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CO-AXIAL ELECTROSPINNING OF CORE-SHELL PLA AND P[(3HB-co-3HV)] FIBERS FOR TUNABLE TRICLOSAN RELEASE, ANTIMICROBIAL EFFICACY AND ENHANCED CYTOCOMPATIBILITY

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BACKGROUND & OBJECTIVE

- Controlled drug release from electrospun scaffolds remains a major challenge in wound healing and infection
- PLA: biocompatible but slow degradation limits controlled drug diffusion
- P(3HB-co-3HV): High crystallinity restricts uniform drug release
- A core-shell coaxial design may overcome these limitations by combining polymer advantages

METHODS

- Materials: PLA and P(3HB-co-3HV) polymers, Triclosan as a microbial agent
- Fiber fabrication: Scanning Electron Microscopy (SEM) & Transmission Electron Microscopy (TEM) for core-shell confirmation
- Drug release study: Triclosan release measured over time using UV-Vis spectroscopy
- Antibacterial testing: Disk diffusion method against *Escherichia coli* and *Staphylococcus aureus*
- Biocompatibility evaluation: HDF culture assays with viability measured at 24h and 72h
- Cell imaging: Immunofluorescence staining of F-actin and DAPI, along with CLSM was performed to evaluate fibroblast morphology, distribution, and attachment behavior on electrospun scaffolds

SCHEMATIC COAXIAL ELECTROSPINNING & DRUG RELEASE

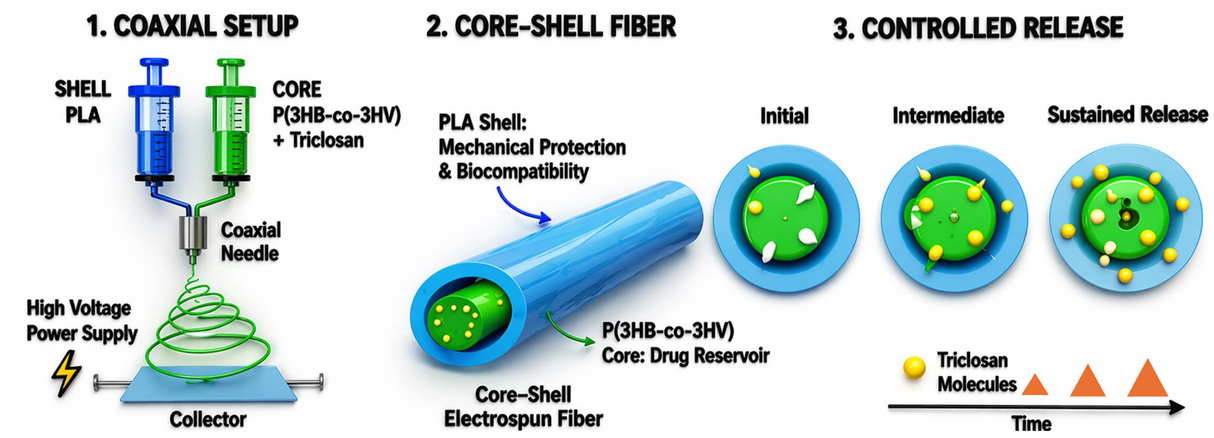
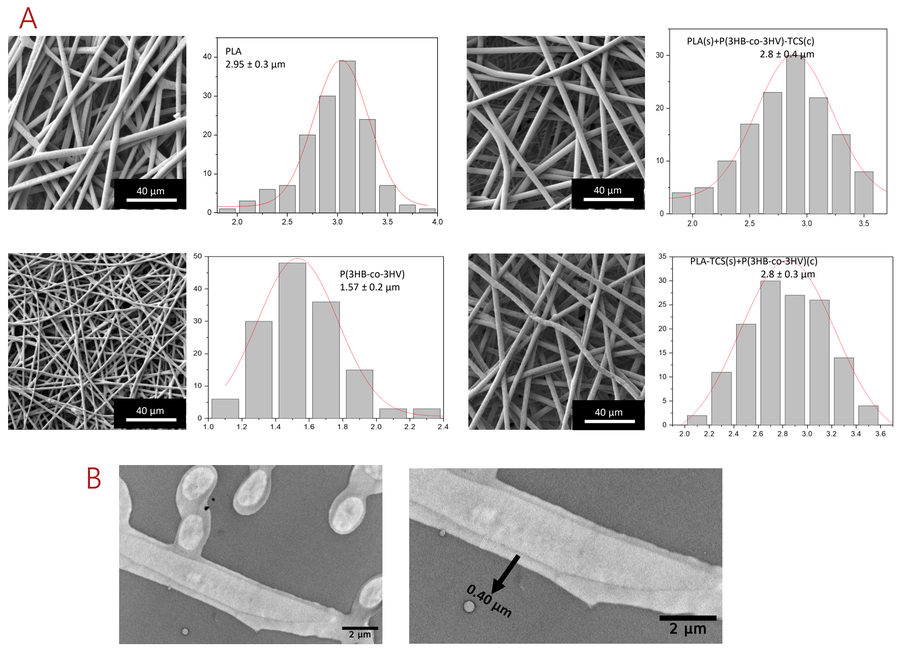


Figure 1: Schematic representation of coaxial electrospinning and controlled drug release, showing the formation of PLA and [P(3HB-co-3HV)] drug-loaded core-shell fibres and their sustained triclosan (drug) release behaviour over time

RESULTS AND DISCUSSION

MORPHOLOGY: SEM & TEM



PLA(s) + P(3HB-co-3HV)-TCS(c)

Figure 1: (A) SEM images and corresponding fiber diameter distribution of uniaxial and coaxial electrospun Polylactic acid (PLA), Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (P(3HB-co-3HV)) with and without Triclosan (TCS) showing uniform fibers. (B) TEM images of PLA & P(3HB-co-3HV)–TCS fibers revealing a dense internal structure showing the core-shell structure; the fiber wall thickness is approximately 0.40 µm

ANTIBACTERIAL ACTIVITY

Touch and Diffusion test:

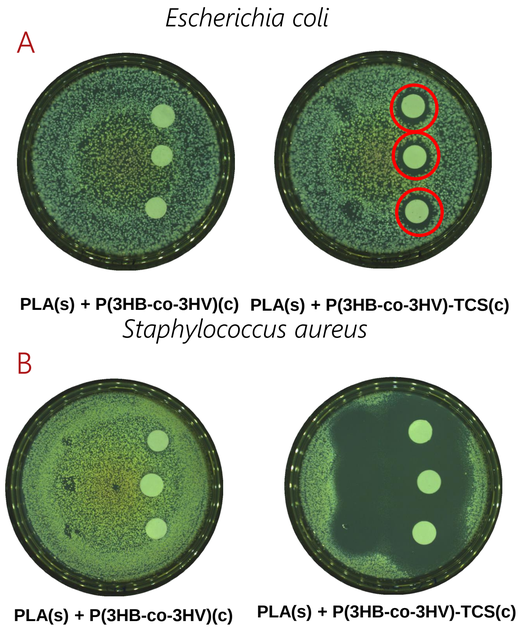


Figure 2: (A) & (B) Antibacterial activity of the electrospun evaluated by touch and diffusion test against Escherichia coli and Staphylococcus aureus, where TCS-loaded fibers exhibit clear inhibition zones compared to control samples

Core–shell fibers achieve sustained release over ´ vs burst release in controls

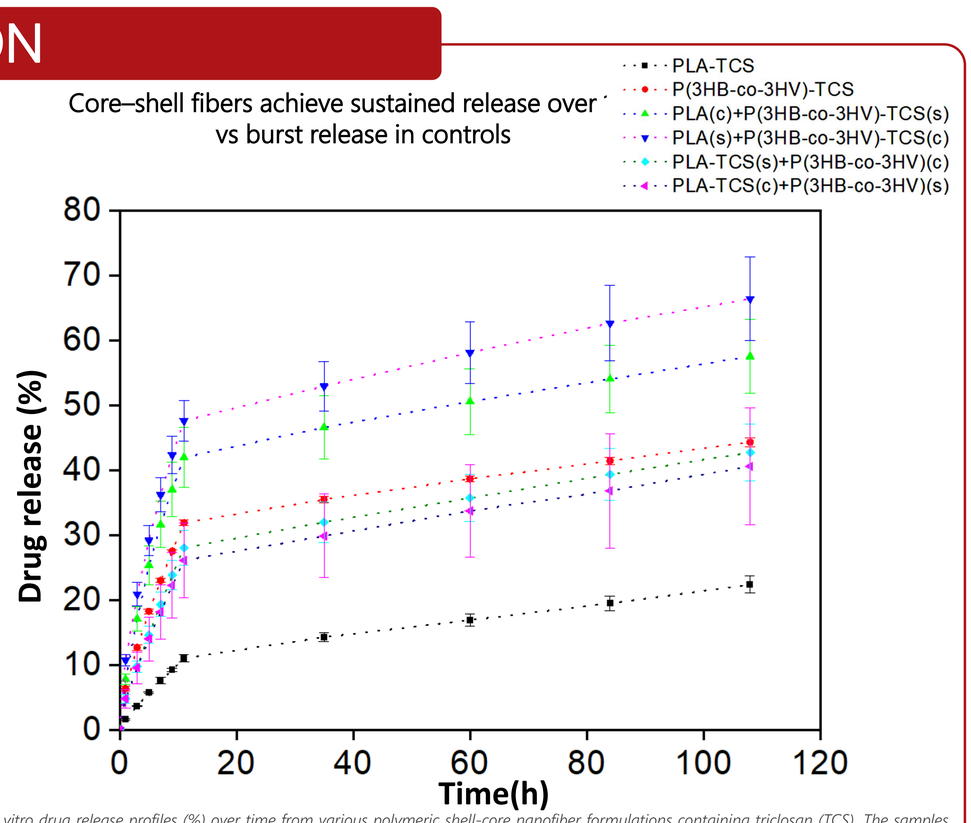
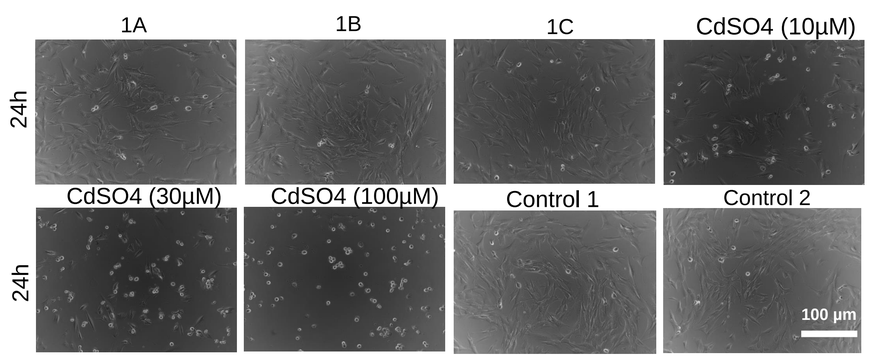


Figure 3: In vitro drug release profiles (%) over time from various polymeric shell-core nanofiber formulations containing triclosan (TCS). The samples include different combinations of polylactic acid (PLA) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) [P(3HB-co-3HV)] with and without Triclosan (TCS)

Cytocompatibility with HDFs



1A-1B-1C: PLA(s) + P(3HB-co-3HV)-TCS(c)

Figure 4: Morphology of HDFs after 24 h exposure to fibre extracts. Representative phase-contrast images showing normal fibroblast morphology in extract-treated groups (1A–1C) compared with controls, while $CdSO_4$-treated cells exhibit reduced cell density and cytotoxic effects

Sustained cytocompatibility of core-shell fibers over 24–72 h

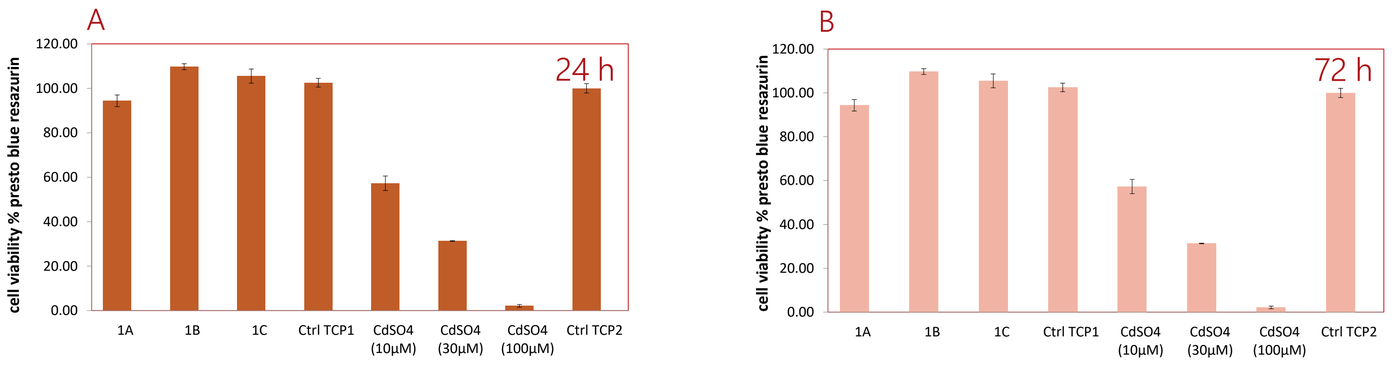


Figure 5: (A) Cell viability measured by PrestoBlue after 24 h exposure, showing high viability (~80–100%) and no acute cytotoxicity. (B) Cell viability after 72 h exposure, confirming sustained viability and no delayed toxicity. $CdSO_4$ served as the positive cytotoxic control

DNA Quantitative Analysis Shows Enhanced Cell Growth on Core–Shell Fibers

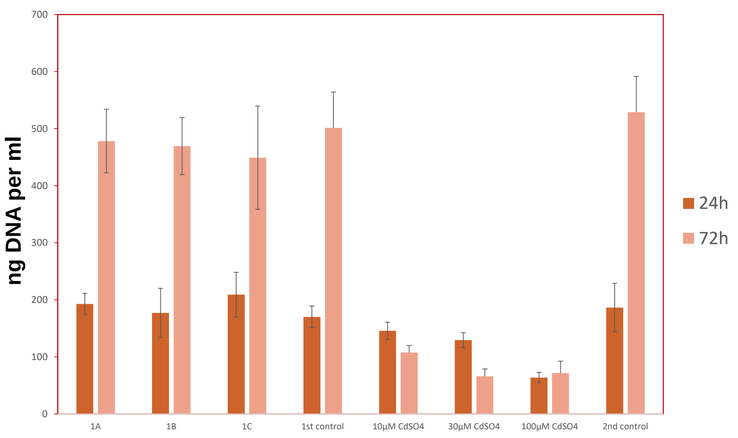


Figure 6: DNA quantification of HDFs cultured with fibre extracts. DNA content increased from 24 h to 72 h for all fibre groups (1A–C), indicating cell attachment and proliferation with no cytotoxic leachables. $CdSO_4$ controls showed reduced DNA levels, confirming assay sensitivity

Cellular response of HDFs on coaxial electrospun scaffolds

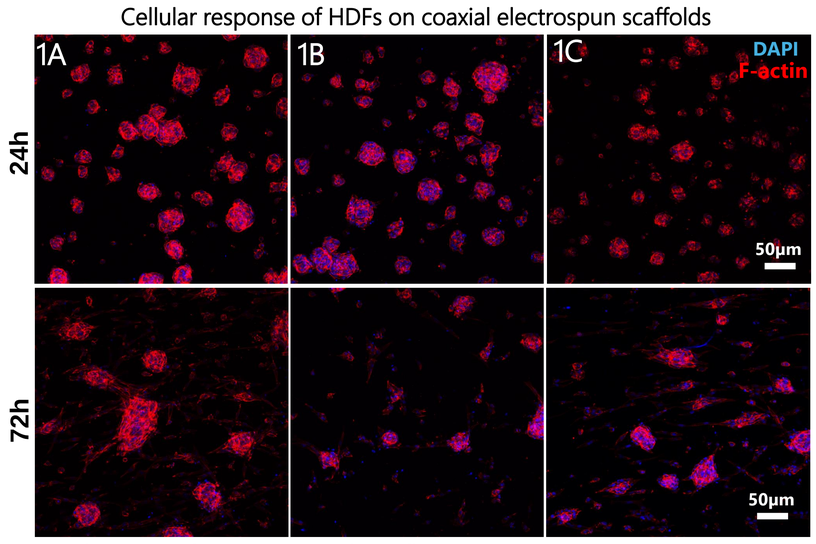


Figure 7: Confocal imaging of HDFs on electrospun fibre scaffolds. Representative images at 24 h and 72 h showing fibroblast attachment and proliferation on TCS-only (1A-C) coaxial fibres. Cells at 24 h exhibit limited spreading, whereas increased cell density at 72 h suggests sustained viability and proliferation. This low adhesion profile is beneficial for wound dressings, helping to minimise tissue disruption during removal

CONCLUSIONS & FUTURE WORK

Controlled drug release from electro-spun scaffolds: Core-shell PLA & P(3HB-co-3HV) electrospun fibers were successfully developed to enable controlled drug delivery. The coaxial structure provided sustained release, effective antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* and improved cytocompatibility compared to free drug exposure. These findings demonstrate the potential of core–shell fiber systems as multifunctional scaffolds for infection-resistant tissue engineering applications

NEXT STEPS:

- Evaluate long-term performance and degradation behavior under physiological conditions
- Optimize fiber structure and drug loading for application-specific needs
- Explore the application of this core-shell system in wound closure and healing, focusing on infection prevention and tissue regeneration