Toni Krause

The defensive roles of terpenoid resin in Norway spruce and the regulation of terpenoid biosynthesis

Many plants produce sticky mixtures of terpene compounds called resins. Known especially from conifer trees, resins have long been suggested to protect plants against herbivores and pathogens, but this role has never been rigorously proven since it has been difficult to manipulate resin abundance and composition in living plants for experimental testing. In addition, there is little information about which components of resin, the volatile C_{10} monoterpene olefins or the non-volatile C_{20} diterpene acids, are important against enemies and why these compounds occur in such complex mixtures.

Since resin in living trees is stored under pressure in ducts that rupture on enemy attack, it is hard to mimic realistically in in vitro experiments. For this reason, we have developed a stable genetic transformation system for Norway spruce (Picea abies) over the last several years and used it to modify resin composition for testing the function of resin in the living plant. By transformation with constructs resulting in constitutive over-expression or RNAi-driven suppression of terpene biosynthetic transcripts, we have created transgenic lines with altered terpene resin phenotypes. Manipulating the expression of specific isoprenyl diphosphate synthases that control the formation of different classes of terpenes allowed us to create spruce lines some with increased monoterpenes and others with decreased diterpenes with no major morphological differences from untransformed control lines. These now offer an ideal experimental system for testing the function of plant resin against enemies in a living tree.

We now plan to characterize these transgenic lines in detail to determine the chemical changes present, investigate the effects of altered resin content on herbivores and pathogens, and learn more about what factors control terpenoid biosynthesis. The goal is to understand more about the biological function of terpenoid resins in conifers and what regulates their formation.

Publications

Krause T, Reichelt M, Gershenzon J, Schmidt A (2020) Analysis of the isoprenoid pathway intermediates, dimethylallyl diphosphate and isopentenyl diphosphate, from crude plant extracts by liquid chromatography tandem mass spectrometry. *Phytochem Anal* 31(6), 770-777. Details PubMed

Supervisor

Jonathan Gershenzon

Start of PhD

March 1, 2017