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ABSTRACT

The objectives of the research work are to explore the unique properties of nanocellulose from fruit waste like banana rachis and pineapple peel, such as high specific surface area, mechanical strength, biodegradability, and sustainability, while analysing its diverse applications in food, including emulsion stabilizers, hydrogels and aerogels. The study seeks to characterize and optimize cellulose morphologies by examining the influence of cellulose sources and processing conditions on functional properties, crystallinity, and particle morphology. It further focuses on developing nanocellulose-stabilized Pickering emulsions as sustainable, non-toxic particle emulsifiers, minimizing traditional surfactants use, and optimizing their design for controlled release of a bioactive molecule in the gastrointestinal tract. The research also advances natural polymer-based hydrogels by creating nanocellulose/protein-based hydrogels with stable network structures for functional food applications to enhance the stability and bioavailability of encapsulated ingredients. Additionally, it promotes the development of polysaccharide-based aerogels, including nanocellulose, as sustainable alternatives for food packaging and biomedical applications. Finally, the work contributes to environmental sustainability by utilizing biopolymers in packaging, while enhancing human health through improved drug delivery systems and stabilization of bioactive compounds using nanocellulose-derived materials.

The study systematically addressed research gaps by structuring the work into four objectives, focusing on innovative product development, detailed characterization, and advancing sustainable applications of nanocellulose in diverse fields. **Chapter 3** focuses on the materials and methodologies employed for the isolation of nanocellulose from banana rachis and pineapple peel samples. Two distinct methods, ultrasonication and high-pressure homogenization, were used for nanocellulose isolation. For ultrasonication, independent variables included temperature (40-60°C), time (20-60 min), and concentration (25-45%), with particle size and zeta potential as dependent variables. In high-pressure homogenization, the independent variables were pressure (250-500 bar), passes (1-3), and concentration (30-50%), with particle size and zeta potential as dependent variables. Both methods underwent optimization to determine the most effective parameters for nanocellulose extraction. Results indicated that ultrasonication produced nanocellulose with superior characteristics compared to high-pressure homogenization. Particle size and zeta potential analysis showed that ultrasonication yielded a

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by Beatrice Basumatary

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