Nectar: A sweet reward from plants to attract pollinators

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This is the ovary and nectary of a *Nicotiana* flower. Credit: Danny Kessler, Max Planck Institute for Chemical Ecology

Evolution is based on diversity, and sexual reproduction is key to creating a diverse population that secures competitiveness in nature. Plants had to solve a problem: they needed to find ways to spread their genetic material. Flying pollinators—insects, birds, and bats—were nature's solution. Charles Darwin's "abominable mystery" highlighted the coincidence of flowering plant and insect diversification about 120 million years ago and ascribed it to the coordinated specialization of flowers and insects in the context of insects serving as pollen carriers. To make sure the flying pollinators would come to the flowers to pick up pollen, plants evolved special organs called nectaries to attract and reward the animals. These nectaries are secretory organs that produce perfumes and sugary rewards. Yet despite the obvious importance of nectar, the process by which plants manufacture and secrete it has largely remained a mystery.

New research from a team led by Carnegie's Wolf Frommer, director of the Plant Biology Department, in collaboration with the Carter lab in Minnesota and the Baldwin lab in Jena, Germany, now identified key components of the sugar synthesis and secretion mechanisms. Their work also suggests that the components were recruited for this purpose early during the evolution of flowering plants. Their work is published March 16 by *Nature*.

The team used advanced techniques to search for transporters that could be involved in sugar transport and were present in nectaries. They identified the transport protein SWEET9 as a key player in three diverse flowering plant species and demonstrated that it is essential for nectar production.

In specially engineered plants lacking the SWEET9 transporter, the team found that nectar secretion did not occur, but rather sugars accumulated in the stems. Importantly, when they added a copy of the SWEET9 gene, the plants produced more nectar. In parallel, they also identified genes necessary for the production of sucrose, called sucrose phosphate synthase genes, which turned out to also be essential for nectar secretion.

Since sugars are apparently the drivers for secretion of nectary fluids, they uncovered a whole pathway for how sucrose is manufactured in the nectary and then transported into the extracellualar space of nectaries by SWEET9. In this interstitial area the sugar is converted into a mixture of sucrose and other sugars, namely glucose and fructose. In the plants tested, these three sugars comprise the majority of solutes in the nectar, a prerequisite for collection by bees for honey production.

These are flowers of wild tobacco *Nicotiana attenuata*. Credit: Danny Kessler, Max Planck Institute for Chemical Ecology

"SWEETs are key transporters for transporting essential nutrients from leaves to seeds. We believe that the nectarial SWEET9 sugar transporter evolved around the time of the formation of the first floral nectaries, and that this process may have been a major step necessary for attracting and rewarding pollinators and thus increasing the genetic diversity of plants," Frommer said.

More information: Nectar secretion requires sucrose phosphate synthases and the sugar transporter SWEET9, *Nature*, DOI: 10.1038/nature13082

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