Sea lettuce offers sustainable source of nanomaterial

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Video Abstract

Keywords: Cellulose, KTH Royal Institute of Technology, nanocellulose, CNF, extraction, macroalgae, *Ulva lactuca*, *Ulva fenestrata*, optotracing, sea lettuce, cellulose nanofibril, UN Sustainable Development Goals, lignin-free, optotracer, green chemistry, xylose, polysaccharide, xyloglucan, FTIR, HPAEC-PAD

Posted Date: October 23rd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-97508/v1>

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Abstract

Today, millions of people throughout the world lead richer, more productive and comfortable lives thanks to the thousands of chemicals poured into modern products and services. That makes the effective use and handling of chemicals and waste more important than ever. The United Nations' 2030 Agenda for Sustainable Development outlines a plan of action for "preserving peace, people, prosperity, and our planet". Central to that plan is the sound management of chemicals and waste, wherein reduction and renewable resources are key. Here's where materials like cellulose play an important role. Cellulose is the most abundant natural polymer on earth, and one of the most in-demand. That's because on top of being non-toxic and biodegradable, cellulose also tends to be lighter, cheaper, and stronger than other commercial polymers. There's only one problem. While cellulose is an environmentally friendly material, extracting it through processes such as Kraft and sulfite pulping and reforming it into a useful form, such as nanofibrils, tends to be energy-demanding and involves a long list of chemicals. Fortunately, that could soon change. All thanks to an edible green algae commonly referred to as "sea lettuce". It's scientific name is *Ulva lactuca*, and it's actually a macro-algae found sprouting along coastlines all over the world. Its cellulose content has made the algae especially interesting to science and industry—mostly because, sea lettuce, unlike wood, contains no lignin. This makes the energy- and chemically intensive process of de-lignification unnecessary—and it makes extracting cellulose easier overall. Just how easy?

Researchers from Sweden recently obtained highly pure cellulose and cellulose nanofibrils from freeze-dried bits of the algae using little more than a coffee grinder, water, ethanol, and minute amounts of hydrogen peroxide. Though simple, their method produced nanofibrils composed of up to 90% cellulose. The researchers verified their results using an innovative technique known as optotracing. Unlike more destructive methods for determining composition, this method uses optically active molecules, or optotracers, to quantify the polymeric sugar content of raw algae and its extracts. That allowed the team to make a seemingly small but critical distinction: that their aquatically sourced cellulose was indeed cellulose and not a hybrid of xylose and glucose. Making this distinction was previously impossible, as these plant sugars share extremely similar structures and analysis almost always involves sample destruction. New sources of aquatic-based biomass could help alleviate society's dependence on fossil fuels and reduce the production of chemical waste. Coupled with novel tools, such as optotracers, that help researchers in both industry and academia probe biomass like never before, hidden gems such as "sea lettuce" could be pivotal in the push toward the circular economy envisioned by the 2030 Agenda.