Biofortification of Maize with Omega-3 Fatty Acids by CRISPR/Cas9-Mediated FAE1 Gene Editing

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Abstract

Omega-3 polyunsaturated fatty acids (PUFAs) are essential nutrients with established roles in reducing cardiovascular risk, modulating inflammation, and inducing apoptosis in cancer cells. However, sustainable and scalable dietary sources of therapeutic omega-3 remain limited. This study applies CRISPR/Cas9 genome editing to enhance endogenous omega-3 accumulation in maize, a major staple crop, by targeting the fatty acid elongase gene (FAE1), which diverts precursors toward longer-chain fatty acids.

Guide RNAs were designed to downregulate FAE1 and cloned into a CRISPR/Cas9 vector. Following Agrobacterium-mediated transformation of maize embryos, putative edited plants were screened by PCR and validated through Sanger sequencing. qRT-PCR analysis confirmed nine independent events with significantly reduced FAE1 expression. Gas chromatography–flame ionization detection (GC-FID) revealed a 24% increase in omega-3 fatty acid content compared to non-edited controls.

These findings demonstrate the feasibility of precise metabolic pathway engineering in crops to generate nutritionally enhanced biofactories. By integrating genome editing with translational nutrition, this work supports CRISPR-enabled strategies for disease prevention and therapeutic dietary interventions, aligning with emerging themes in precision medicine and sustainable health innovation.

Keywords

Omega 3 fatty acids, therapeutics, maize, *FAE1* gene, CRISPR-Cas, downregulation.