Blood Block – Development of Suberin Bioactive Membranes Enriched With Tannins Targeting Anti-Hemorragic Properties

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Uncontrolled minor bleeding requires effective, safe, and accessible materials. However, most commercial hemostatic dressings rely on synthetic, non-renewable polymers and present high production costs. This project aimed to develop a low-cost, biodegradable membrane based on suberin incorporating tannins sustainably extracted from agro-industrial waste and Aloe vera to enhance hemostatic performance and enable infection monitoring. Suberin was extracted from cork biomass using deep eutectic solvents selected for selective recovery and low toxicity. Structural characterization was performed by Fourier transform infrared spectroscopy. Tannins were extracted from tea and coffee by-products, and process parameters were optimized by varying solvent, temperature, and time. Bioactive membranes were produced via melt-based processing using scalable techniques. Anti-hemorrhagic activity was evaluated through the prothrombin time assay in human plasma. Cytotoxicity was assessed in fibroblast cultures. Methods were also developed to incorporate colorimetric indicators into both the membrane and a complementary gel to allow visual detection of microbiological infection. Optimal extraction yielded 0.64 mg/g TA at 50 °C for 30 minutes. The membranes were translucent and flexible. Prothrombin time decreased in tannin-containing samples, with further reduction when Aloe vera was added, indicating synergistic hemostatic activity. No cytotoxic effects were observed. The indicators exhibited visible color change in the presence of microbial activity. These findings demonstrate a biocompatible, sustainable, multifunctional, and cost-effective dressing with strong potential for accessible hemorrhage control and early infection detection.

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