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Antibacterial Activity and Cytotoxicity of Spinel Copper Ferrite Nanoparticles Synthesized by using Sol Gel Technique and Lemon Juice as Substrate

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ABSTRACT

The objective of the present study was to prepare $CuFe_2O_4$ ferrite nanoparticles using the sol-gel combustion method, employing lemon juice as a surfactant and energy agent. This method is located within the green chemistry, representing an environmentally friendly and less expensive approach compared to other methods. The nanoparticles were subsequently evaluated as antibacterial agents against different pathogenic bacteria. Before the antibacterial assays, a cytotoxicity test was conducted to evaluate their safety when applied to organisms. The structural, morphological, elemental composition, and magnetic properties of the samples were analyzed using Fourier-Transform Infrared Spectroscopy (FTIR), X-ray diffraction (XRD), Field Emission-Scanning Electron Microscopy (FE-SEM), and Energy Dispersive X-Ray Detection (EDX). The X-ray diffraction patterns confirmed both the phase purity and the particle size to be 24.27 nm. The results demonstrated that the $CuFe_2O_4$ nanoparticles exhibited substantial antibacterial activity against both Gram-negative bacteria (*Sphingomonas paucimobilis*) and Gram-positive bacteria (*Staphylococcus lentus* and *Bacillus subtilis*). The antibacterial efficacy was more pronounced against Gram-negative bacteria, with inhibition diameter 5.46mm and 10.64mm at concentrations of 5000 ppm and 10000 ppm, respectively. When making a comparison, the effectiveness against Gram-positive bacteria displayed a slight reduction. Inhibition zones measured 2.76 mm and 8.33 mm for *Staphylococcus lentus*, while they were 3.58 mm and 5.35 mm for *Bacillus subtilis*. These measurements were observed at nanoparticle concentrations of 5000 ppm and 10000 ppm, respectively. Furthermore, the study confirmed the safety of the $CuFe_2O_4$ nanoparticles by assessing their toxicity on human red blood cell at different concentrations (50, 100,250,500,1000,5000, and 10000 ppm).

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INTRODUCTION

Over time and with the advancement of pharmaceutical antibiotics, the world witnessed the emergence of bacterial strains exhibiting both virulence and resistance to diverse antibiotics, even in cases where they previously lacked such traits.(Terreni et al., 2021). This circumstance calls for the development of innovative strategies to generate and improve antibacterial agents, or to reinvigorate the advancement of antibiotics that have already been established and proven successful in the market. (Miethke et al., 2021), (Nas et al., 2018). Therefore the best and environmentally strategy involves the use of metallic and metal-oxide nanoparticles (1–100 nm), as zinc, silver, and copper, which display antibacterial machines in their bulk form, other resources, such as iron oxide, are not antibacterial in their bulk form but may show antibacterial properties in nanoparticulate form is begin used(Mendes et al., 2022).The mechanisms by

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