The development of potato with reduced cold-induced sweetening facilitated by genome editing

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Storing potatoes at low temperatures results in the accumulation of reducing sugars, known as cold-induced sweetening (CIS). When these sugars react with free amino acids during high-temperature processing, they produce brownish and bitter-tasting substances. Here, two strategies have been pursued to develop new varieties resistant to CIS. The first is to knock out the vacuolar invertase *(PAIN1)* gene in the potato variety Symfonia. Vacuolar invertase contributes to the accumulation of reducing sugars. Multiplex *cas9*/gRNA vectors were created and used for *Agrobacterium*-mediated DNA transfer to leaf explants, which resulted in 10 PAIN1-mutant lines. Tubers from three knockout lines showed reduced levels of glucose and fructose after 90 days of cold storage. The second strategy is to develop CIS-resistant donors from wild potato genotypes. Screening of our collection showed that *Solanum chacoense* has strong resistance to CIS but is toxic due to high levels of steroidal glycoalkaloids (SGAs). Several candidate genes were selected for the reduction of SGAs in potato. The use of respective *cas9*/gRNA vectors was demonstrated to result in targeted mutagenesis in S. *chacoense* cells.

The study is supported by the Kurchatov Genomic Center ICG SB RAS (075-15-2019-1662).

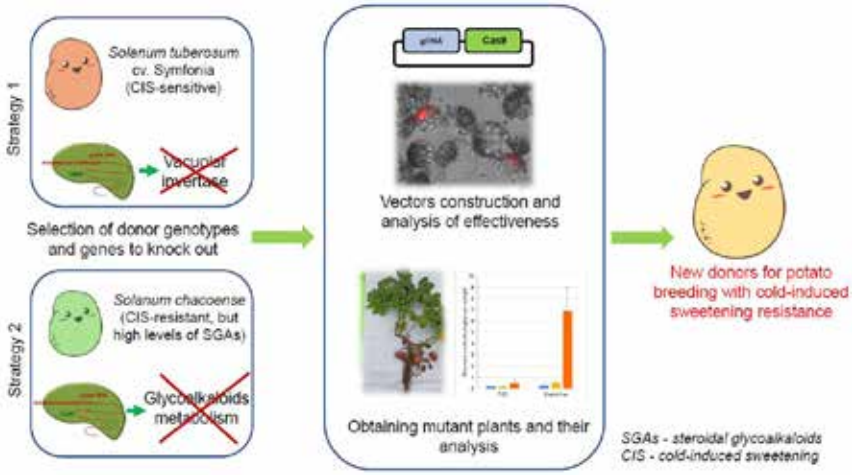
The main publications of authors on the subject of the abstract:

Egorova A.A. et al. Genotype-Specific Features of Cold-Induced Sweetening Process Regulation in Potato Varieties Nikulinsky, Symfonia, and Nevsky // Mol Biol (2023) 57, 193-203. https://doi.org/10.1134/S0026893323020061

Egorova A. A. et al. De Novo Domestication Concept for Potato Germplasm Enhancement // Agronomy (2022) 12 (2) 462. https://doi.org/10.3390/agronomy12020462

Take-home message:

Two strategies have been pursued to develop new varieties resistant to cold-induced sweetening (CIS). The first is to knock out PAIN1 gene in the elite potato variety. The second strategy is to develop CIS-resistant donors from wild potato genotypes.



DOI 10.18699/PlantGen2023-20