Gene triggers male sterility in tomato plants

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Despite its culinary versatility, the humble tomato isn't known for being mysterious. But there's still plenty to learn: researchers from Japan have discovered the gene underlying male sterility in these plants.

In a study published in February 2022 in *Plant Physiology*, researchers

from the University of Tsukuba have revealed that the orf137 gene underpins a particular type of male sterility in tomato plants, and have demonstrated the mechanism behind it.

Cytoplasmic male sterility (CMS) is a trait in which a plant is unable to produce fertile pollen. This trait is the result of incompatibility between the genomes of the cell nucleus and the mitochondrion—the "powerhouse" of the cell from which cellular energy is derived. CMS is important for agriculture, because it is used to efficiently produce F1 hybrid seeds—the first generation that results from the crossbreeding of distinctly different parental types. The CMS-triggering mechanism has been investigated in various cereal crops and was found to occur with CMS-associated genes encoded by the mitochondrial genome. But prior to this study, this mechanism had yet to be determined in tomatoes.

"Genes associated with CMS have been found in a number of crops such as maize, wheat, and rice, but so far none have been identified in tomatoes," explains senior author of the study, Professor Tohru Ariizumi. "We set out to look for these genes using mitoTALENS."

MitoTALENs—mitochondrial transcription activator-like effector nucleases—have recently arisen as an innovative tool for editing genomes, allowing the targeted disruption of genes in the mitochondrial genome. MitoTALENs have been employed to disrupt several mitochondrial genes associated with CMS in other crops. By comparing the open reading frames (ORFs)—the spans of DNA sequence between start and stop codons—of CMS and fertile tomato cultivars, the team identified a gene associated with CMS, orf137, which was present specifically in the CMS tomato mitochondrial genome.

The results showed that mitoTALEN triggered targeted mutagenesis (in which an organism's genetic information is changed via the production of a mutation), causing double-stranded breaks (DSBs) around orf137. It

was also demonstrated that the repair mechanism following DSBs is mediated by homologous recombination—the DSB repair pathway that maintains genome stability.

"We identified mitochondrial orf137 as the CMS-associated gene that entirely underpins the male sterile phenotype of CMS tomato plants," says Professor Ariizumi.

The results of this study offer a basis for developing an efficient F1 hybrid breeding system that uses CMS tomato plants carrying orf137. In the future, tomato F1 hybrid seeds could be produced by using insect pollinators in place of the hand-pollination systems currently in use, reducing the costs of F1 seed production.

More information: Kosuke Kuwabara et al, orf137 triggers cytoplasmic male sterility in tomato, *Plant Physiology* (2022). DOI: 10.1093/plphys/kiac082

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