ABSTRACT

This study aims to synthesize and model enzymatic activity using a transition metal system through the engineering of molybdenum disulfide (MoS_2) as a mimetic of phenoxazinone synthase and the synthesis of Cu(II)-Schiff base complexes as inhibitors of DNA gyrase. MoS_2 was synthesized via a hydrothermal route and characterized to evaluate its aerobic photocatalytic performance in the oxidative coupling reaction of 2-aminophenol to phenoxazinone under visible light irradiation. Cu(II) complexes with 4-aminoantipyrine and vanillin derivatives (Cu-OVAAP and Cu-PVAAP) were synthesized, and their binding affinities were evaluated via molecular docking on the DNA gyrase receptor; their antibacterial activity was also tested in vitro using the agar well diffusion method. The results of the study showed that defect engineering in the form of sulfur vacancies in the hierarchical MoS_2 structure successfully narrowed the energy bandgap to 1.59 eV and increased the specific surface area to 18,998 m^2/g. This enabled it to act as a mimetic enzyme with a phenoxazinone yield of 80.75% and excellent reuse stability. In the modeling of enzyme inhibition, Cu(II) complexes with a square-planar geometry were successfully synthesized. Bioactivity assays and molecular docking revealed that the Cu-PVAAP complex exhibits a stronger binding affinity (-8.8 kcal/mol) and twice the antibacterial activity against E. coli compared to Cu-OVAAP. This difference in performance was validated as a result of the availability of free hydroxyl groups on Cu-PVAAP that are not coordinated to the metal center, allowing it to form hydrogen bonds with amino acid residues at the active site of the bacterial cellular enzyme.

Keywords: Enzyme modeling, MoS_2, photocatalyst, phenoxazinone, Schiff base, copper(II), DNA gyrase inhibitor.

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