Apple trees' natural response to virus mirrors genetic modification mechanism, study shows

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Apple trees respond to a common viral infection by targeting a gene in the same pathway that genetic scientists are aiming at, find scientists from The University of Manchester. The discovery published in *Current Biology* shows that the fruit trees, which develop rubbery branches when infected, mirror how scientists are trying to genetically modify trees.

Apple rubbery wood virus (ARWV), which causes apply rubbery wood disease, is now largely—if not totally—eliminated from commercial apple trees. However, an extensive survey in the UK during the 1950s when ARWV was widespread revealed that in some cases, over 50% of apple trees sampled were infected with the virus. The widespread presence of the virus across the globe is well documented.

Though their branches become more flexible, no adverse effects to humans who have eaten fruit from the infected trees have been recorded and there have been no adverse environmental consequences.

The study also provides important insight into how scientists might one day be able to process woody plant tissue so that it efficiently produces sugars needed for biofuels. Woody plant material represents a vast renewable resource that has the potential to produce biofuels and other chemicals with more favorable net carbon dioxide emissions. However, scientists haven't yet worked out an efficient way to release its substantial store of sugars, estimated to be at around 70%.

The scientific team showed that the symptoms of ARWV infections arise from a reduction in lignin—a complex organic polymer that forms key structural material supporting the tissues of most plants.

Using next generation sequencing (NGS) to analyze the expression of all the genes in the rubbery apple tree branches, they discovered that phenylalanine ammonia lyase (PAL), an enzyme responsible for lignin biosynthesis, was suppressed by the plant in response to the infection.

The response to ARWV infection results in the plant generating multiple small interfering RNAs, known as (vasiRNAs). The vasiRNAs then target several of the plant's own genes to be downregulated—or degraded—in what is assumed to be part of an antiviral defense response.

One of the genes downregulated by the plant is PAL, and this leads to the decrease in lignin biosynthesis that gives the increased flexibility of the branches and facilitates the release of sugars.

The mechanism used by the apple rubbery wood virus to alter lignin closely resembles how scientists have been altering lignin in genetically modified trees to make it easier to process. Despite the altered lignin, the trees manage to grow normally.

Lead author Professor Simon Turner said, "Widespread genetic engineering of many plants is limited by regulatory hurdles and public opposition, and this appears particularly true for trees. These research findings offer an important contribution to that debate.

"It is apparent from our work that technologies considered as new and under regulatory oversight exhibit similarities to events considered to occur naturally.

"It seems that unbeknown to us, the ARWV infections have been performing something akin to a huge field trial.

"Since the disease has been present across the globe for many decades, even conservative estimates would suggest that many thousands of infected apple trees were propagated.

"Millions of apples from ARWV-infected trees were eaten with no known adverse health or environmental consequences despite the siRNA-induced alterations in lignin caused by the plant's response to the virus."

He added, "Currently, the biofuel industry uses huge areas of agricultural land to produce corn starch that is used to generate 60 billion liters of bioethanol.

"That's relatively inefficient in terms of CO_2 savings, but may also impact on global food production systems.

"But our increased understanding of this mechanism may one day unlock the potential to isolate the sugars within the woody tissue, making the production of biofuels much more efficient."

More information: Holly Allen et al, Flexible and digestible wood caused by viral-induced alteration of cell wall composition, *Current Biology* (2022). DOI: 10.1016/j.cub.2022.06.005

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