Safe repellents that protect fruit from spotted wing Drosophila found

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The males have a characteristic dark spot on tip of wings. Credit: Ray Lab, UC Riverside.

Insects destroy a very large fraction of the global agricultural output - nearly 40 percent. The spotted wing Drosophila (*Drosophila suzukii*), for example, feeds on ripening fruits. A nuisance especially in Northern California and Europe, it lays its eggs inside ripe berries, and, when its larvae emerge there, the fruit is destroyed. As a result, each year *D. suzukii* causes hundreds of millions of dollars' worth of agricultural damage worldwide.

Scientists at the University of California, Riverside have now identified a safe repellent that protects fruits from *D. suzukii*: Butyl anthranilate (BA), a pleasant-smelling chemical compound produced naturally in fruits in small amounts. In their lab experiments, the scientists found BA warded off *D. suzukii* from blueberries coated with it. The finding, when extrapolated to other agricultural pests, could provide a strategy for controlling them and increasing the productivity of crops and fruit.

Study results appear June 22 in *Scientific Reports*, an online and open-access *Nature* publication.

"Toxic insecticides are often risky to use directly on fruits - especially when they are close to being harvested," said Anandasankar Ray, an associate professor of entomology and the director of the Center for Disease Vector Research at UC Riverside, whose lab performed the research project. "A safe and affordable repellent such as BA could provide protection and reduce use of toxic chemicals."

T o test whether BA can protect fruit from *D. suzukii*, Ray and his graduate student Christine Krause Pham conducted a series of experiments using two bowls of fresh, ripe blueberries - a preferred fruit of *D. suzukii*. They applied BA to blueberries in one bowl and solvent on the blueberries in the second bowl (the latter served as the control). They placed the bowls in a glass chamber and exposed them to *D. suzukii* for a week, repeating the experiment subsequently for a variety of BA

concentrations. They found a clear dose-dependent decrease in the number of larvae and pupae emerging from the BA-treated blueberries.

"We saw decreases after only a single treatment," Pham, the first author of the research paper, said. "We saw substantial decreases at 2.5 percent of BA and nearly complete protection at the 10 percent concentration, strongly indicating that insect repellents with good safety profiles can be useful to reduce fruit damage during ripening."

Found in low concentrations in a number of fruit, BA smells like grapes and is commonly used as a flavor and fragrance component. It belongs to a category called generally recognized as safe (GRAS) and is approved for human consumption as a food additive.

"Most flies are attracted to rotting fruit," Ray explained. "*D. suzukii*, however, is specialized in that it is attracted to ripening fruit. What makes BA especially appealing is that not only does it repel *D. suzukii*, but it also reduces the flies' desire to lay eggs. There is good potential in the future to develop brand-new strategies for reducing crop damage using repellents like BA. From previous studies we have done in the lab, we have hundreds of such compounds to explore and test."

Initially, Ray and Pham investigated conservation of insect olfactory pathways to do the current research. They found that the DEET avoidance pathway is conserved across insects. Because DEET is costly and could elicit safety concerns if applied on food, they focused on DEET substitutes they had discovered in 2013, that are approved for addition to food. Upon testing these compounds, they found that a number of them worked well in repelling a variety of flies such as D. melanogaster, D. yakuba, D. suzukii, D. pseudoobscura and D. virilis. They found best results with BA and D. suzukii.

"The natural repellents discovered by Dr. Ray are particularly promising

for supporting multiple possible applications," said Michael Pazzani, the vice chancellor for research and economic development. "The safe and inexpensive compounds are not only effective for the protection of fruit and agricultural produce from pests, but also from biting insects that transmitting disease to us and livestock."

Next, Ray wants to test how efficacious BA is in field trials, and if they are, to request approval from the Environmental Protection Agency.

"We hope that BA and other similar chemicals we have in our portfolio will be able to work against the Asian citrus psyllid, Mediterranean fruit flies, whiteflies and other flies that can damage fruits and crops," Ray said. "In the future we can begin developing repellents for agricultural use that could cover fruits, crops like wheat and corn, and produce. The long-term grand vision is that one day we will be able to integrate safe naturally-occurring repellents into the repertoire of farmers to reduce their dependence on insecticides. It is conceivable also that similar chemicals and approaches could be developed to protect homes, humans and farm animals."

Last year, the UCR Office of Technology Commercialization helped Ray launch a company, Sensorygen Inc. around this technology. The office has filed a patent on the technology reported in the research paper, which has been licensed to Sensorygen Inc.

"The world needs additional tools to minimize the impact insects have on humans but without impacting the health of those people and the communities that we are working to protect," said Paul Zorner, chairman and CEO of Sensorygen Inc. "Dr. Ray has developed a remarkable and novel method to find safe, powerful insect repellants that won't kill anything but will simply keep them away from people as well as their homes, pets and food. It's an exciting and unique discovery that has great global commercial potential to resolve some of the most challenging

human health and food concerns facing us today."

Provided by University of California - Riverside