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CRISPR mediated Gene Editing for Quality Improvement in Food Crops

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Breeding of crop plants for evolving new varieties can be made possible by identifying unique traits from one parent and then crossing it with others. The resulting offspring may exhibit desired traits but with some unwanted ones that can be identified by screening large groups of plants. This method involves more time and labour which demands faster and more efficient process using better accurate methods. Agriculture, which provides the essential nutrients needed to support life, has been significantly influenced by the development of genome editing. In this article, we highlight recent advancements in plant biotechnologythat have made a big impact. The use of CRISPR-Cas technology in plant biotechnology has led to several valuable products that remain available across generations and have benefited consumers.

Efforts to improve food crops quality include:

(i) Anti-browning mushrooms:US Scientists have developed anti-browning mushrooms using CRISPR-Cas9 that prevent the browning of white truffles, increase their shelf life, and offer a commercial advantage.The polyphenol oxidase genewas targeted to achieve this effect with a small deletion which otherwise leads to an unappealing appearance. The product received approval by the US Department of Agriculture (USDA) for commercial cultivation since it did not involve any foreign DNA from other closely related plant species or bacteria (Waltz, 2016).

(ii) Low gluten wheat: Gluten proteins in wheat contribute to its elasticity. About 1% to 2% of the global population with celiac disease, immune system reacts to gluten and causes intestinal damage. These individuals often have to follow expensive gluten-free diets, which reduce their nutritional intake. Gene editing has been used to remove CD epitopes that trigger immune reactions, while maintaining the dough quality

(iii) Sweeter strawberries: One of the biggest challenges for fruit producers is the short shelf life of fruits before they are eaten.This can be addressed by targeting genes that enhance fruit quality and nutrition during ripening. The strawberry breeding program at the Institute of Food and Agricultural Sciences, University of Florida has identified key genes for disease resistance and improved genetic backgrounds that can be passed on to future generations through traditional breeding. With the use of CRISPR, DNA marker-assisted breeding tools can help track edited genes in future generations

(iv) Rice with differing levels of amylose: Rice is a major cereal grain widely used around the world.Glutinous rice has very little or no amylose and is used in the brewing industry. The waxy gene (OsWaxy), which encodes the granule-bound starch synthase, is responsible for amylose production. Using CRISPR-Cas9, researchers have created sticky rice with low amylose content (Yunyan et al., 2019). Similarly, targeting the starch branching enzyme SBEIIb led to the development of rice with high amylose content

(v) Lignin-enriched rice: Lignin is a natural polymer that plays a crucial role in plant cell wall formation.Breeding approaches that enrich lignin can offer benefits for biorefineries. However, there is limited information on molecular breeding methods for this trait. By geneome editing, researchers have altered the transcriptional repressor OsMYB108, there by increased levels of p-coumaroylated and tricin lignin units in stems of rice.

(vi) Higholeic acid soybeans: Soybeans are an important legume crop, providing protein, oil, animal feed, and food.High levels of monounsaturated fatty acids such as alpha-linolenic and linoleic acids can cause oxidative instability in soybean oil and processed foods. The soybean omega-6 desaturase gene GmFAD2 is involved in converting oleic acid into linoleic acid. Targeted mutagenesis of this gene using CRISPR-Cas9 technology reduced linoleic and alpha-linolenic acids while increasing the concentration of high oleic acid.

(vii) Tetraploid potato: CRISPR-based genome editing has recently been used to alter the granule-bound starch synthase gene (GBSS) in potatoes using U6 promoters (Johansen et al., 2019).By replacing the Arabidopsis U6 promoter with an endogenous one, researchers achieved almost double the editing efficiency. They used InDel detection amplicon analysis (IDAA) for identifying editing at the cell pool and ex-plant levels in the complex potato genome. This method, which showed greater success in editing at the explant level, has become a powerful tool for improving traits in polyploid species.

(viii) Novel waxy maize hybrids: The waxy maize developed by CortevaAgrisciences, a subsidiary of DowDupont, is a key example of SDN-1/NHEJ technology using CRISPR-Cas9.A 30-bp deletion at the exon/intron boundary resulted in a frameshift or null allele in the wx1 gene. The starch characteristics of these CRISPR-edited waxy maize seeds were similar to those of conventional waxy seeds. Additionally, these hybrids produced significantly higher yields and had more amylopectin content in their seeds.

Current methods used to improve the nutritional content of crops involve techniques such as traditional breeding, adding mineral nutrients through fertilizers, and genetic modification. In recent studies, there has been growing interest in the potential of the CRISPR-Cas9 system to enhance plant defenses. This system has the ability to specifically target multiple parts of a virus's genetic material and can even address different viruses that affect the same plant at the same time.

References

1. Johansen, I.E., Liu, Y., Jørgensen, B., Bennett, E.P., Andreasson, E., Nielsen, K.L., Blennow, A., Petersen, B.L., 2019. High efficacy full allelic CRISPR/Cas9 gene editing in tetraploid potato. Sci. Rep. 9, 17715.
2. Waltz, E. Gene-edited CRISPR mushroom escapes US regulation. *Nature* 532, 293 (2016).
3. Yunyan, F., Jie, Y., Fangquan, W., Fangjun, F., Wenqi, L., Jun, W., Yang, X., Jinyan, Z., Weigong, Z., 2019. Production of two elite glutinous rice varieties by editing WxGene. Rice Sci. 26 (2), 118–124.