UMaine Researchers Develop Recyclable Nanocellulose Food Containers

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Takeout food is more popular than ever, but waste created by single-use plastic containers is environmentally harmful. University of Maine engineers have created a grease-proof, water-resistant container from recyclable cellulose nanocomposites that could be the next big thing in takeout technology.

The demand for takeout, fast food and ready-made food has created an enormous plastic problem. Plastic takeout containers are useful because they are sturdy, grease-resistant and water-resistant, so they can hold a variety of foods without leaking. However, plastics are not biodegradable, and thus create an increasingly massive amount of waste.

A 2021 Swedish study showed that approximately 80% of marine wastes are plastic wastes, and of that, 70% are single-use plastics such as disposable plates, bottles and straws.

Pulp and paper-based containers are more environmentally friendly because they break down over time, but they are much less resistant to water, oil and grease. Applying a coating of plastic can improve these qualities in the containers, but they make the containers more difficult to recycle. Other methods for improving water, oil and grease resistance, such as adding substances like PFAS, pose serious health concerns and environmental hazards.

To address this problem, a group of UMaine researchers developed containers out of recyclable wood composites with a new coating made of lignin-containing cellulose nanofibrils, which improves the quality of the containers for takeout purposes while allowing the container to be properly recycled without the health risks imparted by plastic coatings or PFAS.

“Research in my lab has been focused on two main topics: using cellulose nanomaterials as binder in composites for building and automotive applications, and producing renewable packaging materials with barrier properties against oxygen, water, oil and grease,” says Mehdi Tajvidi, co-author of the study and associate professor of renewable nanomaterials at UMaine. “This work essentially combines these two topics by coating a grease-proof layer of lignin-containing cellulose nanofibrils on a thin wood-flour composite bonded with nanocellulose.”

The containers are constructed from cellulose nanofibril and lignin-containing cellulose nanofibril wood flour composites, which producers have recently shown interest in because they are non-toxic, biodegradable, strong, stiff and resistant to oil and grease.

Normally, though, these materials aren’t very water resistant, which is an important quality for takeout containers. UMaine researchers found that alum — a substance long used by the paper industry to increase particle retention — improves the materials’ water resistance for the length of the food container’s expected use.

The improved containers were also found to be fully recyclable. Researchers could disintegrate the samples and reform them, and the composites would retain their structure and oil- and grease-resistant properties.

The findings could have direct consequences for Maine. In 2021, Maine banned the use of disposable polystyrene takeout containers. A wood-based nanocomposite container could be an alternative for restaurants throughout the state.

There is a market for such a container beyond Maine, too. According to a 2020 study from Acumen Research and Consulting, the market value of the plastic-free disposable plates is expected to grow at a compound annual growth rate of 5.6%, eventually reaching a value of $5.96 billion in 2027 as consumers are increasingly concerned about plastic waste.

The study detailing the development and testing of the container was published in February

2022 in the journal Cellulose. The other UMaine co-authors of the study are Rakibul Hossain, Ph.D. student; Douglas Bousfield, director of the Paper Surface Science Program; and Douglas Gardner, professor of sustainable materials and technology in the School of Forest Resources and Advanced Structures and Composites Center.

“We are working with UMaine’s Process Development Center, which hosts a state-of-the-art fiber thermoforming machine, to evaluate if our material system can be processed using this fully automated system to produce food containers. This will be a huge step to showcase the feasibility and industrial relevance of the work we have done so far,” Tajvidi says.

Read the original article on University of Maine.