Fruit flies use alcohol as a drug to kill parasites

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Alcoholic drinks aren't generally put into the category of health food, but in some cases they might be just the cure for nasty parasites. That's according to a study published online on Feb. 16 in Current Biology, a Cell Press publication, showing that fruit flies will actually seek out alcohol to kill off blood-borne parasitic wasps living within them. Credit: Milan et al., Current Biology

Fruit flies infected with a blood-borne parasite consume alcohol to self-medicate, a behavior that greatly increases their survival rate, an Emory University study finds.

"We believe our results are the first to show that alcohol consumption can have a protective effect against infectious disease, and in particular

against blood-borne parasites," says Todd Schlenke, the evolutionary geneticist who led the research.

"It may be that fruit flies are uniquely adapted to using alcohol as medicine," he adds, "but our data raise an important question: Could other organisms, perhaps even humans, control blood-borne parasites through high doses of alcohol?"

Current Biology is publishing the study, co-authored by Emory graduate student Neil Milan and undergraduate student Balint Kacsoh.

The results add to the growing body of evidence that some animals know how to use toxic substances found in nature as medicine.

Drosophila melanogaster, the common fruit fly that swirls around browning bananas in your kitchen, is an important biological model system. The Schlenke lab uses *D. melanogaster* to study how immune systems adapt to pathogens.

The fly larvae eat the rot, or fungi and bacteria, that grows on overripe, fermenting fruit. "They're essentially living in booze," Schlenke says. "The amount of alcohol in their natural habitat can range from 5 to 15 percent. Imagine if everything that you ate and drank all day long was 5-percent alcohol. We wouldn't be able to live like that, but fruit flies are really good at detoxifying alcohol."

Tiny, endoparasitoid wasps are major killers of fruit flies. The wasps inject their eggs inside the fruit fly larvae, along with venom that aims to suppress their hosts' immune response. If the venom is effective enough, the wasp egg hatches, and the wasp larva begins to eat the fruit fly larva from the inside out. Eventually, an adult wasp emerges from the remains of the fruit fly pupa.

Some fruit flies, however, can overcome the effects of wasp venom and mount an immune response against wasp eggs. The blood cells in these fly larvae swarm over the wasp eggs and release nasty chemicals to kill them, allowing the fruit fly larvae to grow into adults.

"A constant co-evolutionary battle is going on between the immune systems of the flies and the venoms of the wasps," Schlenke says. "Any new mechanism of defense that protects flies from wasps will tend to spread through fly populations by natural selection."

Schlenke wondered if the fruit flies could be tapping the toxic effects of alcohol in their natural habitat to fight off wasps.

To test the theory, the researchers used a bisected petri dish filled with the yeast that fruit flies are normally fed in a lab environment. The yeast on one side of the dish was mixed with 6 percent alcohol, while the yeast on the other side remained alcohol-free. The researchers then released fruit fly larvae into the dish, allowing them to freely move to either side.

After 24 hours, 80 percent of the fruit fly larvae that were infected with wasps were on the alcohol side of the dish, while only 30 percent of the non-infected fruit fly larvae were on the alcohol side.

"The strength of the result was surprising," Schlenke says. "The infected fruit flies really do seem to purposely consume alcohol, and the alcohol consumption correlates to much higher survival rates."

Infected fruit flies that consumed alcohol beat out the wasps in about 60 percent of the cases, compared to a 0 percent survival rate for fruit fly controls that fed on plain yeast.

"The wasps aren't as good as the flies at handling alcohol," Schlenke says.

A developing wasp knocked out within an alcohol-consuming fly larva dies in a particularly horrible way, he adds. "The wasp's internal organs disperse and appear to be ejected out of its anus. It's an unusual phenotype that we haven't seen in our wasps before," Schlenke says.

The lab repeated the experiment using another species of wasp that specializes in laying its eggs in *D. melanogaster*, rather than the generalist wasp used previously. Again, 80 percent of the infected flies wound up on the alcohol side of the dish, while only 30 percent of the uninfected flies did. But the alcohol diet was far less effective against the specialist wasps, killing them in only 10 percent of the cases.

"You would expect this kind of result," Schlenke says, "since the generalist wasp species can attack plenty of other flies, but the specialist wasps are under strong pressure to adapt to the alcohol-infused habitat of *D. melanogaster*."

The researchers hope that their data will lead to more studies of how alcohol may control pathogens in other organisms, including humans.

"Although many studies in humans have shown decreased immune function in chronic consumers of alcohol, little attempt has been made to assay any beneficial effect of acute or moderate alcohol use on parasite mortality or overall host fitness following infection," Schlenke says.

More information: Milan et al.: “Alcohol Consumption As Self-Medication Against Blood-Borne Parasites In The Fruitfly.” DOI:10.1016/j.cub.2012.01.045

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