Tomato, tomat-oh!—understanding evolution to reduce pesticide use

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Dan Lybrand and Bryan Leong, MSU graduate students and study co-authors, examine glandular trichomes on the *Solanaceae* plant's leaf surface. Credit: Michigan State University

Although pesticides are a standard part of crop production, Michigan

State University researchers believe pesticide use could be reduced by taking cues from wild plants.

The team recently identified an evolutionary function in wild tomato plants that could be used by modern plant breeders to create pest-resistant tomatoes.

The study, published in *Science Advances*, traced the evolution of a specific gene that produces a sticky compound in the tips of the trichomes, or hairs, on the Solanum pennellii plant found in the Atacama desert of Peru—one of the harshest environments on earth. These sticky hairs act as natural insect repellants to protect the plant, helping ensure it will survive to reproduce.

"We identified a gene that exists in this wild plant, but not in cultivated tomatoes," said Rob Last, MSU Barnett Rosenberg Professor of plant biochemistry. "The invertase-like enzyme creates insecticidal compounds not found in the garden-variety tomato. This defensive trait could be bred into modern plants."

Last explained that modern cultivated tomatoes make fewer of the compounds found in wild plants because—unaware of their adaptive function—breeders removed undesirable traits such as stickiness.

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Bryan Leong, plant biology graduate student and co-lead author, is interested in how the wild plants evolved to be insect-resistant.

"We want to make our current tomatoes adapt to stress like this wild tomato, but we can only do that by understanding the traits that make them resistant," said Leong. "We are using evolution to teach us how to be better breeders and biologists. For example, how can we increase crop yield by creating a pest-resistant plant and eliminate the need to spray fields with insecticides?"

Advances in technology allowed the team to apply genetic and genomic approaches, including the CRISPR gene-editing technology, to the wild tomato plant to discover the functions of specific genes, metabolites and pathways. Using these new techniques, the team identified an invertase-like enzyme specific to the cells at the tips of the sticky hairs. Invertases regulate many aspects of growth and development in plants. In the wild tomato, the enzyme evolved to facilitate the production of new insecticidal compounds.

"It is a race over evolutionary time between the consumed and the consumers," said Leong. "Insects benefit by eating the plants. Yet, evolution favors plants that make more seeds and pass on their genes to another generation. We hope to take the defensive lessons plants already learned and apply them to existing crops."

This discovery is a step toward understanding the natural insect resistance of Solanum pennellii plants, which could enable introduction of this trait into cultivated tomatoes using traditional breeding practices.

"Plants are amazing biochemical factories that make many unusual compounds with protective, medicinal and economically important properties," said Cliff Weil, a program director at the National Science Foundation, which funded this study. "In this study, the authors found that a common enzyme has been repurposed for forming such compounds, giving us important insight into how life is able to bend existing tools for novel uses."

More information: "Evolution of metabolic novelty: A trichome-expressed invertase creates specialized metabolic diversity in wild tomato" *Science Advances* (2019). DOI: 10.1126/sciadv.aaw3754 , advances.sciencemag.org/content/5/4/eaaw3754

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