Title: Synergistic Blend Spinning of Bioactive Lyocell Fibers for Antibacterial and Anti-Inflammatory Skin Protection

Authur names : Xiongwei Dong, Kaixin Ran, Yujie Wang, Zixiong Yin, Zewei Zheng, Cheng Gao, Yi Xiong, Yun Tang, Sakil Mahmud

Abastact : Functional wound dressings based on regenerated cellulose fibers that concurrently control infection, suppress inflammation, and promote tissue regeneration remain a major clinical need. Here, regenerated cellulose (lyocell), a well-defined polysaccharide polymer, is employed as a bioactive matrix to fabricate multifunctional fibers via blend spinning with glycyrrhizic acid, cysteine, tannic acid, and zinc gluconate. Structural analyses confirm preservation of cellulose II crystallinity with reduced crystallite order and surface enrichment of carbonyl, ester, and phenolic groups arising from hydrogen-bonding and coordination interactions. The polysaccharide-rich cellulose network governs additive immobilization, enabling sustained antibacterial activity while maintaining mechanical integrity. The blended fibers exhibit strong antibacterial performance, achieving >99% inhibition against *Escherichia coli* and *Staphylococcus aureus* under contact conditions and >90% inhibition under oscillation conditions, despite minimal tannic acid release (~0.001% w/v over 20 h). In vivo, the fibers achieved a 98.37% inhibition rate against *S. aureus*, reduced viable bacterial burden to 26.7 ± 18.9%, and accelerated wound closure to 97.6 ± 0.8% by day 14. Immunohistochemical analyses reveal reduced oxidative stress, lower IL-6 expression, increased collagen deposition, macrophage polarization toward an M2-phenotype, and a ~fourfold increase in angiogenesis. These results establish polysaccharide-based lyocell fibers as an effective platform for antibacterial and immunomodulatory wound dressings.

Keyword:

https://doi.org/10.1002/mame.70211

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