Contribution ID: **22** Type: **Oral Presentation**

Photothermal Therapy Using Green-Synthesized gold Nanoparticles Derived from Senna didymobotrya: A Novel Strategy for Targeted Treatment of Melanoma Cells

Thursday 10 July 2025 13:50 (20 minutes)

Melanoma, a highly aggressive and metastatic form of skin cancer, frequently exhibits resistance to conventional treatments such as chemotherapy, radiation therapy, and surgical excision, highlighting the necessity for novel therapeutic approaches. Recently, integrating nanotechnology with photothermal therapy (PTT) has emerged as a promising strategy, offering targeted, minimally invasive therapeutic benefits. This study investigates the photothermal potential and underlying cytotoxic mechanisms of gold nanoparticles (AuNPs) biosynthesized using an aqueous extract of Senna didymobotrya against human melanoma A375 cells. Successful synthesis and formation of AuNPs were confirmed through UV-visible spectroscopy analysis. The photothermal efficacy of these nanoparticles was evaluated by assessing cellular viability through the MTT assay, reactive oxygen species (ROS) production, mitochondrial membrane potential (MMP) disruption, and morphological changes via microscopic examination. Results revealed substantial photothermal efficiency, marked by significant temperature increases upon near-infrared (NIR) irradiation, leading to enhanced cytotoxicity in a dose-dependent manner. The cytotoxic mechanisms primarily involved ROS-induced mitochondrial dysfunction, ultimately resulting in apoptotic cell death. These findings underscore the significant potential of Senna didymobotrya-derived AuNPs as sustainable and potent photothermal agents, representing an encouraging advancement in melanoma treatment strategies.

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Session Classification: Photonics

Track Classification: Track C - Photonics