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Project title: Colloidal stability of cellulose nanofibrils in physiological and cell culture media

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Abstract:

Cellulose nanofibrils (CNFs) are emerging as bio-based alternatives to animal derived matrices for cell culture and tissue engineering. In water, CNFs form colloidal suspensions that support cell proliferation and tissue formation for multiple cell lines. However, their successful use in high value biomedical products requires control of colloidal stability and mechanical properties in complex physiological media that mimic *in vivo* environments. These media contain diverse mixtures of mono and multivalent ions, buffering agents, proteins, and biomolecules that can either disrupt or reinforce CNF networks, directly affecting performance. This study investigates the colloidal stability and interfacial behavior of native CNFs and TEMPO-oxidized CNFs under physiologically relevant ionic conditions and in complex cell culture media. By directly linking colloidal stability to network mechanics, we reveal how ions, buffers, and proteins influence CNF behavior. Increasing ionic strength, as in phosphate buffered saline, compresses the electrical double layer, promoting fibril aggregation and the formation of attractive glasses (kinetically arrested, volume spanning networks) that remain macroscopically stable. The addition of fetal bovine serum to cell culture media reduces visible phase separation via protein adsorption onto fibril surfaces, weakening direct fibril-fibril interactions. These insights into CNF network formation and stability support its use in biomedical applications.

Key words: cellulose nanofibrils, colloidal stability, cell media, phosphate buffered saline, biomedical applications