Title: CRISPR Genome Editing for Climate Resilience and Sustainable Bioproducts in Forest Trees

Keywords: CRISPR, forestry, lignin, DNA-free

Abstract:

Imminent environmental changes caused by global warming are threatening many forest tree species to extinction, and compromising wood supplies for the forest industry. Current procedures to overcome these challenges rely on time-consuming breeding techniques and transgenesis. The application of new genome editing technologies, such as CRISPR-Cas9 can greatly contribute to advancements in forest bioproducts, enhancing wood quality for sustainable pulp and paper, and improving forest tree resilience. In this work, we demonstrate that CRISPR technologies combined with machine learning prediction models can be applied for the genetic manipulation of sophisticated metabolic pathways, such as lignin biosynthesis. The modulation of wood composition led to more efficient pulping for fibers, possibly bringing unprecedented operational efficiencies in pulp mills. Additionally, we have successfully established a DNA-free method for genome editing of multiple tree species through PEG-mediated CRISPR-RNP delivery of protoplasts. Transgene-free CRISPR-edited lines regenerated from edited protoplasts can accelerate the development of trees with enhanced traits bypassing the current GMO regulations. It creates an intriguing opportunity of using forest biotechnology to address sustainable bioeconomy and critical issues associated with climate resilience, forest health, and environmental conservation.