National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Fabrication of Nanostructure-Infused Chitosan Based Composite Films for the Application of Antibacterial Wound Dressing and Active Food Packaging
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Venue	: Offline (BM-Seminar Hall)
Date and Time	: 12 Aug 2025 (4.00 p.m.)
Abstract	: Multifunctional nanocomposite-based materials were developed for advanced wound dressings and biodegradable food packaging application, addressing critical challenges in healthcare and food preservation. The first study addressed the limitations of conventional wound dressings by coating cotton gauze with chitosan and functionalizing it with Ca-doped ZnO and curcumin (Cur@CaZnO) nanocomposites. The coated dressing exhibited potent antibacterial activity, achieving 85% inhibition against S.aureus and 80% against *E.coli* at a 5% nanocomposite coating. It also demonstrated strong antibiofilm effects, inhibiting 80% of S. aureus and 71% of *E. coli* biofilm formation while disrupting over 70% of preformed biofilms. The Cur@CaZnO nanocomposite coating also provided pH-responsive real-time wound monitoring (over wide range from pH 4&ndash10) and improved mechanical flexibility to the pristine gauze. Biocompatibility assessments using L929 mouse fibroblast cells confirmed that nanocomposite reinforcement below 5 wt% was safe. A 2.5% nanocomposite-coated gauze promoted 96% L929 cell migration within 24 h, facilitating wound closure through enhanced fibroblast migration. The second part comprised of the development of tranexamic acid (TRA)-infused chitosan-guargum nanocomposite film (CGT/AgZnO) with 3 wt% Ag-doped ZnO nanoparticles (CGT/AgZnO3), exhibiting 90% and 94% bacterial inhibition against gram-negative and gram-positive bacteria, respectively. The films showed 80% biofilm inhibition, reduced blood clotting index (BCI), and enhanced wound closure, with 100% L929 mouse fibroblast cell migration within 24 h. Hemocompatibility and cytocompatibility studies confirmed their safety. The third part was fabrication of a biodegradable food packaging film by incorporating nano ZnO/N-doped TiO_2 and eugenol (ZTE) into a chitosan-guargum matrix (CG/ZTE). The optimized film exhibited 94% and 88% biofilm inhibition against S. aureus and E. coli, respectively. It also provided enhanced mechanical strength, UV shielding, and moisture resistance, while its photocatalytic activity under 450 nm visible light exposure resulted in complete bacterial inactivation within 30 min. The shelf-life of wrapped chicken fillets in CG/ZTE films was extended to 12 days as compared to 6 days for unwrapped fillets. The weight loss of the composite film was more than 50% in soil within 30 days. Overall, these studies confirmed the potential of biomolecule and inorganic nanostructure based composite films as innovative solutions for antibacterial protection, biofilm inhibition, wound healing, and sustainable food packaging, paving the way for enhanced biomedical and food safety applications.