No rotten tomatoes—Can genetic engineering help create a tastier but still hardy fruit?

For many people, biting into a sweet, ripe tomato is one of summer's great pleasures. But too often, that bite yields a mealy, cardboard sensation with little to no taste.

It didn't have to be this way; in fact, a riper, sweeter tomato was the first genetically modified food made available. It also became the poster child for the battle between advocates of transgenics and anti-GMO activists.

The first commercial GM crop, the Flavr Savr tomato, had been approved by the USDA, FDA in 1994 as well as in Japan, Mexico and the European Commission after years of laboratory and field testing, and was initially popular on both sides of the Atlantic. It was sold (briskly) as a fresh fruit as well as processed puree. Then, in 1998, plant scientist Arpad Pusztai told British broadcasters at Granada Television that his then-unpublished work on potatoes showed that genetically modified food produced certain adverse effects. This interview became fodder for a growing organic food industry and more aggressive environmental activists who were interested in swaying public opinion on GMOs.

At the same time, Calgene, the company behind Flavr Savr, which had little experience in the grocery market, struggled with a host of problems, including pricing (the tomato was more expensive than other varieties), packing and distribution issues. The tomato chosen to genetically engineer was also not the most flavorful variety, which soured many consumers. Opponents of GM food seized the moment, as did organic marketers. Sales dropped like a rock. The GM tomato was discontinued in 1997, which led to a rescue takeover offer from Monsanto. According to anti-GMO critics, Monsanto's arrival "turned the whole GMO business into a secretive, patent-dependent business."

Since Flavr Savr, however, research has continued on making an optimal tomato. The challenges are significant—how do you make a fruit that ripens to a pleasant taste, but also is tough enough to be shipped for hundreds, perhaps thousands of miles? Ripe fruit isn't very stable, but tougher green fruit tastes like, well, green fruit. Currently, "ripening" doesn't occur on the vine for very long, because the pectin that gives fruit its rigid structure isn't given time to break down. Instead, fruit is picked when it's hard—and green. An artificial process involving ethylene gas makes the fruit redder, but doesn't also encourage the sweetness that comes from, for lack of a better term, decaying pectin.

The answers to these challenges are coming from traditional breeding as well as genetic modification:

- After years of breeding, selection and cross-breeding, University of Florida breeders arrived at Florida 8153 (more appetizingly called Tasti-Lee), which was the product of Florida 7907, which was sweet but too round for shippers and stores, and Florida 8159, which was firmer. The new hybrid carried the best traits of both parents. It also had an inherited bonus: Both parents carried the "crimson" gene, giving off a bright red color and high levels of the antioxidant lycopene.
- Last year, Cathie Martin of the John Innes Center in Norwich, England, led an international team that discovered a transcription factor named AtMYB12 could encourage the expression of genes that

boosted production of phenylpropanoids (including resveratrol, which is implicated but unproven in preventing heart disease and number of other maladies), which are beneficial to tomatoes themselves. The study showed how other beneficial chemicals could be boosted using less transgenic methods such as gene expression regulation.

- In 2013, Martin led a group that found that boosting levels of anthocyanin, an antioxidant that gives fruits a purple color, also could increase storage life of tomatoes. Significantly, the traits resulting in anthocyanin concentrations could be transmitted by either genetic engineering or by selective, traditional breeding.
- The enzyme polygalacturonase, which was the target of Flavr Savr antisense technology because of its ability to break down pectin and encourage ripening, remains the target of genetic and chemical studies. A group including tomato antisense pioneer Don Grierson from the University of Nottingham, UK, identified several more genes that regulate the expression of polygalacturonase.

The tomato's road always has been a bumpy one. First raised in the Andean mountains of Ecuador, Peru and Bolivia, the tomato was popular with Europeans, but was avoided in the United States until the mid-1800s because Americans believed the fruit was poisonous. Over the decades, we've had tomatoes from Florida (aside from the Tasti Lee), which gave store-bought tomatoes their cardboard taste; shade-house grown Mexican tomatoes, which could be picked and shipped in a riper state than those from Florida; and on-the vine hothouse tomatoes, which are riper than any other, but more expensive and hard to ship very far. Heirloom fruits (which usually have very old ancestral roots) have also entered the fray, but suffer from over ripening and aren't necessarily well-flavored. Research on the optimal tomato is following a number of directions; there may very well never be one answer.

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