From Fibre to Function: Cellulose Nanocrystals Extracted from Spent Coconut Fibres as Pickering Emulsion Stabilizers

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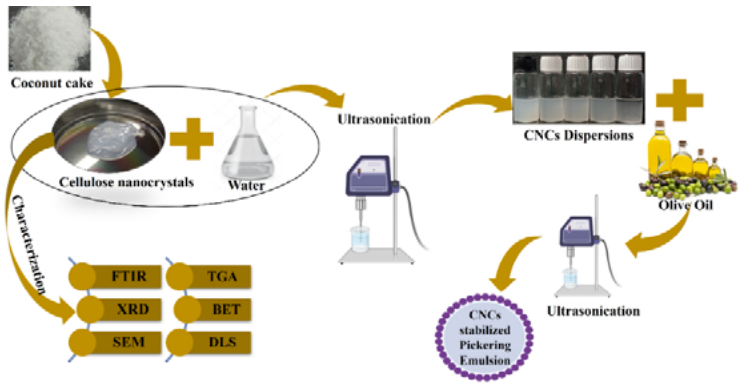
The sustainable production of food ingredients is receiving growing attention due to environmental concerns and the global push for circular economy practices. Spent coconut fibres (SCFs), by-product during virgin coconut oil production, contain considerable amount of cellulose, thereby the effective isolation of cellulose from them leads to value addition to coconut process industries. Cellulose in nano-sized forms, offers a novel green and sustainable technology for stabilizing emulsions, with significant applications in colloid and food soft matter. In the present study, SCFs were sequentially pretreated with alkali and bleaching processes to remove non-cellulosic components, yielding purified cellulose. After that, acid hydrolysis was carried out using 60% (w/w) sulfuric acid at 45 °C for 45 min, resulting in cellulose nanocrystals (CNCs) with a yield of 15.94 ± 0.62% (w/w). FTIR spectral analysis revealed that the functional groups of obtained cellulose and CNCs remained unchanged. The obtained CNCs exhibited a high crystallinity index (76.92%) with an average crystal size of 2.21 nm, enhanced surface area (4.74 m^2/g), good thermal stability (374 °C) and smaller hydrodynamic size (228.5 ± 8.03 nm). The Zeta potential of 0.5% (w/v) CNCs suspension was −47.7 ± 1.00 mV, indicating strong repulsive interactions among the nanocrystals. The water holding capacity (9.94 ± 0.06 g/g), oil holding capacity (10.88 ± 0.55 g/g) and swelling index (14.20 ± 1.2 ml/g) of CNCs demonstrated the unique interaction with both water and oil, defining its amphiphilic nature. The extracted CNCs from SCFs were evaluated at concentration range of 0.1 to 2% w/w, to formulate stable olive oil-in-water (O/W) Pickering emulsions (PEs). All PEs formulated in this study exhibited zeta potential greater than −30 mV, indicating good electrostatic stability. PEs containing 1% and 2% CNCs concentration showed dense three-dimensional gel networks enhancing emulsion stability over a 36-day storage. In conclusion, this study demonstrated the valorisation of SCF for CNC production, contributing to sustainable development and offering a natural, biocompatible stabilizer for O/W Pickering emulsions.

Keywords:
Spent coconut Fibres, valorisation, Cellulose nanocrystals, natural stabilizer, Pickering emulsion, Droplet Size, zeta potential



From spent coconut fiber waste to functional CNCs for Pickering Emulsions

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Acknowledgements:

N Sai Prasanna is thankful for the support provided by the Department of Science and Technology – Science and Engineering Research Board, Govt. of India, Confederation of Indian Industry (CII) under “Prime Minister’s Fellowship for Doctoral Research” scheme. The authors would also like to thank the Department of Chemical Engineering, IIT Tirupati for providing various characterization facilities.