How fruit flies detect sweet foods: Research opens door for investigations into taste receptors of mosquitoes

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Insects, such as the fly seen on a banana in this photo, have taste receptors with which they taste chemicals and make important choices about foods, mates and where to deposit their eggs. Credit: Dahanukar Lab, UC Riverside.

Insects represent remarkable diversity and have adapted to all sorts of ecological nooks and crannies. For example, they have taste receptors—novel proteins—with which they taste chemicals and make important choices about not only foods but also mates and where to deposit their eggs. These receptors are widely seen as being at the leading edge of behavioral adaptations.

Now, using the common fruit fly, researchers at the University of California, Riverside have performed a study that describes just how the fly's taste receptors detect sweet compounds.

"Sweet taste serves as an indicator of nutritive value, and the fly, like many other animals, has quite a sweet tooth," said Anupama Dahanukar, an assistant professor of entomology who led the research project.

The fly is a powerful model organism for studying animal development and behavior. Understanding the mechanisms by which it tastes and ingests sweet substances may offer tools to control insect feeding. The proteins that detect sweet compounds in insects belong, however, to a novel family of receptors that are quite different from the ones found in mammals. Even though these insect receptors were discovered more than a decade ago, how they recognize diverse chemicals remained an enigma and an unmet challenge—until now.

The study, which appears online this week in the *Proceedings of the National Academy of Sciences*, holds promise for uncovering functions of taste receptors in insects that transmit diseases (for example, mosquitoes) or damage crops (for example, beetles and weevils).

The fruit fly has eight sweet taste receptors, and what each one does specifically hasn't been clear. To their surprise, the researchers found that each of the eight receptors confers sensitivity to one of more of the sweet substances they tested in the lab. Their systematic analysis showed that the receptors could be separated into two groups based on which compounds they detect and how closely related they are in sequence.

"Each receptor is likely to make a direct and independent contribution to the overall response spectrum of sweet taste neurons, which could have some important implications in terms of developing strategies to block these receptors," Dahanukar said.

Her research team used a Drosophila olfactory neuron as a host for expressing taste receptors. This particular neuron is unique because, although it is linked to smell, it expresses members of the taste receptor family.

"We expressed sweet taste receptors, one by one, in this neuron, and we found that the host neuron, which normally does not respond to sugars, was now capable of being activated by sweet substances," Dahanukar said.

"One would expect that swapping taste receptors between different taste neurons would be sound strategies, but those have been tried and failed," said Erica Gene Freeman, a bioengineering graduate student working in Dahanukar's lab and the first author of the research paper.

Moving next to mosquitoes, the researchers were able to express a taste receptor from the malaria vector mosquito, *Anopheles gambiae*, in the fly olfactory neuron.

Despite the evolutionary divergence between mosquitoes and flies, the mosquito taste receptor was functional in the fly neuron in the absence of any other mosquito factors.

"This gives us the impetus for investigating other taste receptors from insects such as mosquitoes that transmit diseases, as well as pests that feed on crops," Dahanukar said. "One important goal is to see if we can use this system to find compounds that can modify feeding behaviors of harmful insects in a targeted manner."

Although the researchers' method is laborious, it is the only technique with which many different taste receptors have been successfully expressed. It offers a platform to probe the specificity of individual taste receptors, potentially from a variety of insects.

More information: "Detection of sweet tastants by a conserved group of insect gustatory receptors," by Erica Freeman, Zev Wisotsky, and Anupama Dahanukar. www.pnas.org/cgi/doi/10.1073/pnas.1311724111

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