Tomatoes' crystal ball reveals evolutionary secrets

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Credit: Michigan State University

Michigan State University's Robert Last studies tomatoes. Specifically, he researches their hair, or trichomes.

For this study, he focused on a single type of molecule in trichomes - acylsugars. The secrets Last and a team of MSU scientists found from

studying these specialized metabolites open an evolutionary window for the emerging field of plant defense metabolism, insights that could lead to engineering advances for better pest resistance and human medicine.

There are an estimated 300,000 species of plants in the world, producing roughly more than a million metabolites. Plants use these molecules to grow, communicate with each other or to defend themselves against pests and disease. Humans benefit from many of these products for food, medicines and industrial uses. Thousands of core metabolites are found in every plant, but hundreds of thousands are more specialized and found only in specific groups of plants.

Acylsugars are an example of a group of specialized metabolites found only in the Solanaceae family, which includes tomato and petunia plants. These specialized metabolites have a wide variety of structures and are made by different enzymes working together to carry out a series of biochemical reactions.

"We sought to understand how this novel pathway originated and diversified across 100 million years of plant evolution," said Last, MSU Barnett Rosenberg Professor of Biochemistry and Molecular Biology and Plant Biology and the study's senior author. "This is our crystal ball, our view into evolution."

The crystal ball revealed that many of the enzymes that make acylsugars are "promiscuous," meaning that they could use a variety of molecules as starting points for their chemical reactions. This could be the key as to how the plants make a variety of acylsugars.

The scientists also discovered that many of the enzymes that make acylsugars are encoded by genes that were originally copies of other genes that have subsequently evolved new roles.

Deciphering these codes are important because tomatoes' acylsugars are natural pesticides. Engineering plants to produce acylsugars could reduce pesticide use in crop production. Additionally, some of these mechanisms could help make chemicals that have pharmaceutical value, including ones that treat cancer and heart conditions.

"Plants are master chemists, and we're only just beginning to understand the metabolic pathways that they use to produce these amazing compounds," said Last, who's also an MSU AgBioResearch scientist. "By understanding how the pathways evolved to produce these enzymes could lead to innovative ways to make valuable compounds on a large scale."

The MSU team of scientists contributing to this research included Gaurav Moghe, Bryan Leong, Steven Hurney and Daniel Jones. The paper is published in the current issue of the journal *eLife*.

More information: Gaurav D Moghe et al. Evolutionary routes to biochemical innovation revealed by integrative analysis of a plant-defense related specialized metabolic pathway, *eLife* (2017). DOI: 10.7554/eLife.28468

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