexes with anti-microbial activity. *Chemical and Process Engineering Research*, *35*, 84-86.
2. Arulmurugan, S., Kavitha, H. P., &Venkatraman, B. R. (2010). Biological activities of Schiff base and its complexes: a review. *Rasayan J Chem*, *3*(3), 385-410.
3. Fonkui, T. Y., Ikhile, M. I., Ndinteh, D. T., &Njobeh, P. B. (2018). Microbial activity of some heterocyclic Schiff bases and metal complexes: A review. *Tropical Journal of Pharmaceutical Research*, *17*(12), 2507-2518.
4. Divya, K., Pinto, G. M., & Pinto, A. F. (2017). Application of metal complexes of Schiff bases as an antimicrobial drug: a review of recent works. *Int. J. Curr. Pharm. Res*, *9*(3), 27-30.
5. Hossain, M. S., Roy, P. K., Zakaria, C. M., &Kudrat-E-Zahan, M. (2018). Selected Schiff base coordination complexes and their microbial application: A review. *Int. J. Chem. Stud*, *6*(1), 19-31.
6. Al Zoubi, W. (2013). Biological activities of Schiff bases and their complexes: a review of recent works. *International Journal of Organic Chemistry*, *2013*.
7. K. C. Gupta and A. K. Sutar, "Catalytic Activities of Schiff Base Transition Metal Complexes," Coordinatio try Reviews, Vol. 252, No. 12-14, 2008, pp. 1420-1450.
8. B. Tu¨rkkan, B. Sarıbog˘a and N. Sarıbog˘a, "Synthesis, Characterization and Antimicrobial Activity of 3,5-DiTert-Butylsalicylaldehyde-S-Methylthiosemicarbazones

and Their Ni(II) Complexes," Transition Metal Chemistry, Vol. 36, No. 6, 2011, pp. 679-684

9. S. Eswaran, A. V. Adhikari and N. S. Shetty, "Synthesis and Antimicrobial Activities of Novel Quinoline Derivatives Carrying 1,2,4-Triazole Moiety," European Journal of Medicinal Chemistry, Vol. 44, No. 11, 2009, pp. 4637- 4647
10. Arulmurugan S., Kavitha H. P. and Venkatraman B. R., Biological activities of Schiff base and its complexes: a review. Rasayan J. Chem., 3 (3), 385-410 (2010).
11. Zaky M. F., Badawi A. M, Ead H. A., Aboulimoud M. M., Novel Cationic Schiff Base Surfactants: Surface Studies and Biocidal Activities against Bacteria Fungi and Sulfate Reducing Bacteria, Egypt. J. Chem., 55 (2), 201-211(2012)