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A treatise on benzimidazole based Schiff base metal(II) complexes accentuating their biological efficacy: Spectroscopic evaluation of DNA interactions, DNA cleavage and antimicrobial screening

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ABSTRACT

Two novel imidazole derived Schiff bases, (Z)-1-(1H-benzo[*d*]imidazol-2-yl)-*N*-benzylidenemethanamine (L^1) and 1-(1H-benzo[*d*]imidazol-2-yl)-*N*-(4-nitrobenzylidene) methanamine, and a series of their transition metal complexes of the types $[M(L^1)_2]Cl_2$ and $[M(L^2)_2]Cl_2$ where, M = Cu(II), Ni(II), Co(II) and Zn(II) have been designed and synthesized. These compounds were characterized by various spectral and physicochemical data. UV–Vis, magnetic susceptibility and molar conductivity data indicate that all the complexes adopt square planar geometry. The EPR spectral data of the Cu(II) complexes have provided supportive evidence to the conclusion derived on the basis of electronic absorption and magnetic moment values. Moreover, the interaction of complexes with DNA *via* intercalation has been explored by absorption, fluorescence spectroscopy, cyclic voltammetry, viscosity and circular dichroism. Agarose gel electrophoresis technique reveals that the complexes are good metallonucleases. All the compounds have relatively high antibacterial and antifungal potencies. Among the metal complexes, Cu(II) complexes exhibit higher efficacy against all the pathogens.

1. Introduction

The condensates of aldehydes and amines are known as Schiff bases and the metal complexes of these strong chelators exhibit large prospective applications in various areas such as medicine, agriculture, analytical chemistry, dye and polymer industry, catalysis, enzyme modeling, magneto-structural chemistry and diverse miscellaneous studies [1–4]. On a general front, the synthesis of aromatic Schiff bases shows high yield and purity compared to the aliphatic and the reason is conferred to be the strength of relative stability of amine and imine bonds endowed by the additional electron-rich phenyl rings on the nitrogen and carbon atoms.

The metal complexes comprising aromatic Schiff base ligands especially imidazole based ones have drawn special interest in the past few decades due to their powerful anticancer, antiviral and antimicrobial activities, their use in the design of molecular-based magnets as well as in the simulation of active sites of enzymes since imidazole is present in many natural enzymes and proteins. The short literature survey on the metal complexes of imidazole-based Schiff bases has offered the effective *in vitro* antimicrobial, antifungal and antibacterial activities of Ag(I), Zn(II) and Sn(II) complexes [5–12]. On the other hand, benzimidazoles are an important class of heterocycles containing nitrogen that are found in the drugs available in the market like omeprazole, mebendazole, and astemizole [13]. They are found to display broad potential applications in the form of medicinal drugs [14], supramolecular blocks [15] as well as functional materials [16] and so on. They are also reported as mitochondria targeting photocytotoxic agents [17], as catalysts [18] and also used in the treatment of osteoporosis, cancer, diabetic retinopathy, arthritis and are gastroprotective. The benzimidazole based compounds are important for their applications such as anti-inflammatory, antioxidant, antiulcers, antihypertensives, antiviral, antifungals, antihistaminics and antiparasitic activities [19,20].

DNA is considered to be a collection of all the vital genetic data that is essential in assisting cellular function, thus making it a molecule of great biological significance. Many researchers base their work on these DNA interactions exhibited by their compounds so as to develop this ability into applications like biosensors [21,22], DNA probes and therapeutics. Small molecules such as metal complexes are known to bind to the DNA and alter its functions as claimed by biochemists. Thus the interaction studies between transition metal complexes and DNA have been pursued in recent years [23]. The availability of varied binding sites and binding modes in DNA for non-covalent and covalent interactions, including groove binding, electrostatic forces, intercalation and hydrogen bonds with metal complexes is another reason for the interest in these studies. Thus these interaction modes play an important role in the development of metal complexes into antifungal, anti-inflammatory, antibacterial or anticancer reagents. Hence, a great deal

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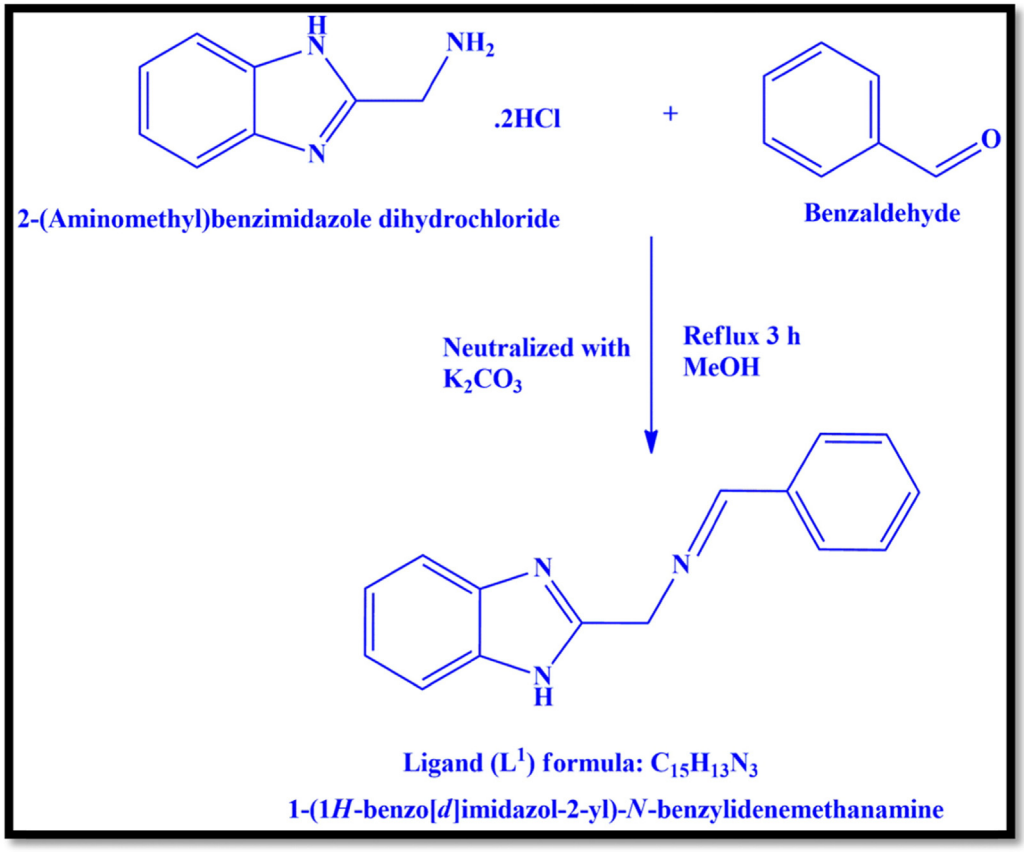

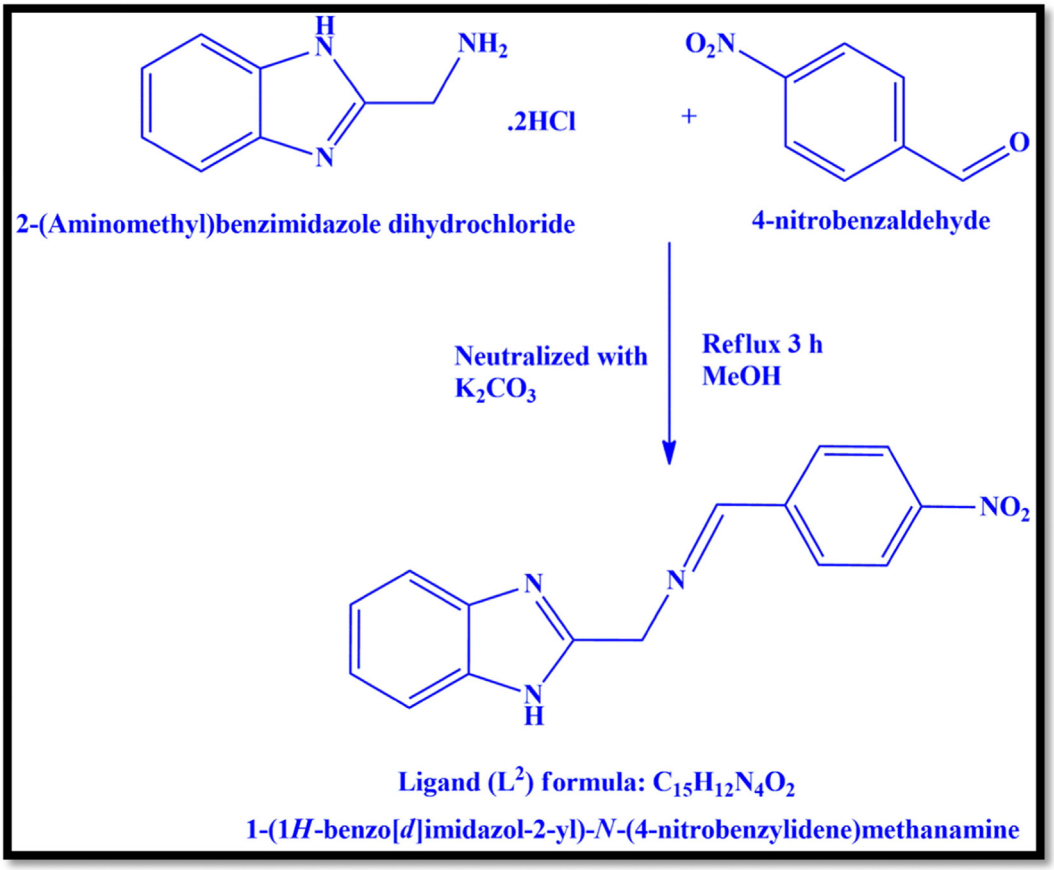

Scheme 1. Synthesis of Schiff base ligands.