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Investigation of antioxidant and antibacterial activity of iron oxide nanoparticles (IONPS) synthesized from the aqueous extract of *Penicillium* spp.

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ABSTRACT

The biological synthesis of metal nanoparticles has arisen vastly with significant health and medical applications in recent years. The current study employs *Penicillium* spp. that was isolated from soils to synthesis iron oxide nanoparticles (IONPs). The antimicrobial and antioxidant activity of the IONPs were investigated. The IONPs were synthesized via the extracellular method using cell-free filtrate and challenged with $FeCl_3$. The characterization of IONPs was performed using UV-spectrophotometer, FTIR, TEM, SEM, EDX, and Zeta Potential Analysis. The antibacterial and antioxidant activity was examined through the disk diffusion method and DPPH-scavenging activity, respectively. This study showed that the IONPs were successfully synthesized from the fungal filtrate of *Penicillium* spp. The UV-spectrophotometer displayed a peak at 350 nm, indicating the formation of IONPs. The spherical shape of IONPs was determined by TEM and SEM analysis, with the size ranging from 3.31 to 10.69 nm. The FTIR spectrum of IONPs showed bands at 3313 cm^{-1}, and 1636 cm^{-1} revealed the protein's involvement in the formation and capping of nanoparticles. The EDX showed the presence of iron elements in the biosynthesized IONPs, and Zeta potential analysis indicated the high stability of IONPs (+33.9 mV). Biosynthesized IONPs exhibited good antibacterial activity against pathogenic bacteria as well as showed potent antioxidant activity. At the highest concentration (250 μg), the IONPs showed higher inhibition activity against *S. aureus* (12 ± 0.6 nm), *E.coli* (11.3 ± 1.2 nm), *K.pneumonia* (11.3 ± 0.6 nm), *S.sonnie* (11.3 ± 0.6 nm), and *P.aeruginosa* (11.3 ± 0.6 nm). IONPs also exhibited antioxidant potential against DPPH radical compared with ascorbic acid with IC_{50} values of 12.2 μg/mL. In conclusion, the biosynthesized IONPs from *Penicillium* spp. demonstrated the potential biomedical application such as antimicrobial and anticancer agents in the future.

1. Introduction

Nanotechnology is a technology to synthesize nanoparticles with various shapes, sizes, and chemical compositions. Nanoparticles are microscopic particles with multiple sizes ranging from 1 to 100 nm [1]. The nanoparticles have a high surface-area-to-volume ratio making them applicable to various fields such as medicine, environment, biosensor, catalysis, electronics and agriculture [2,3]. Among the vital metal nanoparticles, Iron oxide nanoparticles (IONPs) have significant applications in medicine, such as drug delivery, targeted therapy, cancer therapy, magnetic resonance imaging (MRI), and hyperthermia [4,5]. Furthermore, due to non-toxic, biodegradable, non-immunogenic, and biocompatible characteristics, the research on IONPs keeps expanding for various applications [6].

The synthesis of nanoparticles includes chemicals, physical and biological methods. The synthesis of nanoparticles through chemical processes involved hazardous chemicals; meanwhile, the physical methods involved high temperature and energy usage, affecting the environment [7]. In recent years, green nanotechnology has been paid attention to producing non-toxic, environmentally friendly, and cost-effective

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