**Formulation of CNC/WPI Complexes for Enhanced Surface Properties and Pickering Emulsion Stabilization**

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This study aimed to fabricate, characterize, and utilize cellulose nanocrystals (CNCs) derived from cherry stalks, an agricultural waste material, within the framework of valorization. CNCs were fabricated through ultrasound-assisted acid hydrolysis, yielding spherical particles with a size of 160.25 ± 32.05 nm and a zeta potential of -33.645 ± 5.06 mV. Fourier-transform infrared (FTIR) spectroscopy confirmed the successful removal of impurities, such as lignin, as evidenced by the absence of a peak around 1720 cm⁻¹. Additional characterization through energy-dispersive X-ray (EDX) and X-ray diffraction (XRD) analyses validated the purity of the CNCs. To functionalize CNCs and improve their emulsification ability, negatively charged CNCs were interacted with positively charged WPI. The mass ratios of CNC to WPI were selected as 1:1, 2:1, and 1:2. The surface charge of CNC, WPI, and CNC/WPI complexes at pH 2.0–9.0 was investigated to determine the pH at which the complexes remained stable based on their corresponding zeta potentials. WPI exhibited a positive zeta potential until pH 5, while the zeta potential of CNC ranged between -8.38 ± 2.05 and -43.06 ± 2.70 mV. Considering the charges of each molecule, complexes formed at pH where the zeta potentials of all prepared samples were lower than -20 mV. FTIR spectra of the freeze-dried CNC/WPI complexes further demonstrated the interaction between the components.

Changes in intrinsic fluorescence spectra of the proteins were analyzed to interpret structural modifications and interactions with polysaccharides. The excitation wavelength was set at 295 nm, with emission signals collected from 290 to 450 nm at 25 °C. A decrease in fluorescence intensity indicated that CNC-WPI effectively interacted with and quenched the signals caused by interactions between tryptophan residues and CNC. The change in hydrophobicity of CNC after modification was assessed using contact angle measurements. Native CNC samples exhibited highly hydrophilic characteristics, with a contact angle of 25.5°, whereas modified CNC with increasing WPI ratios showed contact angles of 36.0°, 35.85°, and 50.9°, respectively. These results demonstrated that WPI modified the surface characteristics of CNC, enhancing its hydrophobicity.

The adsorption/desorption behavior of CNC/WPI complex on hydrophobic surfaces was evaluated using quartz crystal microbalance with dissipation monitoring (QCM-D). For these measurements, the gold surfaces of QCM sensor chips were modified with 1-hexadecanethiol. Finally, CNC/WPI complex was used as stabilizers to prepare Pickering emulsions (PEs). The droplet size and storage stability of the emulsions were investigated to assess their performance.