**Viability of cellulose nanofiber in algal bio-ink for 3D bio-printing applications**

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The ability to precisely control material deposition by adjusting fabrication parameters makes bio-fabrication or bio-printing a promising method for regenerative medicine. This includes applications in tissue engineering, transplantation, clinical medicine, drug development, high-throughput screening, and cancer research. Bio-inks are crucial in bio-printing as they help create biological structures like living tissues and organs. They support and protect cells during and after printing, control the printing process, maintain the structure and environment of printed cells/tissues, and promote cell growth and functional tissue formation. These tasks require bio-active bio-inks that respond to spatial and temporal stimuli. Our research explores bio-mass derived hybrid hydrogel compositions, including sodium alginate, carboxymethyl cellulose (CMC), and TEMPO-mediated nano-fibrillated cellulose (TO-NFC), to enhance the mechanical and biological functions of algal infused bio-ink. We studied the rheological behavior of these composite hydrogel precursors over time to understand their potential as bio-ink formulations. We also tracked cell growth using a hemocytometer and optimized the bio-ink's printability based on its rheological properties and printing parameters. Unexpectedly, we found a significant decrease in viscosity in many compositions, which depended on the growth of algae in the hydrogel precursor. This indicates that introducing additional components into hydrogel precursors can significantly affect their performance. Understanding viscosity changes in these hybrid systems can optimize the design and use of hydrogel-based materials, especially in 3D bioprinting for biopharming, biomedicine, and tissue engineering.