

Identification of genes responsible for sour taste in citrus fruit may enable the creation of new, sweeter varieties

February 27 2019, by Sarah Nightingale



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A team of researchers, including two from the University of California, Riverside, has identified the genes responsible for the hallmark sour taste of many citrus fruits. Published Tuesday, Feb. 25 in *Nature Communications*, the research could help plant breeders develop new,

sweeter varieties.

Modern citrus varieties have been bred over thousands of years to generate a broad palette of sour and sweet-tasting fruits. Analyses of their pulp reveals that a single chemical element—hydrogen—is largely responsible for the difference between sour and sweet-tasting varieties, which usually have similar sugar content. The pulp from sour fruits contains more hydrogen ions, giving it a lower pH and a tangy taste that is recognized by acid-sensitive cells in our taste buds. Conversely, pulp from sweeter varieties contains fewer hydrogen ions and tastes less acidic.

Ronald Koes and colleagues at the University of Amsterdam in the Netherlands set out to untangle how some citrus varieties wind up with more acidic juice than others, a process that until now has remained a mystery. Their interest stemmed from a previous study showing that higher acidity in purple petunia flowers resulted in more petal pigmentation.

Intrigued by the Faris variety of lemon tree, which produces branches bearing both sweet and sour fruits, and white and purple-tinged flowers, Koes' team turned to UCR plant scientists Mikeal Roose and Claire Federici. Using the university's vast Citrus Variety Collection, which preserves over 1,000 living citrus and related fruit varieties, Roose and Federici selected the Faris lemon and 20 other citrus fruits ranging from wincingly sour to sugary sweet for Koes' team to analyze.

By studying the expression of [genes](#) related to those controlling acidity in petunias, Koes' team identified two citrus genes, CitPH1 and CitPH5, that are highly expressed in sour varieties and weakly expressed in sweet-tasting varieties. The CitPH1 and CitPH5 genes encode transporter proteins that pump [hydrogen ions](#) into the vacuole, a large storage compartment inside juice cells, thus increasing their overall acidity.

Next, the team turned its attention to genes that control the levels of CitPH1 and CitPH5 in juice cells. While down-regulation of CitPH1 and CitPH5 in sweeter tasting varieties arose multiple times independently in different varieties, the researchers found that mutations in genes for a handful of transcription factors (proteins that help turn specific genes on and off) were responsible for reduced expression of CitPH1 and CitPH5, and therefore a sweeter taste.

Roose, a professor of genetics in UCR's College of Natural and Agricultural Sciences, said the findings could help breeders develop better-tasting citrus fruits. However, he said breeding varieties with severe mutations in the transcription factors such as those studied in the "acidless" citrus would be "overkill," producing sugary citrus fruits with none of their popular acidic kick. Instead, plant scientists should look to target mutations that have a less dramatic effect on the production and activity of transporter proteins.

"By understanding the mechanism acidification of [fruit](#) cells, we can now look for related genes that might reduce the expression of CitPH1 and CitPH5 just enough to engineer or select for new, sweeter varieties," Roose said.

The title of the paper is "Hyperacidification of Citrus fruits by a vacuolar proton-pumping P-ATPase complex."

More information: Pamela Strazzer et al. Hyperacidification of Citrus fruits by a vacuolar proton-pumping P-ATPase complex, *Nature Communications* (2019). [DOI: 10.1038/s41467-019-08516-3](https://doi.org/10.1038/s41467-019-08516-3)

Provided by University of California - Riverside

Citation: Identification of genes responsible for sour taste in citrus fruit may enable the creation of new, sweeter varieties (2019, February 27) retrieved 19 September 2024 from <https://phys.org/news/2019-02-identification-genes-responsible-sour-citrus.html>

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