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An efficient new method of ytterbium(III) triflate catalysis approach to the synthesis of substituted pyrroles: DFT, ADMET, and molecular docking investigations

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ABSTRACT

In this study, the one-pot synthetic methodology for the preparation of substituted pyrroles with diethyl acetylene-dicarboxylate is reported for the various pyrrole derivatives via *the* Trifimow synthesis process from oximes. This method also offers the literature as a cyclization pathway using a ytterbium triflate catalyst. Another importance of this study is the use of pyrrole derivatives in pharmaceuticals, biological processes, and agrochemicals. From this point of view, the development of a new catalyst in synthetic organic chemistry and the difference in the method is also important. The syntheses of the target substituted pyrroles are accomplished in high yields. Also, all synthesized structures were confirmed by ^{1}H NMR, ^{13}C NMR, and IR spectra. The DFT computations were leveraged for structural and spectroscopic validation of the compounds. Then, FMO and NBO analyses were subsequently employed to elucidate the reactivity characteristics and intramolecular interactions within these compounds. Also, ADMET indices were ascertained to assess potential pharmacokinetic properties, drug-like qualities, and possible adverse effects of these compounds. Last, optimized molecules were analyzed by molecular docking methods against crystal structures of Bovine Serum Albumin and Leukemia Inhibitory Factor, and their binding affinities, interaction details, and inhibition constants were determined.

1. Introduction

Pyrrole is a heterocyclic organic compound that contains a five-membered aromatic ring with one nitrogen atom. It is an important building block in organic chemistry and finds applications in the synthesis of drugs, polymers, and dyes. Pyrrole derivatives have also been investigated as potential materials for use in organic electronics and optoelectronics. Due to the pyrrole moieties as bioactive natural products, antibacterial, anticancer as well as in many pharmaceutical structures (Walsh et al., 2006; Massa et al., 1990; Lee et al., 2001; La Regina et al., 2007; Uludag, 2019; Serdaroğlu et al., 2023), various methods have been developed towards their synthesis (Sakhuja et al., 2012; Noboru, 2008; Godoi et al., 2011). There are many methods in the literature for pyrrole derivatives, but the use of a new catalyst and the development of reaction conditions are important for synthetic organic chemists, and compounds of pharmaceutical importance are given in Scheme 1 (Cai et al., 2011; Uludag and Serdaroğlu, 2022a; Khalili et al., 2008; Bodwell et al., 1999). For example, Semaxanib is a drug that blocks a protein called VEGF, which helps to create new blood vessels (Scheme 1). This makes it helpful in fighting angiogenesis, or the growth of new blood vessels. We investigated a new method with the use of new catalysts, as they are widely used in medicine and pharmacy and various substituted pyrroles have recently been found to be efficient catalysts. Kamal's group reported the conjugate addition of thiols to conjugated alkenes (Kamal and Reddy, 2005), Wans's group developed the sulfonyl Group migration with regioselectivity access to functionalized Pyrroles (Wang et al., 2011; Xin et al., 2012). Recently, we have developed different catalysts for the different reactions of tetracyclic indole alkaloids such as trifluoroaceticacid, tetracholoro-1,4-benzoquinone, tetrafluoro-1,4-benzoquinone, benzeneseleninic anhydride (Uludag et al., 2006; Uludag and Mutlu, 2022; Serdaroğlu and Uludağ, 2021; Patir et al., 1997). Therefore, this field needs to develop different catalysis, especially for the synthesis of pyrrole derivatives. Therefore, we investigated a different method using ytterbium(III) triflate catalysis. Hence,

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