



University  
of Victoria

Graduate Studies

Notice of the Final Oral Examination  
for the Degree of Doctor of Philosophy

of

**GERALDINE GOURLAY**

BSc Honors (Dominican University, 2014)

**“Condensed tannins as *in vivo* antioxidants in *Populus tremula x tremuloides*”**

Department of Biology

Wednesday, December 18, 2019

9:00 A.M

Clearihue Building

Room B007

Supervisory Committee:

Dr. Peter Constabel, Department of Biology, University of Victoria (Co-Supervisor)

Dr. Barbara Hawkins, Department of Biology, UVic (Co-Supervisor)

Dr. Juergen Ehling, Department of Biology, UVic (Member)

Dr. Trevor Lantz, School of Environmental Studies, UVic (Outside Member)

External Examiner:

Dr. Scott Allan Harding, Warnell School of Forestry and Natural Resources, University of Georgia

Chair of Oral Examination:

Dr. Dan Smith, Department of Geography, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

## Abstract

Plants are exposed to diverse environmental stresses, which can lead to the accumulation of harmful reactive oxygen species (ROS). To prevent cellular damage, plants have evolved diverse antioxidant compounds and mechanisms to scavenge and remove ROS. My research aimed to determine if condensed tannins (CTs) function as *in vivo* antioxidants in plants. CTs are abundant plant secondary metabolites and are well-known for their strong *in vitro* antioxidant activity, but their function as antioxidants in planta has not previously been investigated. I used transgenic hybrid poplar (*Populus tremula x tremuloides*) with high (MYB134- and MYB115 overexpressing) and low (MYB134-RNAi) leaf CT content. Three different abiotic stresses were used to induce oxidative stress in the plants: methyl viologen (MV), drought, or UV-B stress. Oxidative stress can damage the plant's photosystems, and this damage was assessed using chlorophyll fluorescence. I employed light-adapted ( $F_q'/F_m'$ ) and dark-adapted ( $F_v/F_m$ ) parameters of chlorophyll fluorescence and monitored photosystem II function during each stress. Under all three stresses, the high-CT transgenics retained greater chlorophyll fluorescence, demonstrating reduced photosystem II damage, compared to wild-type plants. Oxidative damage was measured by quantifying malondialdehyde (MDA), and hydrogen peroxide ( $H_2O_2$ ) was quantified as a measure of ROS accumulation. High-CT plants consistently accumulated less  $H_2O_2$  and MDA than wild-type plants before and after each stress. MYB134 RNAi plants showed the converse effects, as predicted by lower CT concentrations, with reduced photosystem function and increased levels of  $H_2O_2$  and MDA compared to wild-type following each stress. Overall, this work demonstrates that CTs can function as *in planta* antioxidants and can aid in protection against oxidative damage. My work provides the first evidence for an antioxidant function of CTs in living plants exposed to stress.