



ScienceWatch – In Search of Real Tomatoes

“Think of the tomato flavor as a symphony with lots of notes. Over the last 50 years, they removed one instrument at a time.” – H. Klee

Wouldn't you like to eat a great tasting tomato? So would I! Over the last 50 years growers have bred tomatoes (*Solanum lycopersicum*) for color and size to make them more appealing. They also selected for disease resistance to allow for long-term storage, and firmness so the fruit can be shipped without getting bruised. Sadly for us they forgot about flavor, ending up with a cardboard-tasting facsimile lacking the bouquet that tomatoes once had. But help is on the way.

Now a paper published in the January 27, 2017 issue of *Science* provides a genetic roadmap to restoring the tomato flavor that has disappeared over the last 50 years. The research team, headed by Harry Klee, a professor of horticultural science at the University of Florida, Gainesville, FL, has spent years figuring out what makes a tomato taste great. They have identified the chemicals that make a tomato taste delicious. They have also tracked down the genes responsible for these flavor components and now are using traditional breeding methods to put them back in store-bought tomatoes.

The team collected 398 types of tomatoes, including modern, wild (before human intervention) and heirloom varieties. They sequenced the full genomes of all 398 types and measured the levels of sugars, acids and volatile chemicals that contribute to flavor. Sugars and acids in the right amounts provide a tasty balance of sweet and sour. Volatile chemicals, which are present in barely detectable amounts, are important flavor compounds that not only contribute to taste, but are also responsible for the fruit's aroma.

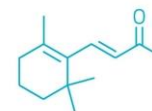
The researchers presented 160 tomato samples to a taste panel comprising 100 people to determine which were most flavorful. Knowing the genetic profile of each sample, they could determine which gene versions (alleles) made tomatoes taste good or bad. Unlike bananas, pineapples or strawberries, tomato flavor is not determined by one dominant substance. Instead, a flavorful tomato is a blend of chemicals, each at just the right level. “There are 30 or more compounds that give us flavor in tomato. [It] is much more complex in that flavor is really a melting pot of lots of different chemicals that together makes you think, this is a tomato,” said Klee.

Sugars like glucose and fructose are important flavor components but the team found that the genes that produce higher sugar levels were lost as tomatoes were bred for size. Evidently, the energy generated by photosynthesis and used to make larger fruit is taken away from the energy converted to sugar.

The researchers found 26 genes that produce volatile chemicals with strange names like geranylacetone, β -ionone and 6-methyl-5-hepten-2-



Geranylacetone



β -ionone



6-Methyl-5-hepten-2-one

one. Detecting these flavor components requires expensive assay techniques like gas chromatography that breeders don't have. As a result modern tomatoes gradually lost these genes because the focus was on color rather than these hard to find substances. The scientists found that 13 of 30 important volatile chemicals were significantly reduced in modern tomatoes.

Now the plan is to create tomatoes in which the undesirable alleles are replaced by flavor-yielding ones. The team will use traditional breeding techniques and not genetic engineering because regulations imposed on producing a GMO tomato would make it too expensive. "We are trying to push the flavor calendar back decades to recapture the characteristics that were present in tomatoes in the first half of the 20th century, said Klee. He predicts it will be fairly easy to raise the levels of volatile chemicals without impacting other important traits like disease resistance because the volatiles only need to be present at low levels. But since sweetness takes away from size, sweeter tomatoes will almost certainly be smaller.

"If we choose our genes wisely, which I think we have, I think we can deliver a product that tastes substantially better in about two years," Klee says. It might take an additional year or so for growers to start adopting the new variety, so Klee hopes it could get out to the public in three years

Most tomatoes are shipped green and ripened at their destination to prevent bruising. Therefore local growers who can let their tomatoes ripen before bringing them to market will probably change over first. Growers who ship long distances will switch only if consumers demand flavor over size and color and are willing to pay for it. These tomatoes may end up costing a little more, but they should be worth it. "I think [now] we know exactly how to make a much better flavor tomato and it's just a matter of time," said Klee.

I can't wait!

Saul Scheinbach