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Waste to Resource: Utilizing Cellulose Nanocrystals from Invasive Tunicates

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ABSTRACT

In order for society to utilize sustainable nanomaterials such as cellulose nanocrystals (CNCs) in industrial applications, a large-scale production capacity for CNCs must first exist. The only available CNCs currently produced at kilogram/day scale are obtained by processing commercial wood pulp (W-CNCs). As the production capacity of W-CNCs isolation has increased, so to have their use in broader applications, which is capturing the interest of researchers, industries and governments. A different source of CNCs with potential for commercial scale production are tunicates, a unique species of prolific marine animal which utilizes highly crystalline cellulose as a skeletal structure. Tunicates are an invasive species on Prince Edward Island and currently cause significant harm to local aquaculture, including our mussel industry which produces about 80% of all blue mussels sold in Canada. However, these tunicate derived CNCs (T-CNCs) are a high aspect ratio CNC (AR 50-100), which can complement commercially available low aspect ratio W-CNCs (AR 5-20) in the growing global CNC market. Thus tunicates can now be viewed as a resource to be harvested and utilized, rather than as a nuisance to only be mitigated and contained. Herein we discuss both the isolation and utilization of T-CNCs from the tunicate Styela clava, an invasive species currently harming aquaculture communities here in PEI and throughout the world. The reported T-CNC isolation procedure utilizes scalable processing techniques and is based on our experiences from laboratory scale T-CNC isolation and pilot scale W-CNC isolation. We have demonstrated the largest scale where T-CNCs have been isolated from any tunicate species, under any reaction conditions previously reported. In addition we will also highlight the use of these T-CNCs in numerous green applications, marking another significant step towards commercial scale isolation of T-CNCs, and offering a sustainable solution to the challenges which invasive tunicates pose to global aquaculture.