New methods show promise for boosting rubber production in US

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Ohio State scientist Katrina Cornish has a greenhouse full of the desert shrub guayule on the Wooster campus, where she hopes to one day build a full-scale latex processing plant. Credit: Katrina Cornish

With disease and high demand posing threats to the world's primary

natural rubber supply in Southeast Asia, scientists are working to ramp up the U.S. rubber market by advancing methods to extract latex from two sustainable North American plant sources: a dandelion species and a desert shrub.

Researchers reported their methods to improve efficiency and increase latex yield in two recent publications, building upon decades of research led by Katrina Cornish, professor of horticulture and crop science and food, agricultural and biological engineering at The Ohio State University.

Cornish and colleagues have added specialized agents during processing of the Taraxacum kok-saghyz (TK) dandelion and the guayule shrub to coax a higher amount of latex from both plants. Neither source can simply be tapped—the method used on tropical trees that produce the only commercially available natural rubber in the world.

"We need to have efficient extraction methods for any and all alternative natural rubber-producing species, especially at a large scale," Cornish said. "And they have to be low-cost if you're going to be able to compete in the tire market in the long term."

The TK dandelion work was published recently in *Industrial Crops and Products*, and the guayule research in *Environmental Technology & Innovation*.

Beyond tires, rubber has applications in an estimated 50,000 products. The need is urgent for a domestic natural rubber industry: While the United States produces synthetic rubber, it is entirely dependent on imports for natural rubber. In 2019, 10% of the natural rubber supply was lost to disease—and the risk for transmission of South American leaf blight to Southeast Asia has increased with the expansion of direct airline travel between Brazil and China.

It is not an overstatement, Cornish said, to suggest that if leaf blight were to make it from South America to Asia, the disease could wipe out most of the world's natural rubber supply in short order.

"And then we could see the collapse of the world's supply chains, and subsequently, entire economies," she said. "We've concentrated an entire global industry around a tropical plant. But TK dandelion and guayule are sustainable and can grow in temperate conditions."

Guayule latex comes from generalized cells in the shrub's bark. Extracting the latex involves grinding up the bark to break open its cells and release latex particles into what Cornish calls a "milkshake." A series of washing and spinning cycles follow to separate the latex from other solid material—and with each centrifugation step, some latex is lost.

The research team found that adding chemical substances called flocculants to the milkshake helped bind other solid materials together and separate them from the latex, effectively cutting the washing cycles in half and improving the overall latex yield. The addition of one substance doubled the available latex and that yield was increased by 12-fold when a creaming agent was added for purification.

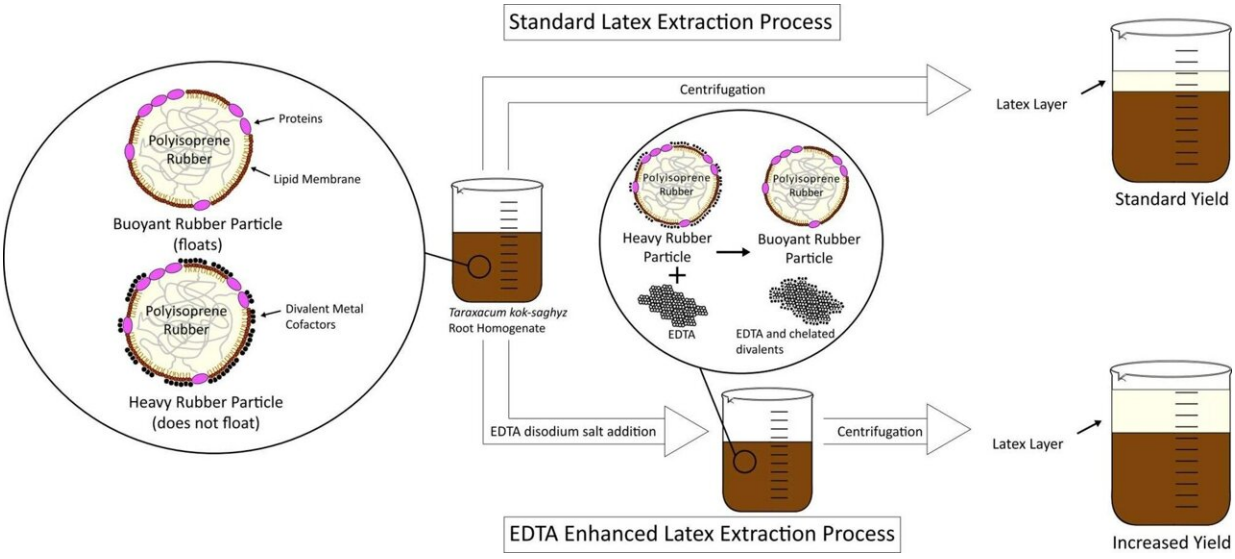
"By adding flocculants, latex extraction is more efficient and clean," said first study author Beenish Saba, a postdoctoral researcher in food, agricultural and biological engineering at Ohio State. "We found specific flocculants that work best at improving the quality of latex extraction and reducing the time it takes."

The study also showed that feeding the remaining solids back through the processing system enabled extraction of even more latex and also reduced the environmental footprint of the entire operation, Saba said.

Guayule contains a particularly attractive high-performance latex that is stronger and softer than any other known polymer, Cornish said, meaning more filler can be added in production without any loss of its valuable properties. She used guayule latex to develop the first hypoallergenic medical glove to block both radiation and pathogens.

Though TK dandelion latex is produced in the plant's roots, the extraction process is similar—the roots are trimmed, blended into a slurry and filtered to remove solid chunks of plant material and dirt. Latex floating on the top of the remaining liquid is slurped up with a pipette and rinsed up to three times for purification, and then dried.

A bit of serendipity led to the improvement to this extraction method. First author Nathaniel King-Smith, a graduate student in Cornish's lab, found that processed samples sitting in the lab for three months had significantly more latex floating on their surfaces. An analysis showed that heavy divalent cations, like magnesium, bound to the latex particle membranes weighed down the particles—until the connection eventually collapsed.



Graphical abstract. Credit: *Industrial Crops and Products* (2023). DOI: 10.1016/j.indcrop.2023.117698

The team found that adding EDTA, a chelator that binds to divalent cations, to processing the dandelion roots allowed for extraction of more than twice as much latex than was extracted without the addition of EDTA.

"Our question was, how can we free up the heavy fraction without waiting three months for rubber particles to suddenly become lighter and float?" King-Smith said. "We found that the extra latex yield after months of storage could be achieved immediately in a standard extraction just by adding EDTA before spinning."

The use of EDTA also increased the gel content of the extracted latex once it was dried—useful information for potential production by industries that are looking for higher-gel rubber, he said.

EDTA may turn out to be applicable to latex extraction from guayule, though Cornish said her lab hopes to partner with flocculant chemists who could help further refine that process. She has been planting, harvesting and extracting latex from TK dandelion for over a decade in Ohio and has a greenhouse full of guayule on Ohio State's Wooster campus, where she hopes to one day build a full-scale latex processing plant.

"We are working on a small scale and focusing on premium latex markets where you can make something of great value with minimal materials so that we can fund expansion," she said. "And in the meantime, we're making extraction more efficient so we can make the

material clean and pure."

Co-authors of the guayule paper included Cindy Barrera and David Barker of Ohio State. Co-authors of the TK dandelion paper included Kristof Molnar, Joshua Blakeslee, Aswathy Pillai and Judit Puskas of Ohio State, Colleen McMahan of the USDA-Agricultural Research Service and Meirambek Mutalkhanov of Al-Farabi Kazakh National University.

More information: Nathaniel King-Smith et al, Extractable latex yield from Taraxacum kok-saghyz roots is enhanced by increasing rubber particle buoyancy, *Industrial Crops and Products* (2023). DOI: 10.1016/j.indcrop.2023.117698

Beenish Saba et al, Base-dependent flocculant treatment improves the extraction of latex from guayule, *Environmental Technology & Innovation* (2023). DOI: 10.1016/j.eti.2023.103388

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