A future of flavorful tomatoes.

Modern tomatoes have poorer flavor than older heirloom varieties, and consumers often complain about the loss of flavor in modern tomatoes. Unfortunately, breeding for traits such as firmness for shipping, shelf-life and disease resistance, without actively selecting for flavor traits, has resulted in a deterioration of flavor. Tomato flavor is the result of interactions between sugars, acids and the unique combination of many aroma compounds that define tomato flavor. Without the optimum combination of all of these compounds, tomato fruit will not have the best flavor. In addition, breeding for flavor has been difficult because taste panels and quantification of flavor compounds is time-consuming and expensive.

Tomato has an interesting history in that it originated in Peru, was first domesticated there and then spread throughout northern South America, Central America and in to Mexico. Spanish explorers to the Americas first introduced tomato to Europe in the 16th century. These European tomato varieties were then carried back to North America by English colonists. As a result of these migrations, tomatoes lack much of the diversity seen in tomatoes found in South and Central America. Only a small amount of the diversity in tomatoes native to Peru was transported to Europe, where more selection occurred over time. Then, much of this diversity was lost again in the migration back to North America. By finding genes that were lost during these migrations, we can introduce some of the desirable flavor traits back in to modern tomato varieties.

By examining the genetic sequences of 725 tomato varieties including early, heirloom, modern and a close relative of tomato, Gao et al. have identified 4873 genes that are not present in a modern tomato variety. These genes were lost during both domestication and improvement of tomato cultivars. Some were lost as tomatoes were domesticated and spread from Peru to northern South America. More were lost as tomatoes spread to other parts of the world. The lost genes were related to diverse functions in the tomato plant and fruit, but especially plant defense responses and disease resistance. Some of these lost genes are also likely responsible for flavor compound production.

A change in the regulatory sequence of a gene called LoxC (lipoxygenase C) is correlated with lower amounts of several important flavor compounds. The rare sequence resulting in higher levels of flavor compounds was lost in many domesticated tomatoes. Loss of this sequence resulted in lower levels of aroma compounds. While over 90% of the tomato’s closest relative have the rare gene, only 2% of heirloom tomatoes have the rare version. This suggests this gene was lost during the domestication process. As the rare sequence affects many aroma compounds, introducing it in to modern tomatoes would be an efficient method of improving tomato flavor.

Further research is likely to identify more genes related to flavor in the lost gene sequences. Return of the lost traits to modern tomato could alter many important traits including flavor, disease resistance, shelf-life and stress tolerance. These newly identified genes will an important new source of diverse germplasm in tomato breeding programs.