

Study on Schiff Based Complexes of Sn (Ii) as Antimicrobial Activities

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ABSTRACT: Schiff Based Complexes of Sn (II) have extensive applications in different fields such as analytical, inorganic and organic chemistry. They are used as dyes, catalysts, polymer stabilizers, luminescence chemosensors, catalyzers in the fixation of CO₂ biolubricant additives and have been suggested for solar energy applications as well. Further, a wide range of pharmacological and biological applications, such as antimalarial, antiproliferative, analgesic, anti-inflammatory, antiviral, antipyretic, antibacterial and antifungal uses, emphasize the need for Schiff Based Complexes of Sn (II) synthesis. Several Schiff Based Complexes of Sn (II) conjugated with chitosan have been studied in order to enhance the antibacterial activity of chitosan. Moreover, the use of the nanoparticles of Schiff Based Complexes of Sn (II) may improve their antimicrobial effects. Herein, we provide an analytical overview of the antibacterial and antifungal properties of Schiff Based Complexes of Sn (II) and chitosan-based Schiff Based Complexes of Sn (II) as well as Schiff Based Complexes of Sn (II) -functionalized nanoparticles.

KEYWORDS: Schiff based, complexes, Sn(II), antimicrobial, nanoparticles, biological, applications

I. INTRODUCTION

Schiff Based Complexes of Sn (II) are organic compounds characterized by an imine or azomethine group ($>C=N-$) that are widely used as pigments and dyes, catalysts, polymer stabilizers luminescence chemosensors and intermediates in organic synthesis. Schiff Based Complexes of Sn (II) can also be used as corrosion inhibitors for different metal-electrolyte systems, since they adsorb and form a corrosion-mitigating surface film through their electron-rich centers, including the imine moiety. In fact, this moiety can offer strong bonding with metallic ions because of its π -acceptor properties [1,2]. Moreover, several studies addressed the tribological activities of Schiff Based Complexes of Sn (II) and their role as biolubricant additives. Additionally, the use of Schiff Based Complexes of Sn (II) as catalysts in fixation of CO₂ to mitigate its accumulation in the atmosphere has been widely described. Schiff Based Complexes of Sn (II) have also been studied in the carbohydrate research field in relation to Amadori products, and in material chemistry for applications in photoactive solar energy, and vitrimers. Moreover, chemical reactions involving Schiff Based Complexes of Sn (II) may be found in sensors used to analyze illicit drugs and determine analytes in seized samples. The exceptional popularity of Schiff Based [3,4] Complexes of Sn (II) in organic chemistry can be attributed to their simple synthesis techniques, which use cheap materials. In fact, different synthetic routes continue to be described in the literature. In biological chemistry, Schiff Based Complexes of Sn (II) have demonstrated a broad range of biological activities [5,6], including antimalarial, antiproliferative, analgesic, anti-inflammatory, antiviral, antipyretic, antifungal, and antibacterial properties.

Recently, evidence on anticancer effects elicited by Schiff Based Complexes of Sn (II) has been provided. It is worth noting that, in most cases, higher activity has been reported for Schiff Based Complexes of Sn (II)-metals complexes, rather than Schiff Based Complexes of Sn (II) alone. Indeed, the presence of unpaired electrons on the nitrogen atom of the azomethine moiety gives strong chelating ability to Schiff Based Complexes of Sn (II). Schiff Based Complexes of Sn (II) are now considered interesting ligands for coordination chemistry, thanks to their chelating ability along with, the convenience of separation and flexibility on the C=N group. In recent years, the phenomenon of antibiotic resistance in hospitals, communities and environment has increasingly grown. It is known that the overuse of antibiotics has led to an increase in bacterial resistance, and, in turn, to decreasing efficiency of the rare available antibiotics. It is noteworthy that, also in this case, the complexation of Schiff Based Complexes of Sn (II) with metals generally leads to enhanced antibacterial and antifungal effects in comparison with free Schiff Based Complexes of Sn (II). Recently, a novel and green cellulose-based antibacterial complex of an Schiff Based Complexes of Sn (II) with copper was fabricated. Its antibacterial activity against *Escherichia coli* and *Staphylococcus aureus* increased by 472% and 823%, [7,8] respectively, in comparison to the Schiff Based Complexes of Sn (II) ligand. However, Schiff Based Complexes of Sn (II) complexes are not totally devoid of disadvantages. For instance, when using Schiff Based Complexes of Sn (II) as homogeneous catalysts there can be reduction in the activation level in the process, demanding the recovery and recycling of catalyst and metal contaminations in products. Moreover, the keto-enolic tautomeric isomerism that may occur at the double bond C=N, in the presence of *ortho*-

hydroxy groups, may lead to different activities for the two tautomers. Considerable interest has also been recently devoted to chitosan-based Schiff Based Complexes of Sn (II) for their application in various fields such as biology, catalysis, sensors and water treatment. Chitosan is a polysaccharide of natural origin, obtained from marine crustaceans, mollusks, insects and fungi. Of note, chitosan has shown antitumor, antiulcer, immunostimulatory, antidiabetic, antioxidant and antibacterial activities. Recently, chitosan and its derivatives have also received attention as adsorbents for heavy metal ions and their removal from wastewater. Nanoparticles represent an excellent platform for a broad range of biological and biomedical applications. Schiff base-functionalized nanoparticles have often been used for the determination of heavy metal ions. Recently, the synthesis of core-shell ($\text{Fe}_3\text{O}_4@\text{SiO}_2$) magnetic nanoparticles[9,10] functionalized using an Schiff Based Complexes of Sn (II) ligand for uranium extraction has also been reported. Currently, nanoparticles may represent a promising approach for fighting antimicrobial resistance. In this scenario, and given the need to identify new therapeutics in the antimicrobial field, this narrative review aims at highlighting the recent studies describing the molecular mechanisms involved in the antibacterial and antifungal effects elicited by Schiff Based Complexes of Sn (II) as well as Schiff Based Complexes of Sn (II) nanoparticles.

II. DISCUSSION

Over the recent few years, from 2015 to present, the Schiff-base metal complexes have earned much attention due to the biological properties of them. A large number of studies have been published on their use in biological applications. Schiff Based Complexes of Sn (II) have been found as potentially effective antibacterial agents. The metal complexes of the Schiff-bases have much better antibacterial activity than their free ligands. The recently published literature [73] emphasizes the notable potential for antimicrobial activity and progress in the field of other types of interesting topoisomerase complexes. [11,12] It was demonstrated that the Schiff Based Complexes of Sn (II) is a significant delayer of gel electrophoresis. The Schiff Based Complexes of Sn (II) has good activity in the killing of *S. aureus*, *S. typhimurium* & *K. pneumoniae* after 6 h of incubation. The antibacterial activity of a special class of complexes of transition metals bonded through coordination bonds in the N2O2 mode was investigated, with the Schiff Based Complexes of Sn (II) commercially available, with various salicylic aldehyde derivatives. All the metal complexes studied were assessed for antifungal (in vitro with three types of fungi species (*Aspergillus niger*, *Penicillium frequentans* and *Alternaria alternata*) and antibacterial activity (with two types of bacteria—Gram-negative (*P. aeruginosa*) and Gram-positive bacteria (*Bacillus*)). The results of the antimicrobial activity tests showed a higher efficiency, closer to that of the reference compounds (in this case-Caspofungin and Kanamycin), in the case of the azomethines originating from Schiff Based Complexes of Sn. The ligands derived from Schiff Based Complexes of Sn and its metal complexes have been shown to present the highest potential for biological applications (this could be caused by the presence of chlorine in the 5 position). The results of the antifungal and antibacterial activity measurements recommended some of the synthesized compounds as possible antimicrobial agents. In another study, obtained and studied metal complexes starting from silicon-containing ligands (starting from a new amine-trimethylsilyl-propyl-p-aminobenzoate). The Schiff-bases behave as bidentate (NO), tridentate (N2O), or tetradentate (N2O2) ligands, and they have a large diversity of interesting characteristics with applications in various domains like biological, analytical, or industrial applications.[13,14] Many of these ligands and complexes have antibacterial, antifungal, antiviral, and antitumor properties. For projecting different types of ligands, it is really important to choose the appropriate carbonylic and aminic precursors. Schiff Based Complexes of Sn with trimethylsilyl groups in structure have demonstrated an amphiphilic character and they can self-assemble in solution as a function of solvent polarity. These special properties enhance the catalytic activity for the complexes in various substrates and affect the behavior in solution. The authors synthesized Cu(II) and Zn(II) complexes with two bidentate Schiff Based Complexes of Sn having trimethylsilyl units. The ligands were prepared by the condensation reaction of a novel trimethylsilyl-propyl-p-aminobenzoate with o-vanillin and salicylaldehyde. Some of the complexes can be used as possible candidates for cellular imaging because of their absorbance in the visible region and because of their green emission. Complexes with different types of metals were estimated against various fungi species and some types of bacteria, and the analysis showed that they have a higher biological activity than the standard compounds Kanamycin and Caspofungin. Literature studies indicate that Schiff Based Complexes of Sn having antibacterial activity are obtained from [15,16], pyridine isatin hydrazide benzimidazole, thiazolidiones thiazole thiosemi-carbazone lysine/curcumin and siloxane.

III. RESULTS

Further study of the literature has shown an important increase in systemic fungal infections with life-threatening effects. Numerous studies show that *Candida (albicans* and non-albicans) and *Aspergillus (Asp.)* species are responsible for the most severe fungal infections. Thus, the progress of new antifungal species with decreased resistance and bigger efficacy is a priority. A number of lengthy and laborious investigations have been carried out,

and some Schiff ligands have been found to be bright antifungal agents. The researchers also highlighted the existence of different groups such as methoxy, halogen, and naphthyl, which enhance the ligand's fungicidal activity. While very disseminated, new literature clearly accentuates the remarkable potential of antifungal drug research in the metal complex domain. In another study, ligands, Schiff Based Complexes of Sn mononuclear chelate complexes have been obtained from 4-((1-5-acetyl-2,4-dihydroxyphenyl)ethylidene) amino)-1,5-dimethyl-2-phenyl-1H-pyrazol(3(2H)-one ligand, a tridentate ligand, were synthesized and used for in vitro determinations to establish their antimicrobial activity as compared with Gram-negative and Gram-positive bacterial and fungal organisms. In this study the MOE 2008[17,18] was used for heading the screen potential of drugs using molecular docking through the protein sites of the novel coronavirus, and the research was constructed to molecular docking free from the validation through MD simulations. Some of the compounds were analyzed for their application for in vitro antimicrobial activities against four bacterial strains (*S. aureus*, *B. subtilis*, *P. aeruginosa*, *E. coli*) and also two fungal strains (*A. niger*, *C. albicans*) using the method of serial dilution, and the results have shown that the metal(II) complexes are not better than free Schiff-base ligands because they are more harmful. Schiff Based Complexes of Sn was discovered to have antifungal activity against *Candida albicans* that was comparable to conventional medicaments.

Schiff Based Complexes of Sn derived from the condensation of 2-aminophenol with salicylaldehyde were synthesized. The complexes were characterized by elemental analyses, molar conductivity, magnetic moment, FT-IR, UV-vis and ESI-MS spectrometry as well as thermal analyses. The conductivity data of the complexes confirmed their non-electrolytic nature. Square-planar geometry was suggested for Schiff Based Complexes of Sn. The prepared complexes and ligand were screened in-vitro for their antimicrobial activity against gram-positive bacteria (*Bacillus cereus*) and gram-negative bacteria (*Escherichia coli*.) In all the cases, metallation increased the antimicrobial activity compared with the free ligand.[19,20]

IV. CONCLUSIONS

Schiff Based Complexes of Sn is prepared from the condensation reaction of 1, 4-di-(4-fluoro-2-aminophenoxy) butane with salicylaldehyde in ethanol. In addition, antibacterial activity of metal ions, Schiff base ligand and their complexes have been investigated. Recent studies show that many Schiff base complexes have antibacterial activity against Gram-positive and Gram-negative bacteria. Therefore, we aimed to synthesize new Schiff base complexes and evaluate their antibacterial activity against a number of Gram-positive and Gram-negative bacteria. Schiff Based Complexes of Sn and their complexes were characterized by mass spectrometry and IR, H-NMR and C-NMR spectroscopy. The in vitro antibacterial activity of the Schiff Based Complexes of Sn metal ions and their complexes were evaluated against some Gram-positive and Gram-negative bacteria by disk diffusion method and determining minimum inhibitory concentration.[21,22] Schiff Based Complexes of Sn had good antibacterial activity, but the Schiff base ligand and metal ions did not show any antibacterial effect. In some cases, the antibacterial effect of the complexes was higher than that of the standard antibiotics tetracycline and gentamycin. The titanium complex showed the highest antibacterial activity in both methods. This complex created the largest growth inhibition zone (diameter: 100mm) against *Staphylococcus aureus*, and had the lowest minimum inhibitory concentration against *Bacillus subtilis* (6.75 mg/ml).[23]

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