

How eggs of the Zika-carrying mosquito survive desiccation

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A male and a female *Aedes* mosquito, taken in the researchers' lab. Credit: Anjana Prasad (CC-BY 4.0, <https://creativecommons.org/licenses/by/4.0/>)

Eggs of the mosquito that carries Zika virus can tolerate extended desiccation by altering their metabolism, according to a new study published October 24th in the open access journal *PLOS Biology* by Anjana Prasad, Sunil Laxman, and colleagues at the Institute for Stem Cell Science and Regenerative Medicine in Bengaluru, India and the Indian Institute of Technology in Mandi, India. The finding offers potential new ways to control the spread of this mosquito.

Cells are made mostly of water, and desiccation is a potentially fatal event for any organism, since the structures of many proteins and other cellular molecules are dependent on adequate hydration. While many types of microbes have evolved mechanisms to survive drying out, only a few animals have. Among them is the mosquito *Aedes aegypti*, the carrier of a variety of viral diseases, including, Zika, dengue, yellow fever, and Chikungunya. Originally found in North Africa, *Ae. aegypti* has expanded globally, and is now a threat in warm, moist regions throughout the world.

Aedes eggs require from 48 to 72 hours to hatch into larvae, and the authors first showed that eggs must be at least 15 hours old to survive desiccation; eggs that were dried out before this stage failed to hatch when rehydrated.

They then compared the proteomes of viable eggs that had and had not been desiccated, and found multiple major changes in [metabolic pathways](#) within the desiccated eggs. These included increases in the levels of those enzymes in the tricarboxylic acid (Krebs) cycle that promote [lipid metabolism](#), and a decrease in enzymes of glycolysis and ATP-producing parts of the TCA cycle, which together shunted cellular [metabolism](#) toward the production and use of fatty acids.

Overall, the level of metabolism was reduced, while the levels of the amino acids arginine and glutamine were increased. In addition, enzymes

that reduce the damaging effects of oxidative stress, a known consequence of dehydration, were also increased.

When linked together, arginine molecules form polyamines, which are known to help protect [nucleic acids](#), proteins, and membranes from a variety of insults. Here, the authors showed that the eggs accumulate polyamines, suggesting that they may be a key aspect of desiccation tolerance.

To test this, they fed egg-laying female mosquitoes an inhibitor of polyamine synthesis. The eggs that they laid were significantly less able to survive desiccation than eggs from untreated females. A second inhibitor, this one of [fatty acid metabolism](#), also reduced egg viability after desiccation. Finally, they showed that this fatty acid inhibitor reduced polyamine synthesis, indicating that one role of the increase in fatty acid breakdown is to supply the energy needed for production of protective polyamines.

"Given the importance of *Ae. aegypti* as a primary vector for numerous viral diseases that affect nearly half the world's population, as well as the rapid geographical expansion of this mosquito vector, these results provide a foundation for reducing *Aedes* egg survival and global spread. Additionally, some of the specific inhibitors described here that reduce desiccation resistance in *Ae. aegypti* eggs, as well as new ones affecting other steps in the egg desiccation tolerance pathway, may prove useful as vector-control agents," Laxman said.

Laxman adds, "Aedes mosquito eggs can indefinitely survive after drying up completely, and hatch into viable larvae. The embryos rewire their metabolism upon drying, to protect themselves through desiccation, and revive after water becomes available again."

More information: Prasad A, Sreedharan S, Bakthavachalu B,

Laxman S (2023) Eggs of the mosquito *Aedes aegypti* survive desiccation by rewiring their polyamine and lipid metabolism. *PLoS Biology* (2023). [DOI: 10.1371/journal.pbio.3002342](https://doi.org/10.1371/journal.pbio.3002342)

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