Vita

Candidate's name: Zhan Mai

Universities Attended:
University of New Brunswick (2023)
Bachelor of Science

University of New Brunswick (2025)
Masters of Science

Publications/Conference Presentations:

Mai, Z., Richardson, M., Mann, S., Greene, J., Paul, A., Perley, J., Deslongchamps, G., & Qu, Y. (2025). *Promiscuous and Regiospecific Vinca Minor Hydroxylases for Opioid Akuammine Biosynthesis and Monoterpenoid Indole Alkaloid Diversification*.

Hwang, J., Kirshner, J., Ramey Deschênes, D. A., Richardson, M. B., Fleck, S. J., Guo, J., Perley, J. O., Shahsavarani, M., Garza-Garcia, J. J., Seveck, A. D., Doiron, S. S., Mai, Z., Silliphant, S. N., Calhoun, L., Gao, D., Lian, J., Deslongchamps, G., Albert, V. A., & Qu, Y. (2025). *Ancient Gene Clusters Initiate Monoterpenoid Indole Alkaloid Biosynthesis and C3 Stereochemistry Inversion*.

Mai, Z., Kim, K., Richardson, M. B., Deschênes, D. A., Garza-Garcia, J. J., Shahsavarani, M., Perley, J. O., Njoku, D. I., Deslongchamps, G., De Luca, V., & Qu, Y. (2024). Oxidation of four monoterpenoid indole alkaloid classes by three cytochrome P450 monooxygenases from *tabernaemontana litoralis*. *The Plant Journal*, *120*(6), 2770–2783.

Farzana, M., Richardson, M. B., Deschênes, D. A., Mai, Z., Njoku, D. I., Deslongchamps, G., & Qu, Y. (2024). Parallel evolution of methyltransferases leads to vobasine biosynthesis in Tabernaemontana elegans and catharanthus roseus. Frontiers in Plant Science, 15.

Identification and characterization of cytochrome P450 monooxygenases for monoterpenoid indole alkaloid diversification

UNIVERSITY OF NEW BRUNSWICK

THESIS DEFENCE AND EXAMINATION

in Partial Fulfillment

of the Requirement for the Degree of
Master of Science

by

Zhan Mai

in the Department of Chemistry

U.N.B., Fredericton, N.B.

Tuesday, March 25th, 2025
10:00 a.m.

Toole Hall, Room 244

Examining Committee

Dr. Yang Qu	Supervisor
Dr. Anna Ignaszak	Internal Examiner
Dr. Audrey Limoges	Int-Ext Examiner
Dr. David Burns	Chair of Oral Examination

Abstract

Cytochrome P450 monooxygenases (CYPs) are well known for their ability to catalyze diverse oxidation reactions, playing a significant role in the biosynthesis of various natural products. In the realm of monoterpenoid indole alkaloids (MIAs), one of the largest groups of alkaloids in nature, CYPs are integral to reactions such as hydroxylation, epoxidation, ring opening, ring rearrangement, and aromatization, contributing to the extensive diversification of these compounds. Integrating the transcriptomes and metabolomes of two MIA producing plants Tabernaemontana litoralis (milky way tree) and Vinca minor (lesser periwinkle), I discovered a new MIA 11-hydroxypseudovincadifformine and biochemically characterized five novel CYPs participating in various MIA oxidation reactions. The T. litoralis tabersonine 14,15-β-epoxidase (TliTbE) catalyzes the formation of pachysiphine, the stereoisomer of 14,15-α-epoxytabersonine (lochnericine) found in Catharanthus roseus (Madagascar periwinkle) roots. The T. litoralis pseudovincadifformine 18-hydroxylase (TliPs18H) is the first CYP identified to modify a pseudoaspidosperma skeleton. The T. litoralis coronaridine 10-hydroxylase additionally catalyzes 10-hydroxylation on voaphylline, which bears a quebrachamine skeleton. The V. minor pseudoakuammigine 10-hydroxylase (VmPs10H) not only catalyzes the last step for akuammine biosynthesis, but also performs 10-hydroxylation on structurally related picrinine and strictramine. The V. minor vincaminoreine 10-hydroxylase (VmV10H) additionally catalyzes oxidation on structurally unrelated MIAs apparicine, pericyclivine, and akuammidine. This study provides a comprehensive understanding of MIA biosynthesis and diversification in T. litoralis and V. minor, highlighting their potential for further exploration.