JBEI
Joint BioEnergy Institute

Causes and Consequences of Experimental Variation in Nicotiana Benthamiana Transient Expression

Background/Objective

- *N. benthamiana* is widely used to test and study gene expression in plants, but little is known about how variable such data is.
- Researchers quantified variation and explored how to best mitigate it.

Approach

- Direct comparison of 17 distinct methods of normalizing *N. benthamiana* transient expression.
- Further optimization of the most effective method of normalization.

Results

- Quantified the amount of variation to be expected from *N.benthamiana* transgene expression.
- Identified the sources of nearly all observed variation.

Significance/Impacts

- Performed power analysis to predict necessary sample sizes for given effect sizes.
- Establishes guidelines for experimental design in this model organism.

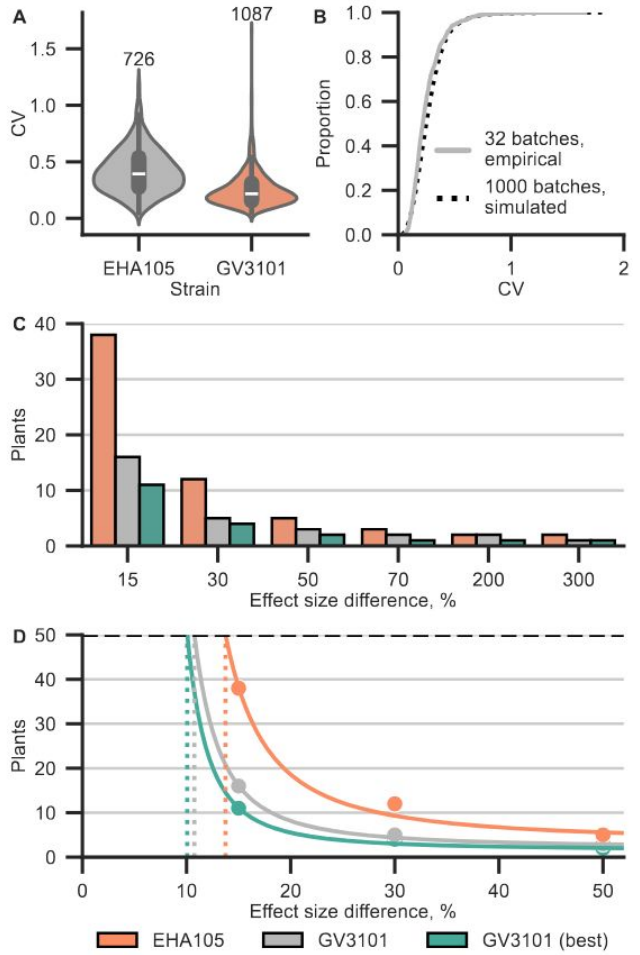


Figure caption: A) Coefficient of variation for 1,807 plants. B) Monte Carlo simulations recapitulating the data in A. C) Necessary sample size to achieve statistical difference for given effect sizes based on the model in B. D) Exponential regression based on the calculations in C.

Tang, S., et.al. Nature communications. 10.1038/s41467-026-69458-1 (JBEI #1298)

JBEI
Joint BioEnergy Institute

Valorization of Protein-rich Plant Biomass: Emerging Strategies and Economic Opportunities

Background/Objective

- Biomass proteins remain underutilized in biorefineries; we assess strategies for their integration and related economic gaps.

Approach

- Reviewed pretreatment and protein recovery strategies considering technical and economic trade-offs.
- Developed a decision matrix to guide protein-first or carbohydrate-first processing.

Results

- Pretreatment strongly affects protein recovery, functionality, and downstream valorization.
- Feedstock composition guides protein-first or carbohydrate-first processing strategies.

Significance/Impacts

- Guides biomass processing by integrating protein and carbohydrate valorization.
- Highlights the need for stronger techno-economic frameworks for protein-rich biomass.

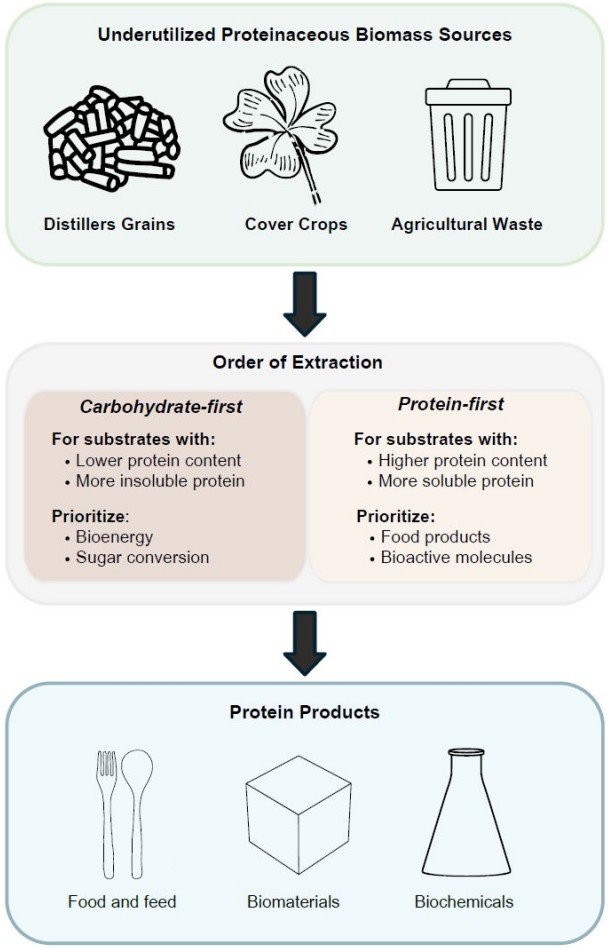


Figure caption: Framework for selecting protein-first or carbohydrate-first processing strategies.

Saldarriaga-Hernandez, S., et.al. Cell Reports Sustainability. 10.1016/j.crsus.2026.100636 (JBEI #1299)

JBEI
Joint BioEnergy Institute

Aligning Development and Deployment of Compostable Plastics for Meaningful Impact

Background/Objective

- An important role for bio-based chemicals/materials is in new, performance-advantaged compostable plastics
- Path to market for new biomaterials can be unclear

Approach

- Outlined various fates of compostable bioplastics and tradeoffs among common polymer types. Laid out path to approval.

Results

- Choices made early in R&D can shorten or prolong path to approval, particularly for food contact materials
- Designing biomaterials with approval in mind is key

Significance/Impacts

- Biomaterials can increase domestic supply of important and widely used polymers
- If thoughtfully designed, these materials can reduce microplastic releases and result in safer product options

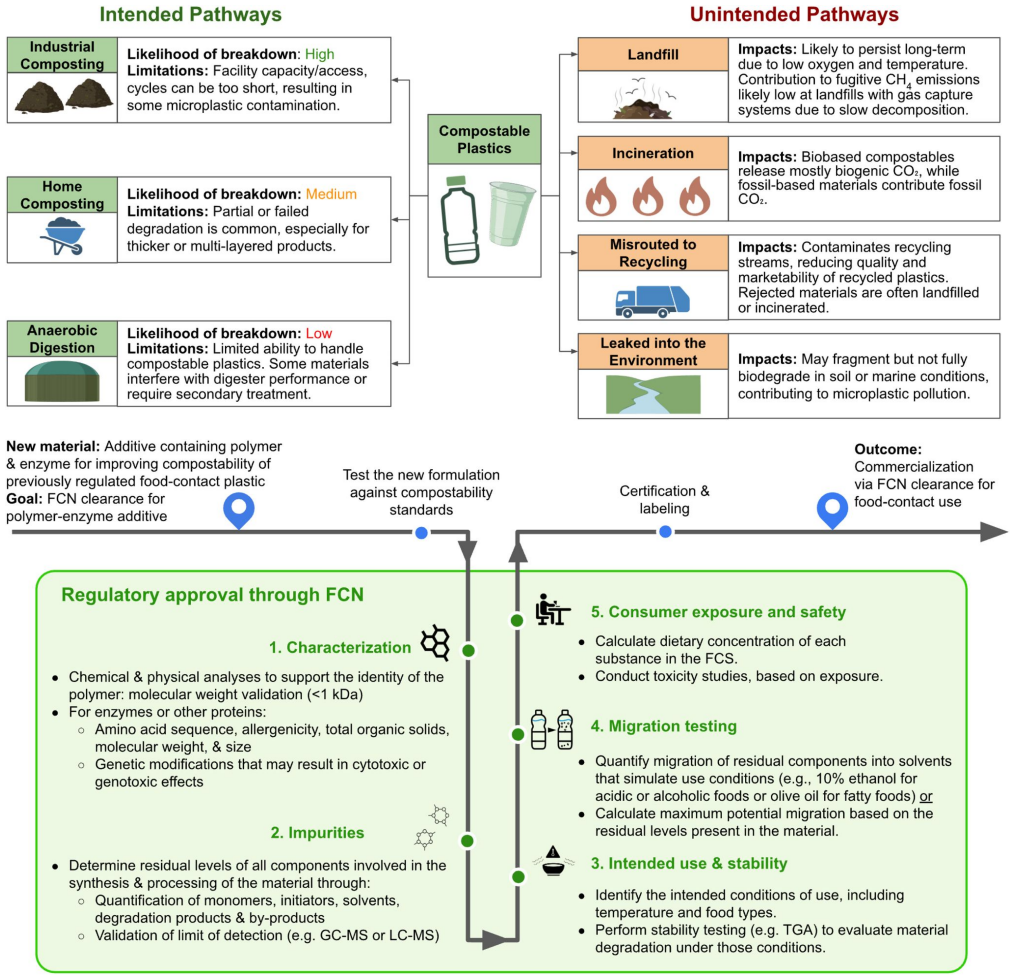


Figure caption: Top: Intended and unintended fates for compostable plastics. Bottom: Path to market for compostable bioplastics intended as food contact materials.

Moon, S., et al. One Earth. 10.1016/j.oneear.2026.101609 (JBEI #1300)

Enabled Publications

JBEI
Joint BioEnergy Institute

Functionalized Benzylamines from Commercial Kraft Lignin

Background/Objective

- Kraft lignin is the most abundant lignin source derived from pulping industry, but remains underutilized mainly due to its condensed structure.
- The study aimed to produce benzylamines, precursors of pharmaceuticals, agrochemicals, and polymers, from lignin-derived aromatics.

Approach

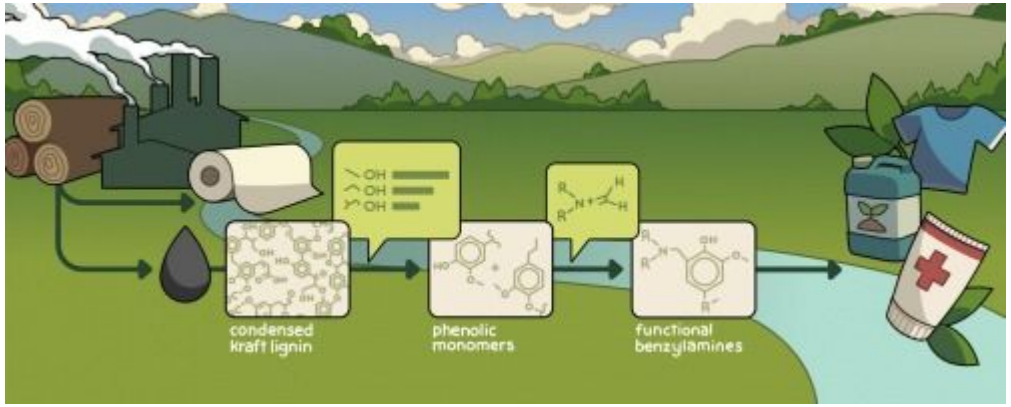
- Catalytic reduction followed by Mannich multicomponent reaction.
- Quantum chemistry simulations were applied to understand the chemistry.
- TEA/LCA were conducted to assess process economics and environment footprint.

Results

- Different alcohol solvent affects guaiacol product yield, not distribution.
- Formic acid and Ru/C catalyst drives guaiacol products with longer alkyl chain length.
- Over 90% benzylamine was achieved from lignin derived guaiacols.
- Methanol-only scenario has lowest benzylamine costs and carbon footprints.

Significance/Impacts

- Establish a scalable, bio-based pathway for producing benzylamines from commercial kraft lignin.
- Offer a sustainable alternative to produce petrochemical-based benzylamines.



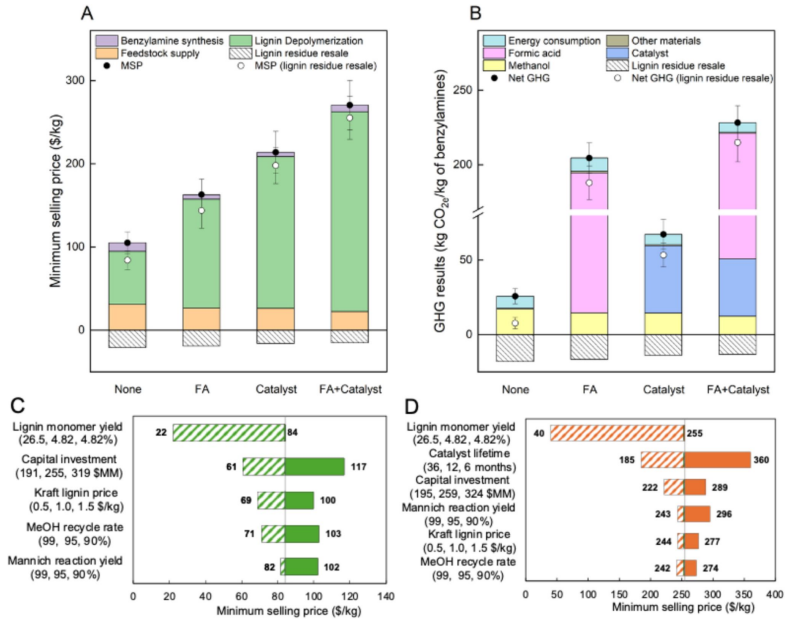


Figure caption: Top: graphic abstract of producing functionalized benzylamines from commercial kraft lignin; Bottom: TEA and LCA analysis

Dou, C., et.al. Chemical Engineering Journal. 10.1016/j.cej.2026.174287 (JBEI #132)

JBEI
Joint BioEnergy Institute

Synthetic Biology for Heterologous Expression and Engineering of Fungal Polyketide Synthases

Background/Objective

- Fungal PKSs produce valuable natural products but are difficult to express and engineer heterologously.
- Consolidated design principles for fungal PKS host selection and domain-level engineering are lacking.

Approach

- Reviewed heterologous fungal PKS expression in yeast and filamentous fungi, cataloging host trade-offs.
- Explored PKS engineering via starter unit selection, point mutations, and domain swaps to alter structure.

Results

- Host selection and engineering strategy (domain swaps, mutations) are the two key fungal PKS design principles.
- Computational tools combined with domain engineering expand access to polyketide scaffolds beyond nature.

Significance/Impacts

- Provides a unified fungal PKS engineering framework, accelerating natural product discovery for DOE applications.
- Supports JBEI's synthetic biology mission by enabling heterologous polyketide production in microbes.

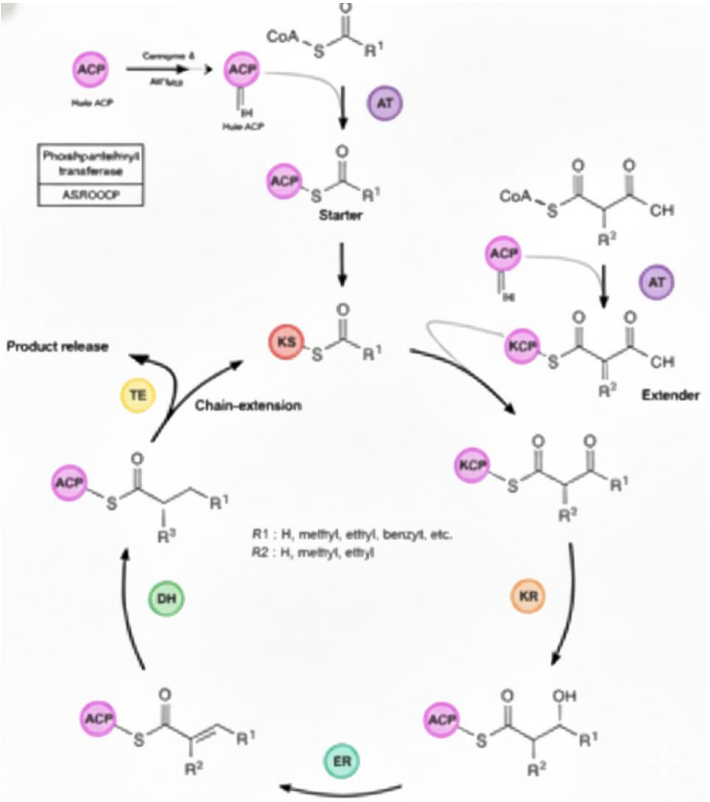


Figure caption: Mechanistic cycle of fungal PKS. Schematic showing the iterative enzymatic assembly of polyketide chains from starter and extender units. The diversity of R1 and R2 groups highlights the potential for synthetic biology engineering to produce novel chemical scaffolds

Jayachandran, S., et al. Natural Product Reports. 10.1039/d5np00020c (JBEI#133)