By uncovering its genetic journey,

researchers believe they can restore the flavour of the old-fashioned tomato

What is wrong with the ubiquitous and attractive supermarket tomatoes? For many city dwellers, the delicious taste of a succulent garden tomato is little more than a distant memory. The standard grocery varieties have grown larger and blander. Indeed, the decline in flavour quality of the modern commercial tomato compared to heirloom varieties is often the cause of consumer complaints.

***The colours of a rainbow appear after violent storms* [*source: PIXABAY* -** https://pixabay.com/**]**

To address the problem an international research team under the leadership of professor Harry Klee of the University of Florida performed a comprehensive study of the chemistry and genetics of tomato flavour. Tieman et al. [2017] identified the key flavour-enhancing genes that have dwindled or disappeared as the tomato changed over the years. These researchers also believe they are able to return their original taste to today's fresh market tomatoes.

Flavour is an intricate combination of what the tongue tastes and the nose smells. The flavour of any food item can be regarded as the sum of interactions between taste and olfaction. Taste is one of the five traditional senses that belong to the gustatory system, whereas olfaction is the sense of smell [Wikipedia]. For the tomato, sugars such as glucose and fructose and acids such as citrate and malate activate the taste receptors. On the other hand, a highly diverse set of volatile compounds including alcohols and aldehydes such as 3-methyl-1-butanol, *cis*-3-hexen-1-ol and hexanal activate the olfactory receptors [Tieman et al. 2012]. Volatiles in particular are essential for good flavour.

For commercial reasons, breeders predominantly focus on yield, disease resistance, and external appearance rather than flavour quality. Also, the fruit and vegetable flavour associated volatiles are present at nano to subnanomolar concentrations. They are difficult to identify and quantify and therefore, have received significantly less attention. Unfortunately, over recent decades, the strong

emphasis on production traits has inadvertently led to a decline in flavour quality. Several scientists also refer to the steadily declining nutrient content in cultivated varieties [Davis et al. 2004].

Breeders have selected plants to produce huge amounts of fruit. What they want is larger fruit on the plant. But since the plant cannot cope, what happens is a substantial dilution of the flavour chemicals. Putting tastier sugar back into mainstream tomatoes is simply not feasible with today's production. That is because growers are not paid for flavour, but per kilo. It costs just as much to have a worker pick a small tomato as it does to pick a huge one, which explains why commercially produced tomatoes are much more massive than their tiny wild ancestors.

Today, however, our first priority is no longer how well tomatoes ship and last on a shelf. The number one priority has now become to substantially increase fruit quality with minimal impact on yield.

Will scientists breed much better tomatoes by focusing on flavour genes? The answer is they soon will.

Step one was to identify the chemical tomato components that most contribute to taste. The researchers studied the alleles, i.e. the variants of a tomato gene located at a specific locus on a chromosome. Alleles induce specific traits. Most genes have two alleles, a dominant and a recessive one. In a certain sense, allele differences can be likened to DNA in humans. We all have the same number of genes in our DNA, but a particular version of each gene determines the specific characteristics, i.e. how heavy we are, how tall, whether we have blue or brown eyes and...

The aim of the study was to uncover why modern tomato varieties are deficient in those flavour chemicals; why they have lost the more desirable alleles of a number of genes. Researchers therefore had to identify the locations of the good alleles in the tomato genome. This required what is called a genome-wide assessment study.

Modern commercial tomato varieties were found to have substantially less flavour than heirloom varieties. To understand and ultimately correct this deficiency, the research team quantified flavour-associated chemicals in 398 modern, heirloom, as well as wild accessions. To include wild accessions and the closest relative of the commercial tomato provided a baseline for its chemical composition before human intervention. A subset of these accessions was evaluated in consumer panels to identify the chemicals that made the most important contributions to flavour and consumer appreciation. It was particularly obvious that modern commercial varieties contain significantly lower amounts of many of these important flavour chemicals than older varieties. The whole-genome sequencing and a genome-wide association study enabled the genetic loci to be identified that affect most of the target flavour chemicals including sugars, acids, and volatiles. Together, these results provide an understanding of the flavour deficiencies in the tomatoes we buy and the information necessary for the recovery of good flavour through molecular breeding [Tieman et al. 2017].

The scientists mapped the genes that control the synthesis of all important chemicals. Once they had found them, they used genetic analysis to replace bad alleles in modern tomato varieties with better ones. So it appears that it is possible to significantly improve our average, ordinary grocery tomatoes.

If these tomatoes could be improved, it would be a big gain for consumers, and this study outlines how to do so.

Will the high-taste, high-quality, and inevitably higher-cost tomatoes sell? Because breeding takes time, it may take three or four years before the genetic traits analysed in the present are actually produced in new tomato varieties. This sounds like great news. Let's not forget, however, that a really tasty tomato is one that ripens on the vine, and that post-harvest practices such as refrigeration can irreversibly damage flavour.

Super tasty tomatoes cannot be produced over long distances and cannot be stored in a grocery store for four weeks without rotting.

Remember also that prime quality comes at a price.

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