

# Cover Letter for PBJ Submission

## Manuscript Title

**Quantitative evidence for developmental canalization: CTâ€™metabolome integration reveals a growthâ€™defense axis in coconut fruit development**

## Submission Details

- **Journal:** Plant Biotechnology Journal (PBJ)
  - **Article Type:** Research Article
  - **Date:** June 10, 2026
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## Dear Editor,

We submit our manuscript entitled â€œQuantitative evidence for developmental canalization: CTâ€™metabolome integration reveals a growthâ€™defense axis in coconut fruit developmentâ€ for consideration as a Research Article in Plant Biotechnology Journal.

This study makes three contributions that align with PBJâ€™s scope:

**1. Technical novelty: First CTâ€™metabolome integrative framework for coconut fruit development.** We systematically integrate CT phenomics (7,686 DICOM slices, five varieties Ã— five developmental stages) with widely targeted LC-MS/MS metabolomics (624 metabolites) to establish CT as a mechanistically interpretable phenotyping tool. The four tissue-specific CT trajectories constitute a quantitative â€œdevelopmental clockâ€ spanning ~1,200 HU, making coconut the most naturally suited fruit system for CT phenotyping.

**2. Biological discovery: Metabolomic evidence of a growthâ€™defense trade-off in a fruit tree crop.** The reciprocal metabolic profile between the elite dwarf W5 (nucleotide/amino acid enrichment, growth-oriented) and the local tall CK (flavonoid/tannin enrichment, defense-oriented) provides the first metabolomic evidence of this classic trade-off in a fruit tree crop, revealing how breeding selection reshapes metabolic networks.

**3. Hypothesis-generating framework: CTâ€™metabolite association asymmetry as a quantitative proxy for developmental canalization.** Systematic correlation analysis identified 3,376 significant CTâ€™metabolite associations in W5 (55 pairs with  $|r| > 0.99$ ) versus none in CK (permutation test  $p < 0.0001$ ). We propose this asymmetry may reflect differences in developmental canalizationâ€™a statistical signature of breeding-induced genetic homogenization. We explicitly acknowledge two alternative

hypotheses (population structure, environmental adaptation) and provide testable predictions for subsequent validation.

**Established research foundation:** This study builds on our group's systematic CT phenotyping programme, which has established a complete pipeline from imaging (Zhang et al., 2023, Plant Methods), automated segmentation (Liu et al., 2023, Front. Plant Sci.) and multi-compartment quantification (Lin et al., 2023, PLOS ONE), through to germination dynamics (Lin et al., 2025, Ind. Crops Prod.; Mehmood et al., 2026, J. Food Compos. Anal.), cross-modal metabolite association (Sun et al., 2024, PeerJ) and location-specific density profiling (Lin et al., 2024, PeerJ). The present submission represents the integrative culmination of this programme.

**Methodological rigor:** We acknowledge the limitations of time-series correlation at  $n = 5$  time points and address this proactively: - Permutation test (10,000 shuffles) confirms asymmetry cannot arise by chance ( $p < 0.0001$ ) - Spearman rank correlation and first-differencing Pearson correlation both preserve the asymmetry pattern - Coefficient of variation analysis rules out insufficient metabolic variation as an alternative explanation - Full data and analysis scripts are publicly accessible at palm.suncx.top

We believe this work will be of broad interest to the PBJ readership and welcome the opportunity to address any reviewer feedback through revision.

Sincerely,

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## Suggested Reviewers

### Primary Reviewers (3)

1. **Prof. Pieter Verboven** Department of Biosystems, KU Leuven, Belgium Expertise: CT phenotyping, plant imaging, fruit microstructure Email: pieter.verboven@kuleuven.be
2. **Prof. Alisdair R. Fernie** Max Planck Institute of Molecular Plant Physiology, Potsdam-Golm, Germany Expertise: Plant metabolomics, fruit metabolism, multi-omics integration Email: fernie@mpimp-golm.mpg.de
3. **Prof. Lacey Samuels** Department of Botany, University of British Columbia, Vancouver, Canada Expertise: Plant cell wall biology, secondary cell wall formation Email: lsamuels@mail.ubc.ca

## Alternate Reviewers (3)

1. **Prof. Michael D. Purugganan** Center for Genomics and Systems Biology, New York University, USA Expertise: Domestication genomics, evolutionary genetics Email: mp132@nyu.edu
  2. **Dr. Yves Gibon** INRAE, Biologie du Fruit et Pathologie, Villenave d'Ornon, France Expertise: Fruit metabolism, primary metabolism, enzymatic regulation Email: yves.gibon@inrae.fr
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