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Tannic Acid-Conjugated Au doped TiO_2 Nanocrystals: Microbiological and Toxicological Profile for Advanced Biomedical Applications

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ABSTRACT

Tannic acid is valued for its antioxidant, antimicrobial, and anti-inflammatory properties, making it a promising agent in biomedical applications, mainly when conjugated with nanomaterials. Doping TiO_2 with gold enhances its photocatalytic properties and interactions with biomolecules, boosting its effectiveness in antimicrobial systems. This study introduces an innovative approach, combining tannic acid with gold-doped TiO_2 to create a nanocomposite with synergistic antimicrobial activity, improved safety, and therapeutic potential. This study investigated the microbiological efficacy and toxicological safety of TiO_2 nanocomposites conjugated with tannic acid, targeting biomedical applications. Structural characterization was performed using Fourier-transform infrared spectroscopy (FTIR) to confirm the successful functionalization of TiO_2 with tannic acid through distinct spectral changes. Scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) provided insights into the nanocomposite's morphology and elemental composition, revealing a homogeneous distribution of tannic acid on the TiO_2 surface. Microbiological assays against pathogenic bacteria, including *E. coli* and *S. aureus*, demonstrated enhanced antibacterial properties of the tannic acid-conjugated TiO_2 nanocomposite, suggesting potential in combating resistant bacterial strains. Toxicological assessments were conducted in *Drosophila melanogaster* models, evaluating the nanocomposites' impact on viability, development, and oxidative stress markers. Initial findings indicate a balanced profile between efficacy and biocompatibility, with low toxicity observed at therapeutic doses. This work underscores the promise of tannic acid-TiO_2 conjugates in safe, practical antimicrobial applications, paving the way for further in vivo evaluations and application in medical fields.

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