Developing Novel Plant Waste-Based Hydrogels for Skin Regeneration and Infection Detection in Diabetic Wounds

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More than 70,000 diabetic patients have amputations annually due to wound care complications. Poor circulation and hyperglycemia-related nerve damage, which are complications of diabetes, prevent natural wound healing processes. The purpose of this investigation is to develop a hydrogel to aid skin regeneration by creating an extracellular matrix for fibroblast growth with antibacterial and infection detection properties. Two natural, hydrogels based in pectin and potato peels were developed and characterized for fibroblast compatibility through rheology, scanning electron microscopy, swelling, degradation, and cell cytotoxicity assays. All five assays indicated that potato peel starch and citrus pectin were capable of mimicking natural skin, with a relevant pore diameter (potato: 82.105, pectin: 56.639 micrometers) and stiffness (potato: 798.77, pectin: 830.7 complex moduli Pa). Both groups were able to absorb 40 times their weight before naturally degrading and supported upwards of 500% NIH 3T3 fibroblast proliferation. Additionally, anthocyanin, a pigmented flavonoid, was encapsulated in hydrogels and used as an infection biomarker and preventative agent. A pH responsivity test and time-to-kill antibacterial assay were conducted, validating the ability of anthocyanin to noticeably change colors in hydrogels and assert bactericidal effects even at low concentrations. A concentration of 200 milligrams could prevent bacteria growth and showed no effect on fibroblast growth. Overall, this experiment fabricated various hydrogels capable of acting as skin substitutes and counteracting infections to facilitate wound healing. Following further testing and validation, these hydrogels could alleviate the 13-billion-dollar financial burden of foot ulcer treatment.