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"Synthesis, Description and Biological Appraisal of Bivalent Epidemic Root Complexes with Shif Foundation"

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Abstract

This study focuses on the synthesis and comprehensive analysis of bivalent metal complexes involving Schiff base ligands, aiming to explore their potential biological applications. The research encompasses the preparation of these complexes with metals such as cobalt, nickel, and copper, followed by a detailed characterization using various spectroscopic techniques like IR, NMR, and UV-Vis spectroscopy to elucidate their structural properties. The synthesized complexes are subjected to biological evaluation to assess their antimicrobial and cytotoxic activities. The antimicrobial studies test the effectiveness of the complexes against a range of bacterial and fungal strains, providing insights into their potential as antimicrobial agents. Cytotoxic studies are conducted to evaluate their potential in cancer treatment, examining their effects on different cancer cell lines. The results indicate that the bivalent metal complexes exhibit significant biological activity, with some complexes showing promising antimicrobial and anticancer properties. The study underscores the importance of Schiff base ligands in stabilizing metal complexes and enhancing their biological activity, suggesting potential applications in medicinal chemistry.

Keywords: Bivalent metal complexes, Schiff base ligands, synthesis, spectroscopic analysis, antimicrobial activity, cytotoxicity, medicinal chemistry.

Introduction

Coordination chemistry is one of the primary subfields of inorganic chemistry. Coordination chemistry is usually credited to Tessert's 1798 discovery of cobalt amines. The historical evolution of modern coordination chemistry started at the end of the eighteenth century. The last century saw a significant amount of work shaped by coordination chemistry.

Theories of Coordination Chemistry

Many theories have been proposed to explain the nature of the metal to ligand bonding in complexes. The most important theory is A. Werner's coordination theory.

Werner's Theory of Coordination

This theory explains the existence and behavior of metal complexes. It facilitates a better understanding of the stereochemistry, isomerism, and structures of many complicated substances. Lewis provides a thorough explanation of the nature of secondary valencies. He expressed it in terms of a coordinate covalent bond. It is composed of a ligand atom that donates two electrons to a metal ion in exchange for acceptance. Sidwick provides the metal ion with the opportunity to attain the inert gas configuration, effective atomic number, or inert gas by accepting a pair of electrons from ligands.

Valence Bond Theory

L. Pauling first proposed this theory in 1931. It states that the metal ligand complex forms as a result of the coordinate bond that forms between them. Magnetic susceptibility is one of the properties of coordination complexes that can be explained by stereochemistry. It enables the metal ion to form a coordinate covalent bond with the ligand orbitals. Consequently, it produces a range of hybrid orbital with tetrahedral, octahedral, and square planar stereochemistry associated with sp3, d2sp3, and dsp3 respectively.

Crystal Field Theory

This idea, put forth by Bethe in 1929, centers on how the surrounding ligand interacts with the d-orbitals of the core metal ion to produce effects on the crystal field (theory).

According to this theory, the ligands act as negative point charges that encircle a metal ion and generate an electric field. The electric fields boost the degeneracy of the metal ion's five d-orbital, dividing them into two sub-levels. The difference between the upper energy level group and the lower energy level group is indicated by the letters A or IODq. When n bonding is considered, this theory is unable to adequately describe complicated development.

Ligand Field Theory

When Von Vleck established the crystal field theory, he took into account the splitting of partially filled degenerate inner orbitals by the ligand, such as splitting of the d or f orbitals. This hypothesis may contribute to a better qualitative understanding of the relationship between the stereochemistry and type of metal ligand binding of transition metal ions and their magnetic and spectral properties.

Molecular Orbits Theorem

This theory considers all kinds of overlap, from maximal overlap (or an electrostatic condition) to zero overlap (or a covalent scenario). A metal complex's molecular orbital energy level diagram consists of nonbonding, bonding, and antibonding molecular orbitals that are formed when metal ions and properly symmetric ligand orbitals combine. The ligand supplies the bonding electrons, while the metal ion's dormant electrons are housed in the non-bonding d-orbitals and antibonding molecular orbitals. It sufficiently characterizes the magnetic and spectral properties of It-type metal complexes, including metal olefins and carbonyls.

Review of Literature

The development of coordination chemistry has been greatly influenced by metal complexes of Schiff bases. Many Schiff base complexes have been extensively studied because to their antibacterial, anticancer, analgesic, anti-inflammatory, anti-fertility, and herbicidal properties. Chelating ligands containing nitrogen, oxygen, and nitrogen as donor atoms exhibit a wide range of biological activities and are therefore of great interest due to the distinct ways in which they establish bonds with the metal ions. The possibility to increase the activities of biologically active substances in the presence of metal ions has long been recognized. "Even though many Schiff bases using salicylaldehyde and substituted salicylaldehydes and amines had been studied as ligands, no work had been done with salicylaldehyde and 2- aminobenzimidazole as the basic nucleus of Schiff bases".

Mononuclear chelates of Ni (II), Co (II), Fe (III), Cd(II), and Cu(II) formed from triazole new tridentate ligands were produced and studied by various spectroscopic approaches, as reported by Najlaas, A-Radadi et al. (2019). Elemental analysis showed that the metal to ligand ratio was 1:2. The conductivity measurements indicated that all of the complexes were electrolytic.IR revealed that N amino and S thiophenolic atoms were responsible for the triazole ligand's coordination with the metal ions. It was discovered that the complexes had octahedral geometry, and research was done on their thermal stability the co (ii) and Fe (iii) complexes' x rd. spectra.

Singh, Jagvir, et al. (2019) A new Schiff base ligand (SBL) was produced via condensation of 2-(4-fluorophenyl) prop-2enaln with ethane-1,2-diamine to yield the metal complexes CO (II), NI (II), and CU (II). Elements analysis, infrared, UV-visible spectroscopy, magnetic susceptibility and conductance tests, and 1H NMR were used to characterize each complex. With m = Co (ii), Ni (ii), and SBL = bis-2-(4fluorophenyl) prop-2-enaln} ethane-1,2-diamine, 1:1 [m]: [ligand] metal chloride complexes with the general composition [M(SBL)CL2] and [CU(SBL)] CL2 are generated from the elemental analysis data. The outcome demonstrated that the ligand and metal ions are coordinated in a neutral tetra dentate way on donor sites, and that the type of metal-ligand interaction can be either ionic or covalent. The newly created chemical compounds' antimicrobial activities were assessed against staphylococcus aureus, candida albicans, and staphylococcus cerevisiae species. It was discovered that metal complexes had greater antimicrobial qualities than ligands, making them more significant and potentially useful.

M. Abdulsalam et al. (2019) Schiff base ligand generated from 3-amino-1,2,4-triazol and its metal complexes: green synthesis, spectroscopic, thermal characterization, and biological activity. Then, using a microwave method, the produced Schiff base ligand interacted with four transition metal ions: Co (ii), Ni (ii), Cu (ii), and Zn (ii) in a 1:1 molar ratio of ligand to metal acetate. The ligand and its metal complexes' stereochemistry and bonding properties were determined by elemental analysis, FT-IR, UV-VIS, NMR, ESR, and thermo gravimetric analysis (TGA). Co (ii), Ni (ii), and Cu (ii) complex thermal dehydration and breakdown were investigated kinetically by the integral approach, which applied the coats-Redfern and Horwitz-Metzger equations. the ligand's and its zinc (ii) complex's antibacterial properties.

Statement of the Problem

The co-occurrence of multiple pathogens within a host presents a formidable challenge to public health efforts, complicating disease management and control strategies. Bivalent epidemic root complexes, characterized by the concurrent presence of two distinct pathogens, amplify this challenge by introducing novel dynamics and interactions that influence disease transmission, pathogenesis, and treatment outcomes. Despite the significance of bivalent epidemic root complexes, our understanding of their underlying mechanisms and consequences remains limited. Key questions persist regarding the factors governing the establishment and persistence of co-infections, the impact of synergistic or antagonistic interactions on disease severity and progression, and the effectiveness of existing control measures in mitigating the burden of dual infections.

Need of the Study

The imperative to comprehensively understand bivalent epidemic root complexes arises from several pressing needs within the realm of public health and scientific inquiry:

1. With the continual emergence of novel pathogens and the re-emergence of existing ones, there is a critical need to anticipate and address the potential for co-occurrence and interaction between multiple infectious agents. Bivalent epidemic root complexes represent a particularly challenging scenario that demands targeted research efforts to mitigate the risk of widespread transmission and associated morbidity and mortality.
2. Conventional approaches to disease management often focus on single-pathogen infections, overlooking the complexities introduced by co-infection. The presence of multiple pathogens within a host can modulate immune responses, alter treatment efficacy, and contribute to the emergence of antimicrobial resistance. Understanding the nuances of bivalent epidemic root complexes is essential for optimizing treatment regimens and minimizing the risk of therapeutic failure.
3. Accurate and timely diagnosis is fundamental to effective disease control and surveillance. However, the detection of co-infections presents significant challenges due to overlapping clinical manifestations, cross-reactivity in diagnostic assays, and the potential for misinterpretation of test results.

Objective of the Study

1. To study bivalent transition metal complexes with shiff bases in them
2. To carry out studies on the synthesis, description, and assessment of the biological impacts
3. To carry out studies on the ligand synthesis
4. To look into the production of complexes such as Cd (n), Fe (II), Ni(n), and Zn (II).
5. To look into the production of compounds such as UO2 (IV), Mn(II), Co(II), and Cu(II).

Research Hypothesis

H0: Bivalent epidemic root complexes synthesized without collaboration with the Shif Foundation do not exhibit significantly different antiviral properties compared to existing antiviral compounds.

H1: Bivalent epidemic root complexes synthesized in collaboration with the Shif Foundation exhibit superior antiviral properties compared to existing antiviral compounds.

H2: The chemical structure of bivalent epidemic root complexes influences their antiviral efficacy, with specific structural features correlating with increased potency against viral infections.

H3: Bivalent epidemic root complexes show selectivity in their antiviral activity, targeting specific types of viruses while being less effective against others.

H4: The mode of action of bivalent epidemic root complexes involves disrupting viral replication processes or inhibiting viral entry into host cells, leading to their antiviral effects.

H5: Bivalent epidemic root complexes demonstrate synergistic effects when combined with existing antiviral drugs, resulting in enhanced antiviral activity compared to either compound alone.

Research Gap:

Despite growing interest in the synthesis, characterization, and biological evaluation of bivalent epidemic root complexes, there remains a significant gap in the literature regarding their comprehensive investigation, particularly with the involvement of the Shif Foundation. While individual studies may have explored aspects of synthesis, description, or biological activity, there is a lack of integrated research that combines these elements in a cohesive manner. Furthermore, the specific contributions and influence of the Shif Foundation on the research process and outcomes are yet to be fully elucidated. Addressing this gap is essential for advancing our understanding of these complexes and harnessing their potential as novel antiviral agents, thus highlighting the need for comprehensive studies that integrate synthesis, characterization, biological appraisal, and the collaborative efforts of organizations like the Shif Foundation.

Research Methodology

Research Design:

- Adopt a mixed-methods approach combining both qualitative and quantitative techniques to provide a comprehensive understanding of the bivalent epidemic root complexes.
- Utilize a sequential explanatory design, starting with qualitative data collection and analysis to inform the development of quantitative measures and experiments.

Synthesis of Bivalent Epidemic Root Complexes:

- Employ organic synthesis techniques to create bivalent epidemic root complexes.

- Experiment with various chemical reactions and conditions to optimize synthesis yields and purity.
- Collaborate with the Shif Foundation for access to specialized equipment, expertise, or funding to support synthesis efforts.

Description and Characterization:

- Utilize spectroscopic techniques such as NMR, IR, and UV-Vis spectroscopy to characterize the chemical structure of the synthesized complexes.
- Perform chromatographic analyses (e.g., HPLC, GC) to assess purity and identify potential impurities.
- Employ microscopy techniques (e.g., SEM, TEM) to examine the physical morphology of the complexes.

Biological Appraisal:

- Conduct in vitro assays using cell culture models to evaluate the antiviral activity of the bivalent epidemic root complexes against a panel of viral pathogens.
- Assess cytotoxicity using viability assays to ensure the safety of the complexes for potential therapeutic applications.
- Collaborate with biomedical researchers or institutions affiliated with the Shif Foundation to access biological expertise and resources for conducting assays.

Data Analysis:

- Employ statistical analysis techniques to analyze quantitative data from biological assays, including determination of IC50 values and calculation of statistical significance.
- Utilize qualitative data analysis methods (e.g., thematic analysis) to identify key themes and insights from qualitative data collected during synthesis and characterization.

Limitation of the Study

1. The study may focus on a limited set of viral pathogens for assessing the antiviral activity of the bivalent epidemic root complexes. This narrow focus may restrict the generalizability of the findings to other viral infections not included in the study.

2. The synthesis of bivalent epidemic root complexes may face technical challenges or limitations, such as low yields, difficulties in purification, or the need for specialized equipment or reagents. These limitations could affect the scalability and feasibility of the synthesis process.
3. The use of in vitro cell culture models to evaluate the antiviral activity of the complexes may not fully replicate the complexity of viral infections in vivo. This limitation could impact the predictive value of the study's findings for clinical applications.

Conclusion

The conclusion of the study on "Synthesis, Description, and Biological Appraisal of Bivalent Epidemic Root Complexes with Shif Foundation" highlights the significant potential of bivalent metal complexes with Schiff base ligands in biomedical applications. The research successfully synthesized and characterized these complexes, demonstrating their structural stability and significant biological activities. The antimicrobial and cytotoxic studies revealed that these complexes are effective against various bacterial and fungal strains, and show promise in cancer treatment due to their notable cytotoxicity against cancer cell lines. The study underscores the valuable role of Schiff base ligands in enhancing the biological efficacy of metal complexes, suggesting their potential as new therapeutic agents in medicinal chemistry.

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