ADVERTISEMENT FEATURE

FOCAL POINT ON BIOPLASTICS IN JAPAN

PRODUCED IN PARTNERSHIP WITH KANAZAWA UNIVERSITY

BREAKING DOWN JAPAN'S APPROACH TO BIOPLASTICS

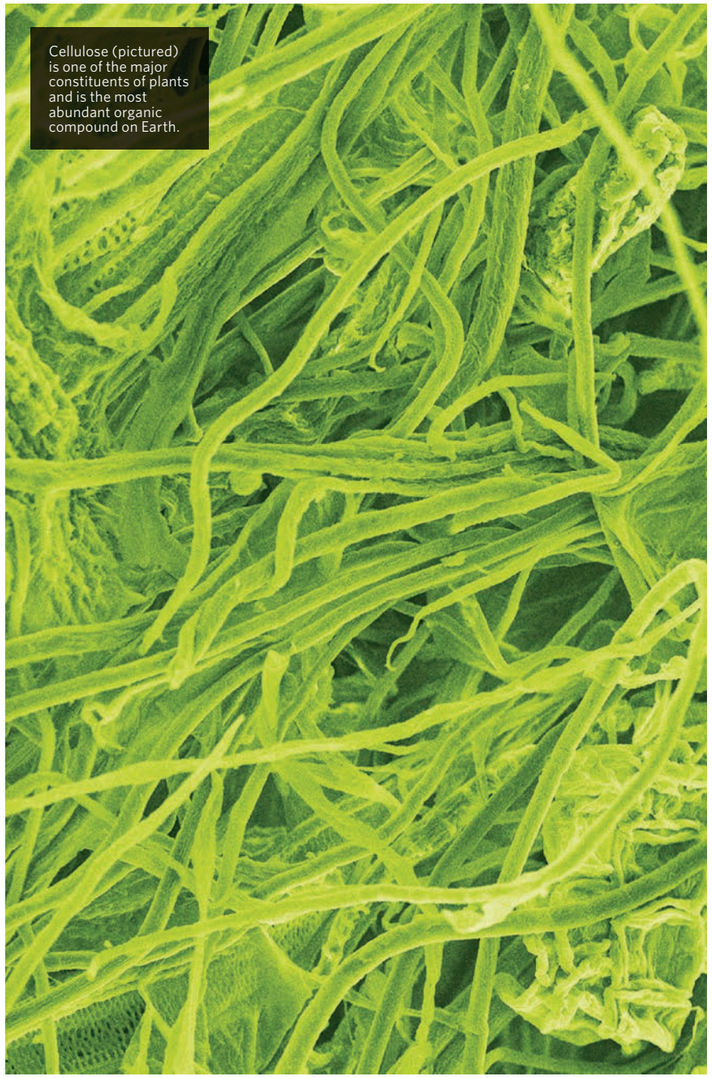
CELLULOSE NANOFIBRES could change the picture of plastics in Japan.

A futuristic car on display at a bustling Tokyo Motor Show in early 2020 was an unlikely poster child for sustainable plastics. The sleek lines of the experimental vehicle, which was commissioned by Japan's Ministry of the Environment, were sculpted from composite materials containing cellulose nanofibres — a plant-derived 'bioplastic' that provides huge structural strength at just a fraction of the weight of steel.

For Japan, the second-largest consumer of plastics per capita in the world, and the third-largest manufacturer of cars, the bioplastic vehicle represented a significant clue towards the future direction of a nation that is hoping to barrel towards net zero by 2050.

Plastics, which are mostly made from petrochemical resources, have a significant carbon footprint, with their production accounting for 3.4% of the world's annual greenhouse gas emissions, explains Kenji Takahashi, a professor at Kanazawa University. Furthermore, as they can take centuries to break down, they are a major contributor to the world's pollution. Some estimates suggest that by 2050 plastic in the world's oceans may weigh more than fish.

Bioplastics are a potential solution, but they are a confusingly broad group of materials. These materials can be low-emission to produce; are often made from renewable plant resources, such as corn starch or sugar beet molasses; are sometimes created with the aid of microbes; and may or may not be easily biodegradable. However, materials made from petrochemicals, such as oil extracts, which are able to biodegrade much faster than conventional plastics, have also been called bioplastics.



Cellulose (pictured) is one of the major constituents of plants and is the most abundant organic compound on Earth.

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The Plastic Resource Circulation Act went into effect in Japan in April 2022. It outlines a plan that should eventually lead to a new certification mechanism for **PLASTICS WITH SUSTAINABLE LIFECYCLES**.

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In 2021, Japan called for the amount of bioplastic products in local markets to increase from 45,000 tonnes to **1.8 MILLION TONNES BY 2030**.

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CELLULOID DREAMS

One of the most abundant base materials for bioplastics is cellulose, which is responsible for the structural rigidity of plant cell walls, says Takahashi. But most plant-derived bioplastics are made from starch, which has fewer bonds between its glucose building blocks than cellulose, meaning it is easier to break down into useful forms. Starch, however, is often sourced from materials that could be used as food, which means it could compete for important agricultural land and contribute to problems of fertilizer pollution. As a result, many researchers in Japan are now looking more seriously at cellulose.

"Europe has focused on starch-based bioplastics, but bioplastics made from cellulose nanofibres from plants are stronger — we hope to use them for car parts and office furniture, among other things," says Takahashi.

His university, located on the west coast of Japan's largest island, is leading a government-funded project called COI-NEXT, which is harnessing globally abundant cellulose polysaccharides to create bioplastics.

The earliest plastics, created in the mid-1800s, were made from cellulose, but were later largely replaced by synthetic petrochemical polymers extracted from oil. Today, cellulose bioplastics make up just a small portion of the emerging bioplastics market.

Data suggest that only about 3% of European-produced bioplastics are cellulose films, used as coatings for products such as vehicle parts. Europe currently leads the world in bioplastics, accounting for 43% of global revenue in 2021.

In addition, the raw materials for cellulose-derived bioplastics are typically cotton and wood pulp, says Kyoto University's Hiroyuki Yano. He helped found the project to produce the futuristic bioplastic car, which used cellulose nanofibres from a type of soft wood pulp.

Takahashi's team wants to produce cellulose bioplastics from agricultural waste, such as leftover banana stems and sugar beet pulp. Cellulose from these crops is harder to process than that from wood pulp, however.

To help solve this, Takahashi's group are pioneering work on 'ionic liquids', which are melted salts that can act as solvents to help extract cellulose from agricultural waste without the corrosive chemicals usually needed.

Japanese scientists are also experimenting with bacterially-derived cellulose nanofibre lattices made with the help of agricultural waste. These can add structural strength and water resistance to the existing range of bioplastics properties, but large-scale production is yet to be fully developed.

Japan has committed to becoming carbon neutral by 2050 — a goal that is becoming increasingly important to businesses facing possible carbon-related taxation and penalties.

Because they are low-emission to produce, bacterial cellulose nanofibres are of increasing interest to the automotive industry, says Yano. "Car manufacturers are also starting to see cellulose nanofibres in a similar light to carbon fibres, which can reduce vehicle weight and improve fuel efficiency," he adds.

Biodegradable bioplastics will also help tackle plastics pollution. In 2019, while Japan was hosting the G20 summit of wealthy nations, the island nation presided over an agreement to eradicate marine plastic litter by 2050.

Japanese researchers are now working towards this goal with cellulose-based bioplastics that can biodegrade in seawater or soil. But many bioplastics will still require some specialized recycling and composting, and so until facilities can be scaled up, the potential pollution benefits can't be realised.

But with the global market for bioplastics expected to grow by at least 17% every year until 2030, interest and investment is tipped to skyrocket, and Japan's manufacturing sector may be poised to benefit. ■

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The Japan BioPlastics Association is working to establish a new identification and certification system specifically for **MARINE BIODEGRADABLE PLASTICS** within the next few years.