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TiO_2 nanoparticles from bakers' yeast: a potent antimicrobial

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Titanium dioxide (TiO_2) is commonly applied in food industry, cosmetics and pharmaceuticals due to its photocatalytic activity, stability, optical and electronic properties and biocidal activity. TiO_2 nanoparticles (NPs) can be synthesized by conventional chemical, physical and biological methods. In this study, TiO_2 NPs were biosynthesized using Baker's yeast (Y-TiO_2) and characterized by X-ray Diffraction (XRD), Transmission Electron Microscopy (TEM) and Energy Dispersive X-ray analysis (EDX). Antimicrobial activity was studied using plate coating method with and without sunlight exposure. XRD pattern confirmed the formation of pure anatase TiO_2 nanoparticles. The porous surface of yeast cells act as the site for Ti^{3+} nucleation. According to EDX data, Ti (Atomic percentage of 20.89%), O (70.95%), P (5.78%) and N (2.38%) were the key elements in the sample. TEM imaging revealed that the nanoparticles were spherical with an average size of 6.7 ± 2.2 nm. The photocatalytic activity of TiO_2 NPs was studied by monitoring the degradation of Methylene blue dye. Fifty percent of dye degradation was observed within 15 min of UV exposure. This study is the first report on antimicrobial study of yeast-mediated TiO_2 NPs synthesized using $TiCl_3$. Antimicrobial activity of TiO_2 nanoparticles was high against selected Gram positive bacteria and *Candida albicans* compared to Gram negative bacteria in the presence or absence of exposure to sunlight. The percentage reduction of colony forming units (CFU/mL) after exposure to Y-TiO_2 NPs following 30 min of sunlight exposure significantly reduced *S. aureus* ATCC 25923 (77%), MRSA clinical isolate (97%) and *C. albicans* ATCC 10231 (95%) compared to the control due to the photocatalytic activity. The percentage reduction of CFU/mL for gram negative bacteria *P. aeruginosa* ATCC 27853, *E. coli* ATCC 25922 and *A. baumannii* clinical isolate were 58%, 46% and 50% respectively after exposure to sunlight. Y-TiO_2 NPs showed antimicrobial activity in the absence of exposure to sunlight under room conditions. After 30 min of contact with Y-TiO_2 NPs, percentage inhibition of *S. aureus* (20%), MRSA (25%), *C. albicans* (74%), *P. aeruginosa* (30%), *E. coli* (26 %) and *A. baumannii* (23%) were lower compared to sunlight exposure. Sunlight exposure has enhanced antimicrobial activity of TiO_2 NPs. The outcomes indicate the significant physical properties and the impact of yeast-mediated TiO_2 nanoparticles as a novel antimicrobial.

Keywords: Photocatalytic activity, titanium dioxide, X-ray diffraction, yeast

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