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AgNP-Polyphenol synergy on cotton fabrics: antimicrobial and free-radical-scavenging activity for dermal applications

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The development of antimicrobial textiles has gained increasing attention due to rising concerns regarding infection control and material safety, Conventional antimicrobial textiles often depend on synthetic agents or metal-based compounds, which may promote environmental and biocompatibility concerns. Hybrid strategies combining nanotechnology with bioactive compounds (BCs) derived from agri-food by-products have emerged as promising alternatives. In this study, silver nanoparticles (AgNPs) were first applied to cotton fabrics to create a stable antimicrobial platform. The combination of AgNPs and BCs is expected to yield synergistic bioactivity, promoting both microbial inhibition and oxidative stress modulation [1]. This study evaluated the biological performance of extracts from acorn shell (AS) functionalized with AgNPs-cotton, focusing on antimicrobial efficacy against pathogenic microorganisms (*S. aureus*, *E. coli*, *C. albicans*, *C. tropicalis*), and antioxidant activity (ABTS and DPPH radical scavenging assays). The biocompatibility with human skin cells will be further assessed through *in vitro* assays using HaCaT keratinocytes, aiming to evaluate potential cytotoxic effects and ensure the safety of the fabrics. Antimicrobial activity was evaluated through CFU counts, expressed as $\log_{10}$ reductions. Fabrics functionalized with extracts showed a greater reduction ($p \leq 0.001$) in microbial load, particularly against *Candida albicans* and *Candida tropicalis*, when compared to AgNP-only treated samples. The functionalized fabrics showed significant radical scavenging activity in both assays. In the ABTS and DPPH assay, samples treated with AS extracts exhibited higher activity compared to AgNP-only treated fabrics with inhibition values of 36 (±4.4)% and 43 (±4.1)%, respectively. In contrast, AgNPs alone showed no measurable antioxidant activity. These compounds likely act synergistically with AgNPs, contributing not only to oxidative stability but also enhancing antimicrobial performance. Interestingly, fabrics with AgNPs alone exhibited minimal antioxidant activity and may have induced pro-oxidant effects, consistent with the known ROS-generating mechanisms. The upcoming biocompatibility will provide further insights into their safety for skin-contact use.

References

(1) Melo A. et al, 2024