Popular foods like oranges and chocolate are being threatened by plant diseases.

Plant 'Vaccines' Could Save Us From a World Without Fruit

RESEARCHERS ARE FORMULATING UNCONVENTIONAL SOLUTIONS FOR TREE DISEASES THAT IMPACT BELOVED FOODS LIKE ORANGES AND CHOCOLATE. THESE INCLUDE A POTENTIAL RNA THERAPY SIMILAR TO COVID-19 VACCINES.

A future in which chocolate, wine and oranges are affordable only for the wealthy certainly feels dystopian. But this may very well become reality, as some of our favorite crops are now in danger of succumbing to plant diseases. To tackle the problem, Anne Elizabeth Simon, a virologist at the University of Maryland, is attempting to create what she calls a vaccine for perennial crops, which could help protect our food supply.

Researchers have long dealt with pathogen spread among plants by quarantining infected flora to spare surrounding ones. And, depending on the type of disease, plants may also receive pesticides or antibiotic sprays. But to create more reliable protection, Simon is part of a team developing a vaccinelike solution as an efficient and relatively quickly deployable way to preempt, or possibly cure, plant diseases.

This potential fix can't come fast enough. Currently, the world grapples with increasing perils to vital agricultural sectors. For example, cacao grown in West Africa, which provides about 70 percent of the world's chocolate, faces the debilitating cacao swollen shoot disease (CSSD). Florida's quickly spiraling

FROM TOP: KAREN GRIGORYAN/SHUTTERSTOCK; IVAN_KISLITSIN/SHUTTERSTOCK

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citrus industry is threatened by the disease huanglongbing (HLB) — commonly called citrus greening — which has wreaked major havoc since 2005.

Of course, plant pandemics are no new challenge. In the first half of the 20th century, for instance, a disease caused by fungus killed about 4 billion American chestnut trees. But overall, climate change, emerging pathogens and human activity, such as ramped-up global travel, have combined to create a perfect storm that endangers our food supply. "The time has come to let people know that there are other pandemics going on," Simon says. "There's multiple pandemics happening with trees, and it's going to lead to a very different world."

TREE "VACCINES"

Simon joined the fight against plant pathogens by chance: While studying plant RNA viruses in her lab, she happened upon a surprising sample in a genetic sequence database that would change the direction of her career.

It turned out to be a new type of viruslike RNA that she named iRNA. Simon was shocked to see that while this iRNA lacked the genes to code its own plant-generated movement proteins, it was still able to move between cells in a plant's veins — contradicting her 30 years of research. Tweaking the iRNA to carry tiny fragments of a virus can provoke plant enzymes to chop up the harmful virus into little pieces, without causing damage to the plant. "This could be a vehicle, and not just for one type of tree, but for many," Simon says. "It's all because of this very unusual, never-before-seen property."

The iRNA sample was first discovered by University of California, Riverside, researchers in the 1950s when it appeared in limequat trees. They found that the iRNA can infect many citrus species with very mild to zero symptoms. Yet its disease-fighting capabilities were only recently discovered when Simon realized iRNA's ability to co-opt its host plant's proteins to move from cell to cell.

Eager to get the ball rolling, Simon co-founded a company called Silvec Biologics in 2019, and is working to develop a single-step preventative treatment that tricks trees into eradicating not only viruses that cause disease, but also fungi and bacteria — somewhat similar to how mRNA jabs force our immune systems to cook up COVID-19 antibodies.

Because iRNA stays in trees for decades, Simon says the vaccine could possibly offer lifetime protection against several pathogens when put into newly planted trees — similar to giving children a standard set of shots. What's less clear, however, is whether highly degraded trees that have been infected for several years can still benefit from the treatment.

Simon hopes that the iRNA therapy can save infected trees that don't yet show symptoms. It seems less likely for those with roots disintegrated by disease, like a growing number of Florida's citrus trees. Even if the vaccine did work in those cases, she says, they would be too weak to recover.

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AIDING AILING PLANTS

Simon's team isn't the only one developing novel techniques to fight devastating plant diseases. Some researchers have, for example, adapted relatively new technologies to take on these threats. In recent years, scientists have proposed genome-editing techniques like CRISPR for this purpose. By manipulating specific portions of plant DNA, CRISPR could allow breeders and researchers to work more precisely when designing disease-resistant varieties.

Ultimately, it will likely take a combination of approaches to keep our food system resilient to current and emerging diseases — just as we have combined masking and social distancing, along with various treatments and vaccines, to work against COVID-19. But if scientists, governments and growers don't combine forces quickly enough, it's possible that certain food production costs will skyrocket and affect consumer prices. Florida's per-box orange price, for example, rose by more than 90 percent between 2003 and 2018 when adjusted for inflation.

This orange comes from a tree infected with citrus greening disease.

That's why Simon says plant epidemics require a Manhattan Project of sorts, where scientists can bring their minds together and offer their individual expertise. Georgios Vidalakis, a plant pathologist at the University of California, Riverside, and director of the Citrus Clonal Protection Program, agrees. "The clock is ticking and we won't have decades to spend on this," he says. "It has to happen soon."

—MOLLY GLICK

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