DNA demethylation explains how tomatoes convert their bitter toxins into something more palatable

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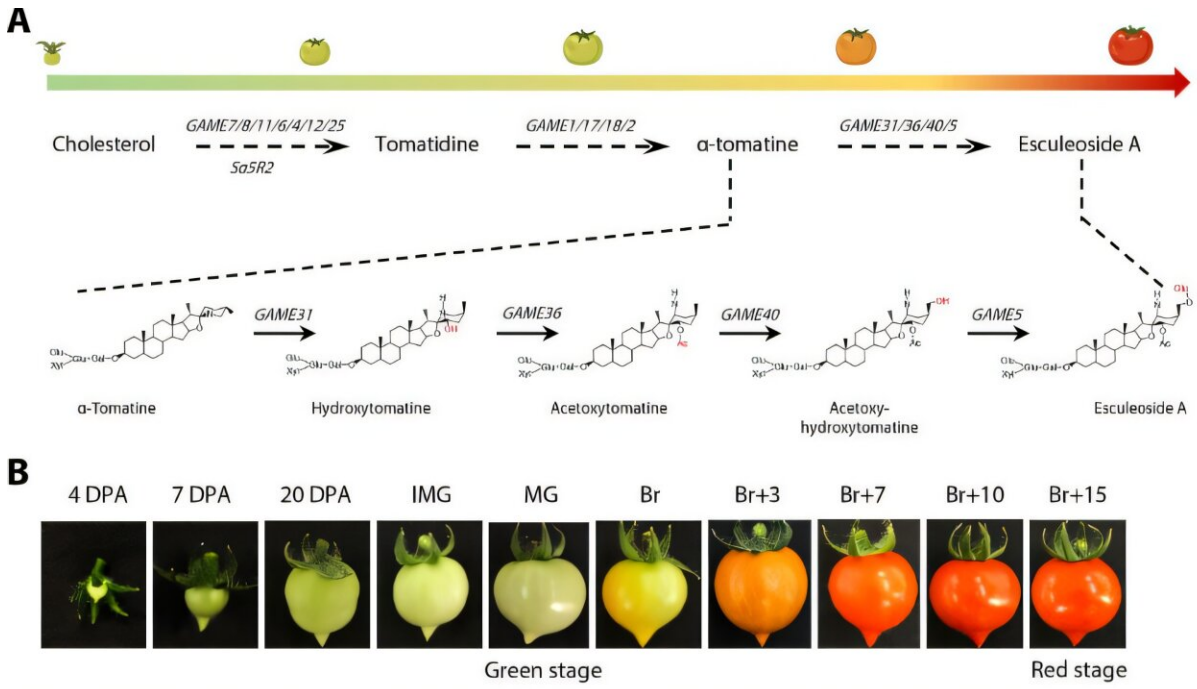

DNA methylation affects metabolic shifts in SGAs during tomato ripening. Credit: *Science Advances* (2025). DOI: 10.1126/sciadv.ads9601

A multi-institutional team of bioengineers has identified the genetic mechanism that converts bitter toxins to palatable compounds in tomatoes. In their study published in the journal *Science Advances*, the

group analyzed whole-genome bisulfite sequencing data obtained through other research efforts and conducted experiments in their lab that involved blocking the production of certain proteins to learn how tomatoes make themselves taste better to seed dispersers.

Prior research has shown that modern tomatoes are members of the nightshade family, which means that in their distant past, they were likely far more dangerous than they are today. Most members of the nightshade family become less poisonous as they mature, a development that encourages animals to eat them so that their seeds will be dispersed.

But the process by which this occurs has not been well studied. The research team focused their efforts on modern tomatoes, noting that during their early stages of development, they are not poisonous, but they are also not very palatable because they do still produce some amount of toxic steroidal glycoalkaloids. They chose to study tomatoes rather than other nightshade family members because much more genetic work has been done with them.

To learn about the natural conversion that occurs with tomatoes, the researchers searched databases for possible genetic clues. They found evidence suggesting that the same chemicals involved in causing tomatoes to ripen also work to break down glycoalkaloids into esculeoside A, a less toxic compound. The chemicals involved were proteins.

To find out what role proteins played in the conversion process, the researchers engineered tomato plants to turn their production on and off, allowing them to see what impact they had. They found one called DML2 that prevented the breakdown of glycoalkaloids when its production was turned off, leaving the fruit too bitter to eat. Further study showed that the protein was able to breakdown glycoalkaloids via a chemical process known as demethylation.

Looking at prior research data, the team found that as tomatoes became more domesticated over the past few centuries, demethylation increased, resulting in increasingly sweeter fruit.

More information: Feng Bai et al, Removal of toxic steroidal glycoalkaloids and bitterness in tomato is controlled by a complex epigenetic and genetic network, *Science Advances* (2025). DOI: 10.1126/sciadv.ads9601