Damage-signalling protein shows parallels between plant and human immune systems

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BTI researchers used *Arabidopsis* plants (left) and gray mold (grown in a petri dish on the right) to investigate the damage-signalling function of HMGB3. Credit: Photo by Patricia Waldron

A protein that signals tissue damage to the human immune system has a counterpart that plays a similar role in plants, report researchers at the

Boyce Thompson Institute (BTI).

Professor Daniel Klessig and colleagues have identified a new damage-associated molecular pattern molecule or "DAMP" in plants. DAMP molecules released by injured cells trigger an immune response in plants and animals. The researchers describe this protein, called HMGB3, in a new paper in *PLOS Pathogens*. Knowledge of HMGB3, and its human equivalent, HMGB1, enhances our understanding of how humans and plants fight off infections.

Plants and animal tissues use DAMPs to detect when they are wounded, so that they can promote healing and to fend off infection. DAMPs are always present inside cells, but are released into the surrounding space in response to tissue damage, where they activate inflammatory and immune responses.

The researchers discovered the actions of HMGB3 through their investigations of plant and animal proteins that interact with salicylic acid, a plant immune regulator and the main breakdown product of aspirin. A previous study by Klessig's lab found that salicylic acid blocks HMGB1, a DAMP in humans that is associated with multiple inflammation-related diseases. When they searched the genome of the model plant Arabidopsis for genes coding for similar proteins, they found HMGB3.

They compared the actions of HMGB3 in *Arabidopsis* plants to other known plant DAMPs, and measured the protein's ability to help plants fight off gray mold infection.

"We injected the protein into the extracellular space of the plant and then examined different layers of immune activity," said lead author Hyong Woo Choi, a senior research associate at BTI. The protein triggered a signaling cascade involved in the plant immune response,

activated the expression of genes involved in defense, started callose deposition—a protective thickening of the cell walls—and made the plants more resistant to gray mold infection.

They found that, like human HMGB1, HMGB3 also interacts with salicylic acid, which inhibits its activities. The immune-boosting effects of HMGB3 in gray mold-infected plants were erased when the researchers added salicylic acid.

"The identification of salicylic acid's shared targets and mechanisms of action in plants and animals enable us to translate what has been learned in one system to the other, said Klessig. "For example, glyceraldehyde 3-phosphate dehydrogenase is another shared target. It is involved in the replication of several plant and animal viruses, including hepatitis A, B and C viruses in humans and tomato bushy stunt virus in plants. Notably, salicylic acid binding to this target suppresses replication of the plant virus."

In future work, Klessig and colleagues will continue to investigate targets of salicylic acid shared by plants and animals, which have important roles in disease.

More information: Hyong Woo Choi et al. Activation of Plant Innate Immunity by Extracellular High Mobility Group Box 3 and Its Inhibition by Salicylic Acid, *PLOS Pathogens* (2016). DOI: 10.1371/journal.ppat.1005518

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