sugars, acids, and volatiles, understanding the dependencies between these traits—and the extent to which they can be altered in concert—will require considerable further research.

Tieman *et al.*[1] identified cases in which the less favorable alleles of modern cultivars appear to have been unintentionally selected through breeding programs. For example, two compounds that may contribute negatively to flavor were linked to a fruit-ripening locus beneficial to growers. In another example, a SNP that lowers sugar content was located in a genomic region known to have been altered by a domestication process that created a larger fruit; the apparent inverse correlation between fruit sweetness and size was confirmed by additional experiments.

"This [study] explains quite clearly why breeding for yield alone doesn't result in a higher quality fruit, and it's the same for nutritional value as well." says Cathie Martin, a group leader in the Department of Metabolic Biology at the John Innes Centre in Norwich, UK, and professor at the University of East Anglia. "If you focus solely on yield, you have losses."

A promising direction for improving tomato flavor is manipulation of volatile content. Because volatiles are active at pico- to nanomolar concentrations, small increases in their concentrations may enhance flavor without sacrificing yield or fruit size. The new data on volatile-associated SNPs should have practical value for breeders.

Tieman *et al.*[1] only studied fruit that had been fully ripened on the vine. As their data are exploited for industrial tomato production, it will be important to consider that tomatoes are usually harvested unripe, to prevent damage during transport, and are later ripened by exposure to ethylene, a natural hormone gas. This treatment is not the same as ripening on the vine, and is partly responsible for the low sugar content of tomatoes in supermarkets, says DellaPenna. How volatile content changes as tomatoes ripen on the vine or in response to ethylene treatment are key questions for future research.

The dataset of Tieman *et al.*[1] provides a valuable roadmap for tomato improvement that may soon yield tangible results. "For the consumer, the good news is that when modern genetic and genomic information is initially applied to a breeding program, usually the first steps are likely to have a large impact, and with 400 tomato lines [sequenced], there will be plenty of resources to use," says DellaPenna. "Flavor is complex like an orchestra. Luckily, the tomato flavor symphony lost during past breeding efforts could be back relatively quickly."

Katarzyna Marcinkiewicz,
Locum Assistant Editor

1. Tieman, D. *et al. Science* **355**, 391–394 (2017).

Research Highlights

Papers from the literature selected by the Nature Biotechnology editors. (Follow us on Twitter, @NatureBiotech #nbtHighlight)

cryoSPARC: algorithms for rapid unsupervised cryo-EM structure determination
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