Enhancing the regulation of phytoalexin biosynthesis in plants

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Abstract

Statement of the Problem: Phytoalexins are natural products (NPs) produced by plants that are biosynthesized in response to pathogen infection or abiotic stresses. Many phytoalexins have potent medicinal activities and are desirable for use as clinical therapeutics or as scaffolds for the semi-synthesis thereof. The major problem is that phytoalexins are absent from non-challenged plant tissues and may be present in challenged plant tissues at relatively low amounts rendering commercial production uneconomical. This is particularly problematic for phytoalexins that cannot be synthesized. Methodology: Chemical and pathogen treatments in combination with RNA sequencing (RNA-seq) were used to identify treatments and genes that can be used to enhance the biosynthesis of the anticancer phytoalexin glyceollin in soybean. Findings: A combination of the inorganic heavy metal silver nitrate ($AgNO_3$) and the wall glucan elicitor (WGE) from the pathogen *Phytophthora sojae* demonstrated an additive effect on the elicitation of glyceollin in soybeans. The additive effect was due to distinct elicitation mechanisms of $AgNO_3$ and WGE. Comparative transcriptome analyses by RNA-seq of pathogen and abiotic stress-treated soybean tissues identified three transcription factor (TF) genes that can enhance the production of glyceollin when overexpressed in soybean hairy roots. The TFs were of the WRKY, MYB, and NAC gene families. Conclusion & Significance: Combined elicitor and gene engineering approaches can successfully enhance the biosynthesis of glyceollin phytoalexins in soybean. Our transcription factor data suggests the potential existence of a conserved regulatory network for phytoalexin regulation in plants.

Image

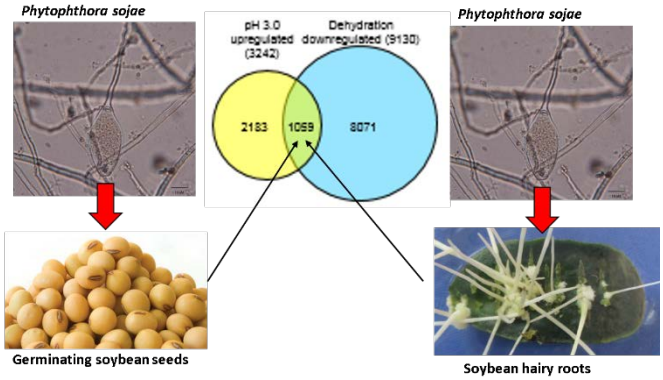


Fig. 1 Comparative transcriptomics identified transcription factor genes that regulate the biosynthesis of glyceollins in soybean.

Recent Publications

1. Farrell KC, Jahan Md A, **Kovinich N** (2017). Distinct Mechanisms of Biotic and Chemical Elicitors enable Additive Elicitation of the Anticancer Phytoalexin Glyceollin I. Molecules 22: 1261-1247.
2. Chanoca A, **Kovinich N**, Grotewold E, Otegui M. (2015). Anthocyanin Vacuolar Inclusions Form by a Microautophagy Mechanism. The Plant Cell. (Cover article for *The Plant Cell*, *and highlighted in Nature*)
3. **Kovinich N**, Kayanja G, Chanoca A, Otegui M, Grotewold E (2015). Abiotic stresses induce different localizations of anthocyanins in Arabidopsis. Plant Signaling & Behavior
4. **Kovinich N**, Kayanja G, Chanoca A, Riedl K, Otegui M, Grotewold E (2014). Not all anthocyanins are born equal: Distinct patterns induced by stress in Arabidopsis. Planta.
5. **Kovinich N**, Saleem A, Arnason JT, and Miki B. (2012a). Coloring genetically modified soybean grains with anthocyanins by suppression of the proanthocyanidin genes *ANR1* and *ANR2*. Transgenic research.
6. **Kovinich N**, Saleem A, Arnason JT, Miki B (2011a) Combined analysis of transcriptome and metabolite data reveals extensive differences between black and brown nearly-isogenic soybean (Glycine max) seed coats enabling the identification of pigment isogenes. BMC Genomics 12: 381.



Biography

Nik Kovinich has expertise is in the genetics of plant metabolism. He is a Beginning Investigator that initiated his research program at the West Virginia University in July 2015. His focus is on understanding the genetic regulation of the biosynthesis of medicinal natural products (NPs) in plants, enhancing NP bioproduction by genetic engineering, and improving the bioactivities of NPs using semi-synthesis. He teaches genetics and bioinformatics courses and had a major role in establishing an Undergraduate Program in Genetics at the West Virginia University.

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Notes/Comments: