Developing Honey-based Antibacterial Wound-healing Agents by Integrating Glucose Oxidase Enhancement with Pectin Hydrogels

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Chronic wounds and ulcers disproportionately affect the world's diabetic, aging, and economically disadvantaged populations, with antibiotic-heavy treatments contributing to global antimicrobial resistance. One of the most promising solutions to this issue is honey; studies show that topical application of honey supports healthy cell growth and fights infections, allowing chronic wounds to fully heal. Natural honeys contain glucose oxidase (GOX), an enzyme that contributes to honey's antibacterial activity through hydrogen peroxide (H_2O_2) synthesis. However, natural honeys are difficult to sterilize, can be allergens, and vary in antibacterial potency across floral sources and seasons. Thus, this research aims to integrate GOX activity enhancement with gelling hydrocolloids to create a synthetic honey that mitigates natural honey's issues. Testing our honey treatments against E. coli and B. cereus showed that the synthesized treatments were statistically comparable to or better than penicillin ($p > 0.05$). Testing synthetic honeys for H_2O_2 accumulation showed that the modified blueberry honey did not have significantly greater activity than its semi-synthetic counterpart; thus, pectin can stabilize GOX without impacting its activity. Furthermore, cost analysis revealed that the synthetic treatment is less than a tenth of the cost of its commercial alternative. This research established a novel and readily reproducible method for developing a sustainable synthetic honey with the physical and chemical properties of natural honey. GOX stabilization and antibacterial activity maximization through the use of hydrogels enables the emergence of a low-cost wound-healing agent with immense potential to revolutionize treatment for infections and chronic wounds.