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Iron Biofortification of Rice Endosperm by Tissue Specific and Synergistic Action of Genes Responsible for Iron Uptake, Transport and Storage

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Abstract

Nearly one-third of the world population, mostly women and children, suffer from iron malnutrition and its consequences, such as anemia or impaired mental development. Iron fortification of food is difficult, because soluble iron is either unstable or unpalatable, and non-soluble iron is not bioavailable. Biofortification programs based on conventional breeding have met with only marginal success because of negative correlations between yield and nutritional quality. Genetic engineering of crop plants to increase iron content has therefore emerged as an alternative for iron biofortification. To date, strategies to increase iron content have relied on single genes, with limited success. Our work focuses on rice as a model plant because it feeds half of the world population, including most of the iron-malnourished people. Recently, we developed rice lines (NFP lines) with more than six fold increase in the endosperm iron content compared to conventional mega rice varieties. Our transgenic rice lines have an iron content of up to 7 mg kg^{-1} in polished grains. This has been achieved through targeted expression of nicotianamine synthase and ferritin genes that exhibited a synergistic effect on iron uptake and storage. Agronomic evaluation of these high-iron rice lines did not reveal a yield penalty or significant changes in trait characters. This demonstrated that rice can be engineered with a small number of genes to achieve iron biofortification at a dietary significant level. We are further performing gene expression profiling in the flag leaves of NFP lines in order to study the effect of transgenes on endogenous gene expression, focusing on genes involved in metal homeostasis. This would also help to identify candidate genes responsible for micro-nutrient composition in the rice grains. In addition, we aim at further increasing the iron content in rice endosperm by root specific expression of iron-regulated metal transporter in the NFP lines. The long term goals of the project include combining the traits like improved pro-vitA content and high iron content into a single rice line.

Keywords: Iron biofortification, rice

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