

Japan researchers engineer onions to produce fewer tear-inducing compounds

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Genome editing of the LFS gene significantly reduces lachrymatory factor production in onion leaves and bulbs, offering a proof of concept for developing tear-reduced varieties



Scientists in Japan have used CRISPR-Cas9 genome editing to target the biochemical pathway responsible for the tears triggered by cutting onions, opening a potential new route for improving one of the crop's most distinctive traits. The researchers targeted the lachrymatory factor synthase (LFS) gene, which is involved in the production of lachrymatory factor, the volatile compound that causes eye irritation when onions are cut. By suppressing the gene, the team reduced production of the tear-inducing compound.

The study is significant for onion breeding because it represents the first reported use of genome editing to modify an onion-specific trait, demonstrating that CRISPR-Cas9 can be used to alter a targeted biochemical characteristic in the crop.

Editing the onion's tear pathway

The researchers introduced CRISPR editing components into onion root calluses using *Agrobacterium*. The transformation system also incorporated visual markers, including green fluorescent protein (GFP), allowing researchers to identify transformed tissue. Callus lines showing high and stable GFP expression were selected for further development. Molecular screening was subsequently used to confirm mutations in the target gene, after which the edited lines were regenerated through plant tissue culture.

Biochemical analysis showed that the resulting plants had significantly reduced LFS enzyme activity in both leaves and bulbs. The finding provides direct evidence that editing the target gene can alter the pathway responsible for lachrymatory factor production. The breakthrough, however, comes with an important caveat: the edited plants did not emerge from the process as commercially ready varieties.

The regeneration challenge

The edited plants displayed morphological growth abnormalities and failed to set seed. The researchers attributed these developmental problems to the prolonged tissue-culture process used during transformation and regeneration. That limitation is significant because a useful gene-edited crop must ultimately be capable of producing healthy, fertile plants that can be propagated and evaluated through subsequent breeding and field development.

The next challenge, therefore, is not simply editing the LFS gene but improving the tissue-culture and regeneration systems used to recover plants after editing. If those bottlenecks can be addressed, the approach could support the development of commercially viable onions with reduced lachrymatory factor. The research also points to a broader opportunity for onion improvement. Rather than relying only on conventional breeding, genome editing could provide a more targeted way to modify specific biochemical, quality and health-functional traits.

For now, the work remains a proof of concept rather than a commercial tear-free onion. But by establishing a route to precisely modify an onion-specific trait, the Japanese researchers have taken a step towards a new generation of genetically improved onions.