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Subject: Final report for Dr. Wesley Zandberg's BCWGC 2017 research grant.

May 07, 2018

Dear BCWGC Members,

Thank-you for your financial support for my 2017 BCWGC research grant titled: *The development of reliable analytical methods for predicting wine-quality issues linked to forest fire smoke-exposed grapes*. These funds were paired with funding from an NSERC Engage (in support of a related smoke-taint project) and have helped my research team establish a productive smoke-taint research program at UBC's Okanagan campus. To date, these funds have led to the publication of three peer-reviewed manuscripts; a fourth article will be submitted in May 2018 (to *Planta*). These research papers are summarized below and electronic copies have been sent to the BCWGC c/o Kate Durisek.

1. Noestheden M, Thiessen K, Dennis EG, Tiet, B, and Zandberg, WF. (2017) Quantitating organoleptic volatile phenols in smoke-exposed *Vitis vinifera* berries. *J. Agric. Food Chem.* **65,** 8418-8425**.**

Quantitating volatile phenols (*i.e*., guaiacol, syringol, 4-ethylphenol, *etc*.) in *Vitis vinifera* berries and wine is necessary to develop predictive models of perceptible smoke-taint in wine when using smoke-exposed berries. We developed accurate methods to quantify free volatile phenols and their acid-labile conjugates. In building these methods, we addressed critical gaps in existing methods that impact quantitative accuracy. Addressing these deficiencies in testing practices will help the wine industry make accurate, informed decisions when producing wines from smoke-exposed berries.

2. Noestheden M, Dennis EG, and Zandberg WF. (2018) Quantitating volatile phenols in Cabernet Franc berries and wine after on-vine exposure to smoke from a simulated forest fire. *J. Agric. Food Chem*. **66**, 695 – 703.

The concentrations of smoke-taint-associated volatile phenols are reported in Cabernet Franc berries from *veraison* to commercial maturity and in wine after primary fermentation following on-vine exposure to simulated wildland fire smoke. Ponderosa pine was used as a fuel source for simulating forest fire smoke, making our results particularly relevant to North America, where many wine regions are close to pine forests. Volatile phenols increased after smoke exposure, were rapidly stored as acid-

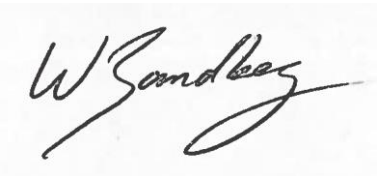
labile conjugates, and the levels of both free and conjugated forms of the volatile phenols remained constant through ripening to commercial maturity. It was also demonstrated that washing the berries immediately after smoke-exposure did not decrease the concentrations of volatile phenol present, suggesting that overhead irrigation is not a viable vineyard-based solution for mitigating smoke-taint. An increase in total volatile phenols after primary fermentation suggested the existence of conjugates other than the acid-labile volatile phenolic-glycosides already reported. This conclusion was supported with base hydrolysis on the same samples. These data suggested a regional identity for the chemical characterization of smoke-taint and they inform efforts to produce a predictive model for perceptible smoke-taint in wine based on the chemical composition of smoke-exposed berries. The fuel source is a key variable that drives regional differences in smoke-taint, which we demonstrated by comparing the volatile phenols present in our smoke *versus* those from an Australian pine species, as well as in the berries and wines.

3. Noestheden M+, Dennis EG+, Romero-Montalvo E, DiLAbio, GA, and Zandberg, WF. (2018) Detailed characterization of glycosylated sensory-active volatile phenols in smoke-exposed grapes and wine. *Food Chemistry* **259**, 147 – 156. (+ = co-authors).

We developed a complete method for the analysis of simple volatile phenol glycosides that can be elevated in berries and wine following smoke exposure. We synthesized 20 model VP-glycosides, four of which are not reported previously, to facilitate method development. Putative non-VP glycosides elevated in smoke-exposed berries are demonstrated for the first time. This supported our previous finding in Cabernet Franc of base-sensitive conjugates. As well, we confirmed the identity of several new VP-glycosides that appear to be specific to our wine growing region, and may be related to the fuel source used to generate the simulated forest fire smoke. Sensory analysis confirmed the presence of smoke-taint in the wine used to identify the new volatile phenol conjugates. However, the concentrations of the glycoconjugates are much lower than those reported elsewhere, providing further evidence for the chemical regionality of smoke-taint as a function of wine growing region.

Again, BCWGC members are thanked for their support. Our group is still currently engaged in smoke-taint research, and we are currently endeavouring to better characterize in-grape VP-storage forms that are not simple glycosides in addition to exploring in-winery and/or in-vineyard amelioration strategies. We would be happy to provide additional details by phone or email.

Sincerely,



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