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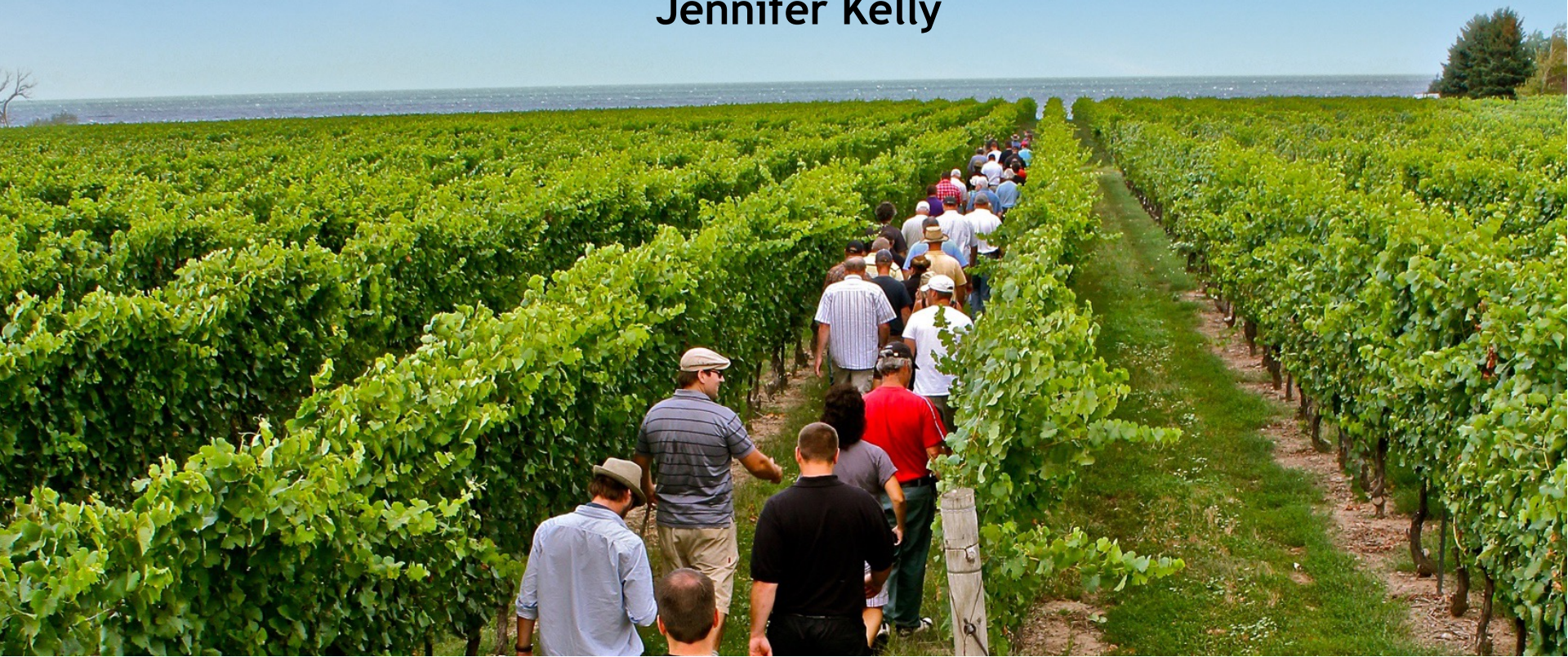
Winemaking Techniques to Manage Tannins:
A Pinot Noir and Cabernet Sauvignon Case Study

April 3, 2024

Jennifer Kelly



Outline

- Cool climate winemaking in Ontario
- Tannins in grape skin and seeds
- What do tannins contribute to wine flavour?
- TanninAlert database
- Data from 2019/2020
  - Winemaking with Pinot noir and Cabernet Sauvignon
- Sensory data from 2019/2020 wines
- Concluding statements

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Winemaking in Ontario

- **Cool climate**
- **Challenges with variation from vintage to vintage**
- **Winemakers and grape growers are constantly adapting**
  - Unpredictable and extreme weather events (increased precipitation during ripening and harvest, warmer than normal winters, early spring frost)
  - Ripening capacity can vary
    - Varieties
    - Sites

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The Problem

- **Consistency→** How can we consistently produce **red wines** of high quality despite vintage-to-vintage variation?
- **Cool climate leader in production**
  - Want to appeal to consumers
- **Important red wine quality markers→** Colour, mouthfeel / texture
  - All driven by tannin profile
    - Want the right balance of skin and seed tannin in grapes at harvest
    - Harvest timing is important
  - This is challenging in cool climate due to barriers in reaching optimal ripeness
    - Slow ripening can lead to low accumulation of tannins in grapes (can be considered “under ripe”)

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Proposed Solutions

- Winemakers may make stylistic considerations and adjustments in their processes
  - Based on varietal, vintage conditions, previous successes, style preference, winery portfolio
- It is common practice to assess other ripeness indicators
  - Brix
  - pH
  - TA
- What about tannin level?
  - Measurement on tannin is important for the bigger picture
  - Can we help make this consideration part of the toolbelt of winemakers?

What are Tannins? Skin and Seed Tannin

- **Skin Tannin**
  - Composed of monomers (catechin, epicatechin and epigallocatechin/gallochatechin) and polymers (procyanidin) (Gouot et al., 2019)
  - Mostly responsible for colour stabilization during winemaking and aging when they bind to anthocyanins→ Bind to grape pigments that are found in the skin (Conde et al., 2007)
  - They are extracted early, usually within the first two-three days of fermentation (Pappas et al., 2015; Rousserie et al., 2019)
  - More desirable for quality

- **Seed Tannin**
  - Also composed of monomers and polymers (more monomers than polymers) therefore smaller compounds
    - Higher in flavan-3-ols like: epicatechin, catechin and epicatechin gallate
  - Structure of wine as well as contributing to colour stabilization and protection from oxidation (Rousserie et al., 2019)
  - Much higher concentration than skin tannins (fresh berry weight) (Casassa, 2017)
  - Over-extraction of seed tannin = high levels of rough/drying tannin, low colour, lack of fruit flavour

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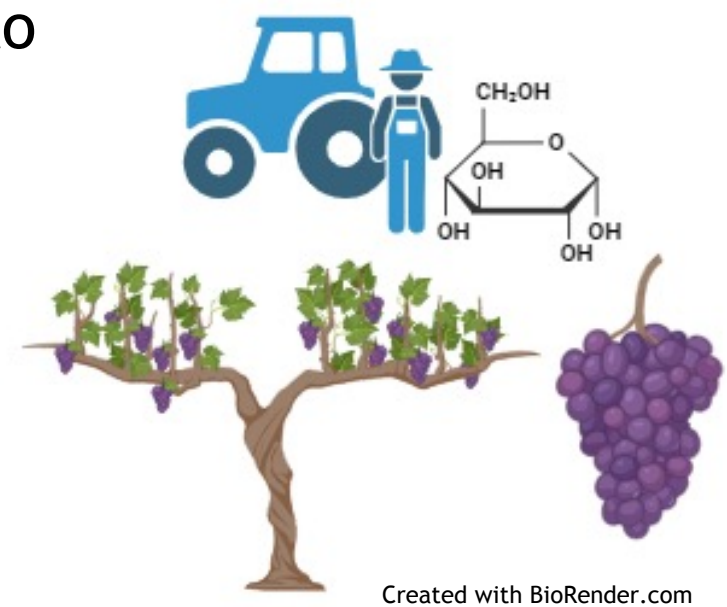
Factors Influencing Tannin Levels

- **Grape maturity→** Increased skin tannin concentration could lead to higher wine tannin
- **Higher sugars→**(and subsequent higher ethanol levels) lead to increase tannin and colour extraction
- **Canopy management→** Bunch exposure, irrigation levels, vine vigour, plant growth regulators (ABA can stimulate the production of skin tannin in grapes when applied exogenously around veraison)



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Watrelot, 2020

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Sensorial Impact of Tannin in Wine

•Associated with **astringency**:

- **Drying & puckering** oral sensation
  - **NOT** a taste, this is a mouthfeel or a tactile sensation
- Smaller tannin molecules (seed tannin) = **bitter**
- Larger tannin molecules (skin tannin) = **astringent**

•Change size via polymerization over time leading to colour changes and reduced astringency

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What can TanninAlert do for the Industry?

- The TanninAlert program reports tannin ripeness levels for six red varieties over different sites→ Veraison to harvest
  - Updated in real time during preharvest monitoring
- Assessment of tannin in both skin and seed
- Input information into an Ontario database for winemakers and growers to gather more data to optimize protocols
- Ultimately the goal is to increase Ontario wine quality, increase domestic wine sales and market share

What can TanninAlert do for the industry?

- **Examples of what the TanninAlert database has demonstrated over many years of data collection**
- Skin and seed tannin accumulation during ripening up to harvest
- Differences amongst varieties
- Differences amongst vintages
- Differences amongst sites

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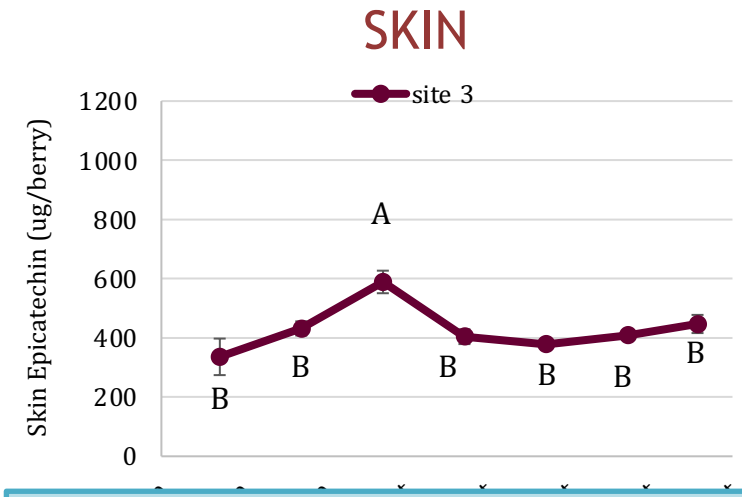
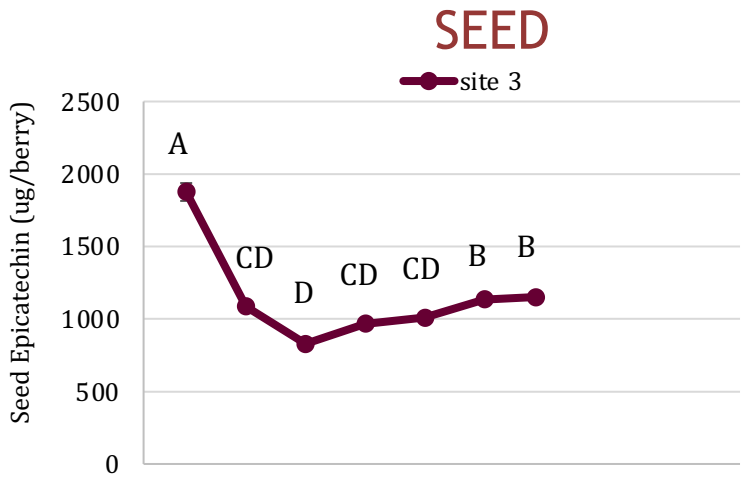
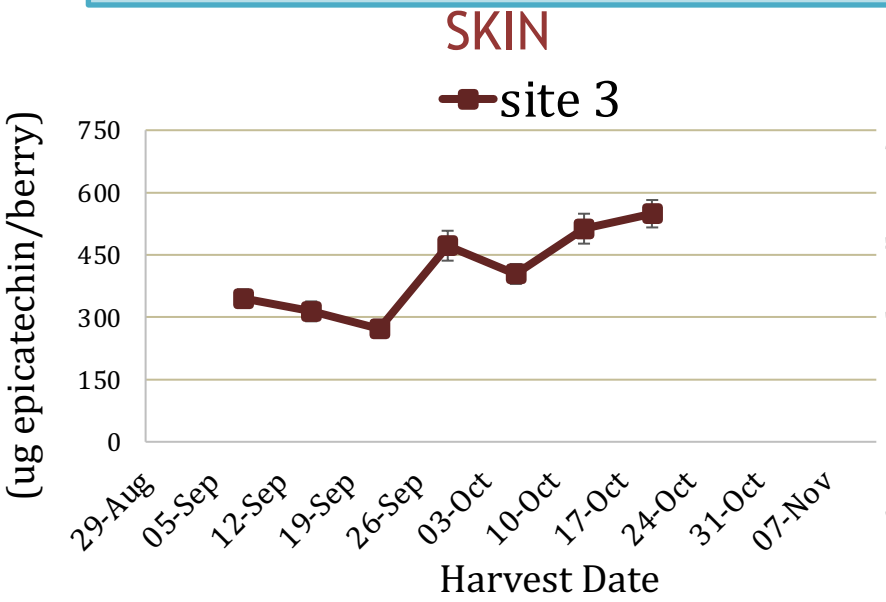
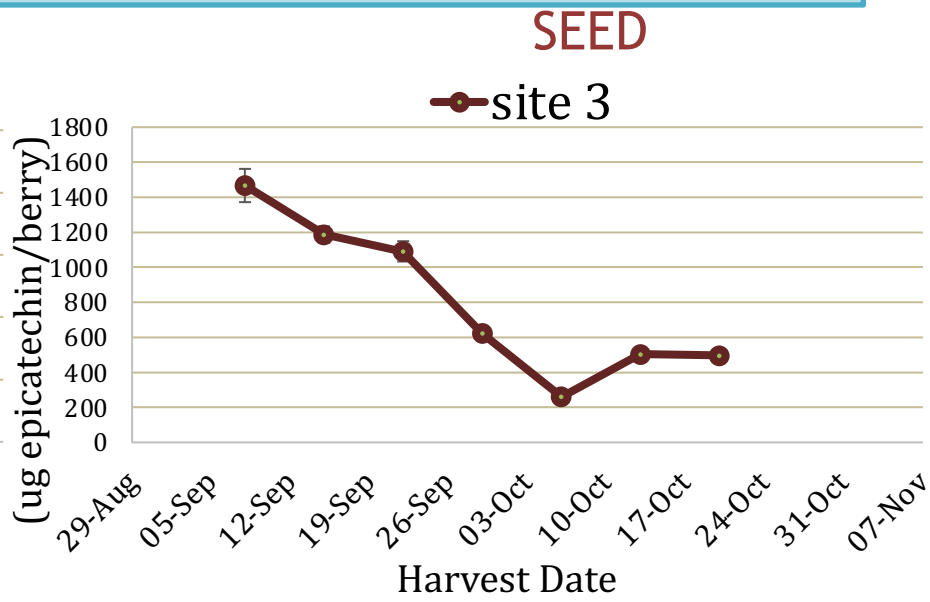
Tannin Development: Up to harvest
Cabernet Sauvignon, 2019/2020 (Vintage variation)





Expecting extractable skin tannin to increase over time and extractable seed tannin to decrease over time





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Tannin Differences: Site Importance of annual data collection

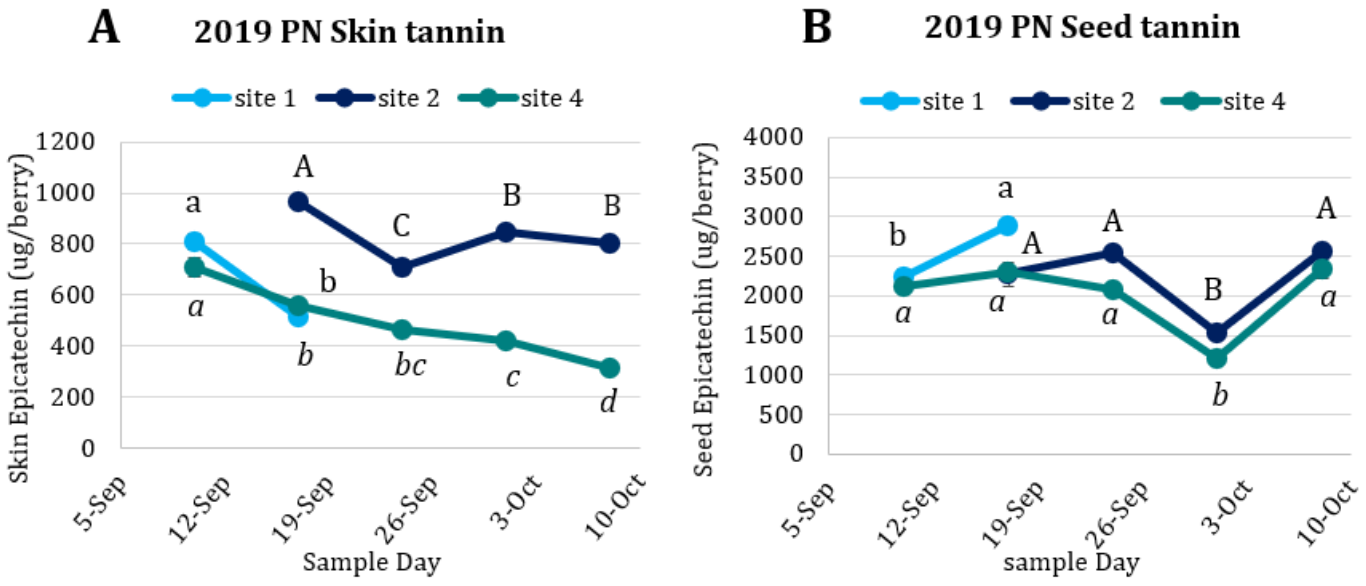
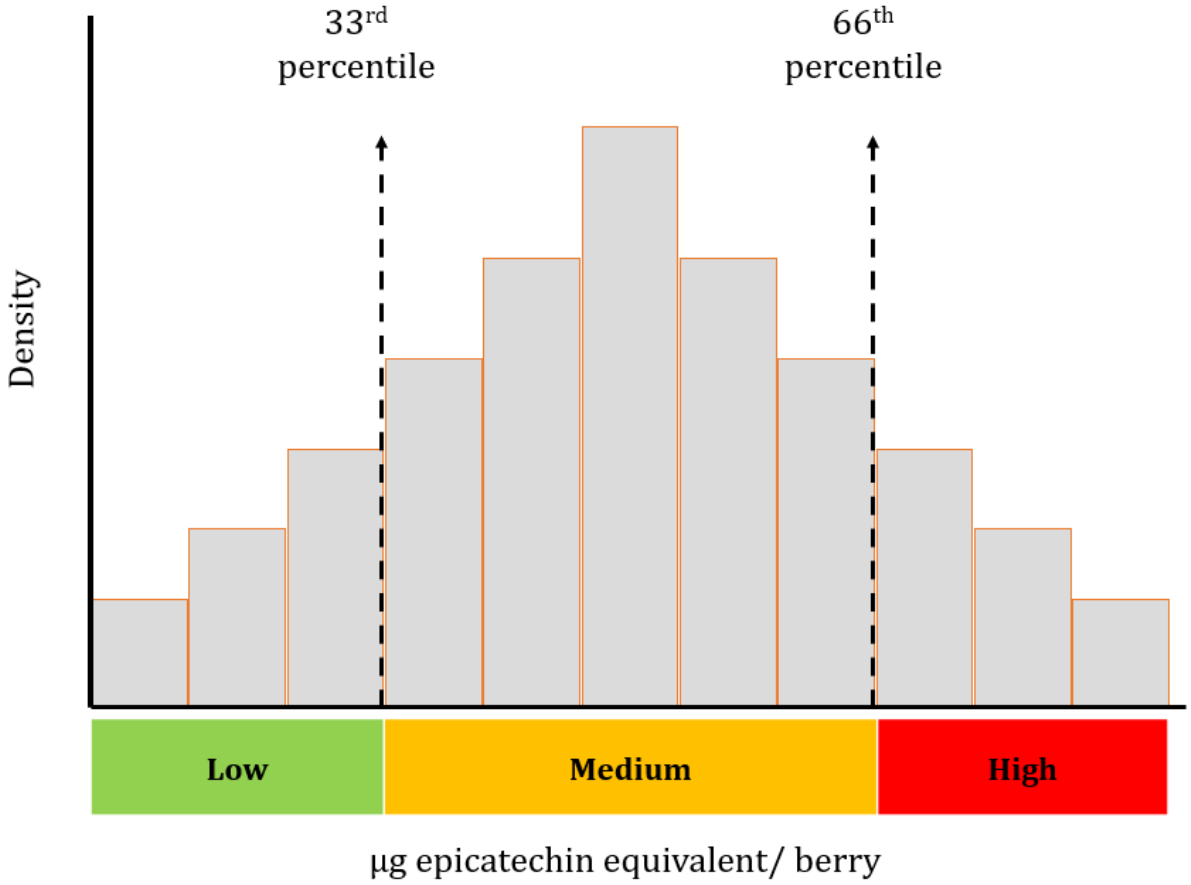


Figure 2.7: Extractable skin and seed tannin concentration (µg/berry) in Pinot noir during the 2019 growing season in 4 vineyards across the Niagara Region. Sites 1 (Four Mile Creek), 2 (Niagara Lakeshore), and 4 (Lincoln Lakeshore). Skin tannin is plotted in figure A and seed tannin in figure B. Different lower-case letters represent significant differences (Student ttest p

Tannin Distribution: Histogram



How would a winemaker compare their skin and seed data to the database?
The tannin levels are categorized as low, medium, or high based on the 33rd and 66th percentile of the distribution

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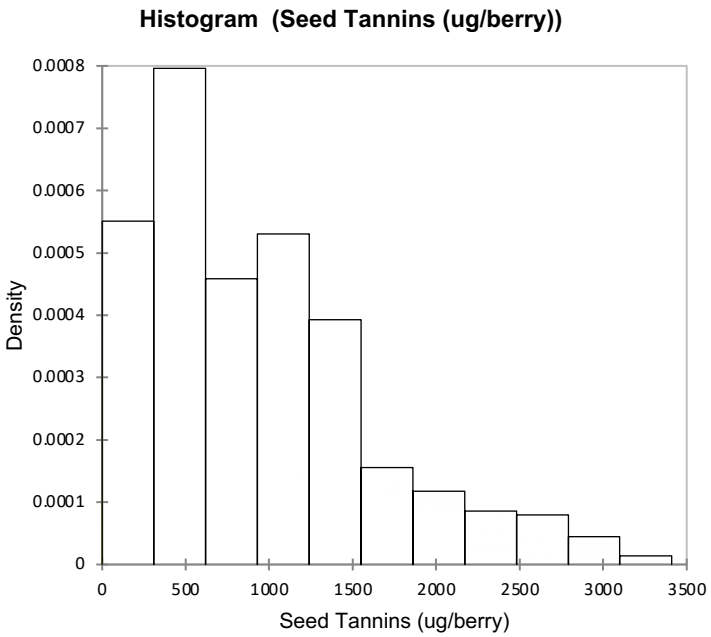
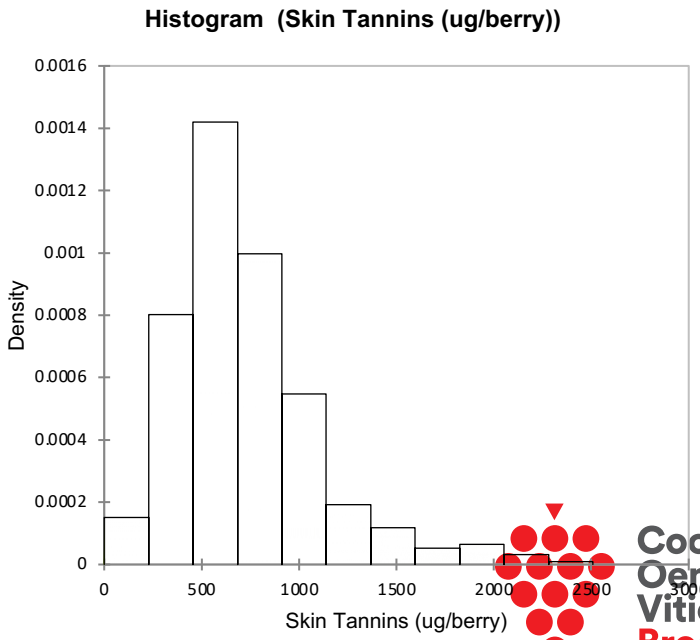
Benchmarking Varieties: Utilizing the Database

Skin and Seed Tannin Ranges for all samples at Harvest 2015-2022 from Excel File
Capturing the full scale of range for the Niagara Region→ Will continue to grow

Variety	Skin tannin range (µg epicatechin/berry)			Seed tannin range (µg epicatechin/berry)		
	low	medium	high	low	medium	high
All Varieties	40.4-526.3	536.2-796.0	796.0-2485.6	12.1-534.4	534.4-1127.2	1127.2-3381.9





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Project: Low Tannin vs High Tannin Varieties

- **This project studied the impact of winemaking techniques on low and high tannin cultivars**
  - Selection of Pinot noir and Cabernet Sauvignon to represent both ends of the tannin spectrum
- **Do the treatments of exogenous tannin addition, pre fermentation pressing, saignée and enzyme addition impact the final tannin concentration of these varieties?**
  - Are high and low tannin cultivars impacted differently?
- **Are there perceptible difference in the treatments?**
- **When compared to the chemical data, do we see an impact?**

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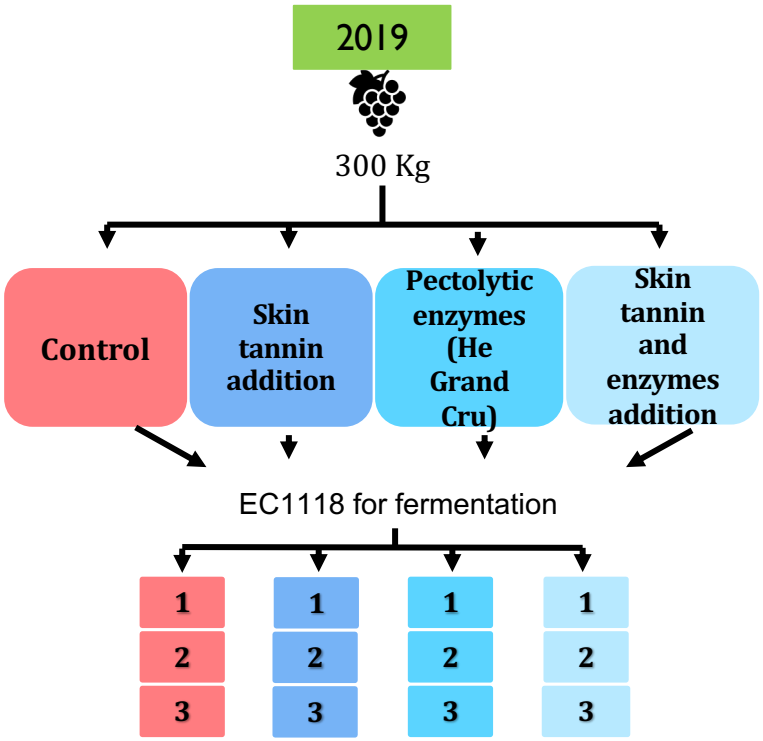
Pinot noir Profile

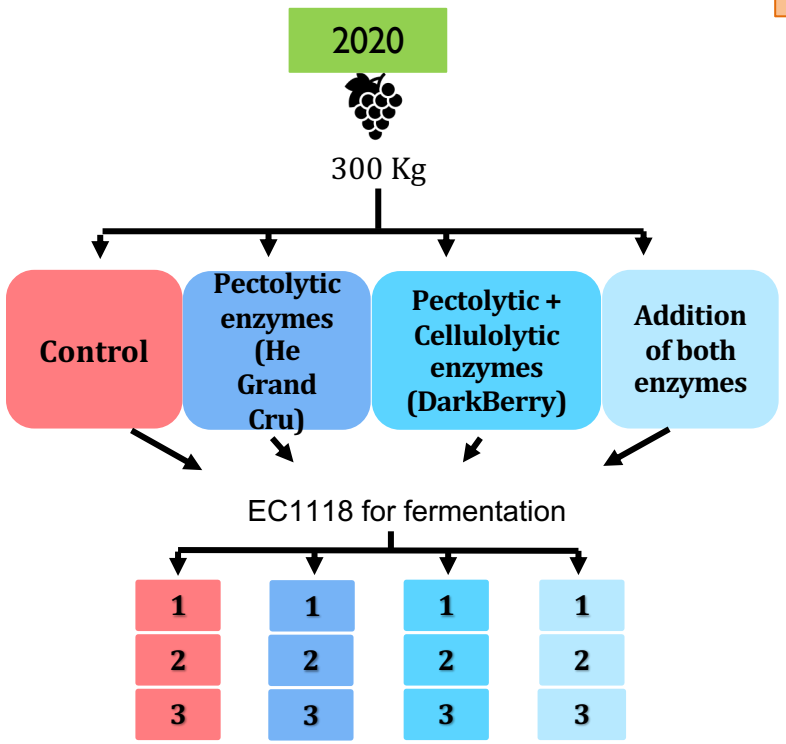
- Seeds: 80% of the total polyphenols in the grapes in Pinot noir; 15-20% from skins (Rousserie et al., 2020)
- Can lead to wines that are higher in astringency
- Potential for over-extraction of the seed tannins to extract as much skin tannins and colour as possible during fermentation

Cabernet Sauvignon Profile

- Seeds: 95% of total polyphenols in grapes from Cabernet sauvignon; only 5% from skins (Mattivi et al., 2009)
- In a cool climate, Cabernet sauvignon grapes are often harvested when not fully ripened, which leads to a low skin tannin and pigment accumulation (Salamone et al., 2019).

Pinot noir: Winemaking Experimental Design





Tannin analysis

- MCP
- Phenolics

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Pinot Noir: Skin and seed values 2019 / 2020, site 5

Pinot Noir:
Skin and seed tannin concentrations at harvest

2019

	Low	Medium	High	Site 5
Skin	40.4-526.3	526.3-796.0	769-2485.6	562
Seed	12.1-534.4	534.4-1127.2	1127.2-3381.9	3124

Pinot Noir Skin:
Seed tannin concentration at harvest

2020

	Low	Medium	High	Site 5
Skin	40.4-526.3	526.3-796.0	769-2485.6	697
Seed	12.1-534.4	534.4-1127.2	1127.2-3381.9	798

More optimal

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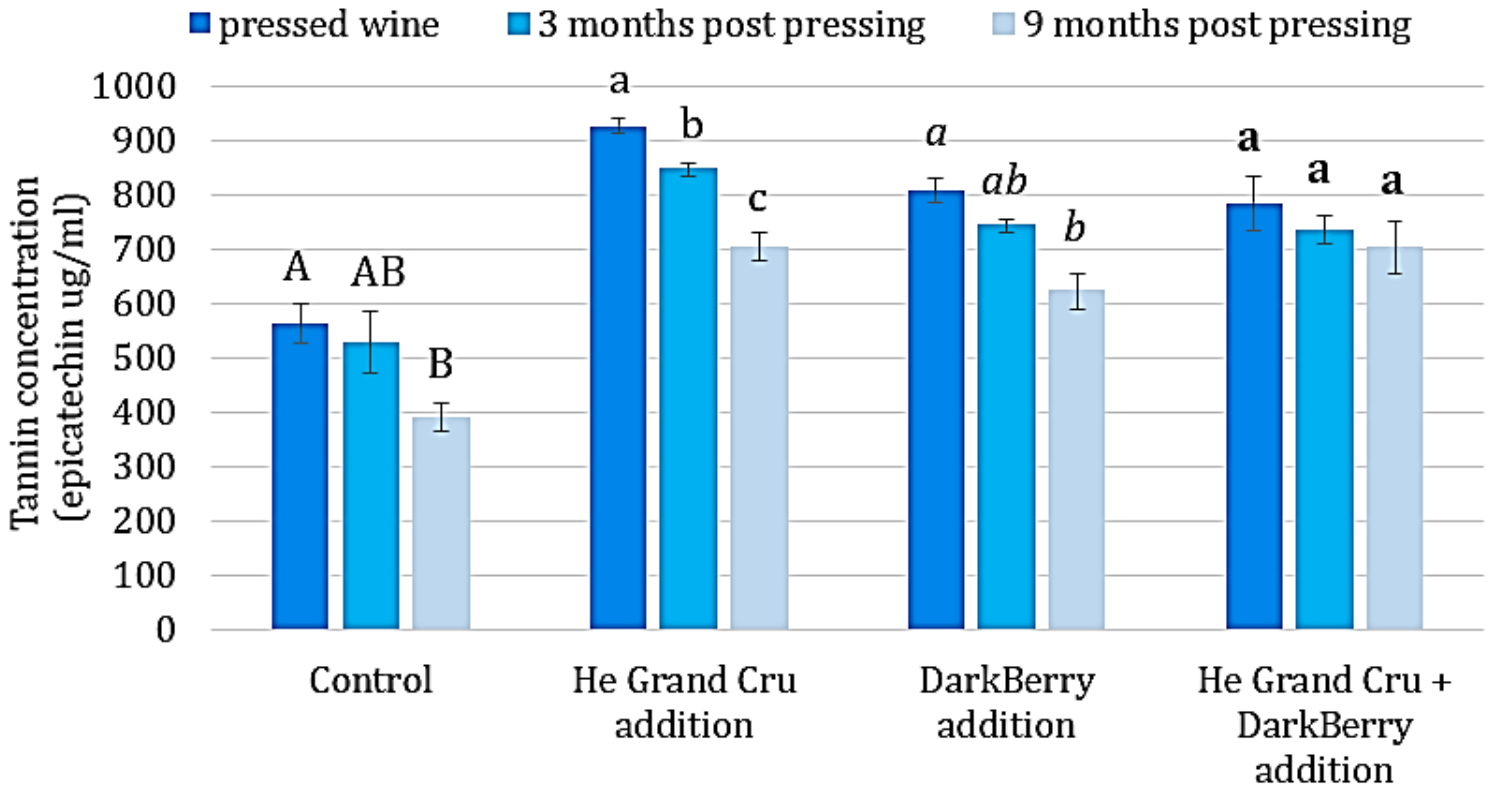
Pinot Noir: 2020
Tannin retention over time



Tannin retention also better with enzyme addition versus the control

Addition of enzymes increased the concentration of extractable tannins

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Design of Difference Test

- Sensory tests were conducted in August, 2023
- Participants were recruited from Brock University
- “Everything was compared to everything”
- Participants received 6 triads and were asked to determine which wine was different
- Aroma and taste were assessed and the question was: “which wine is different?”

Compusense.

- Pinot noir: Week 1, 31 participants
- Cabernet Sauvignon: Week 2, 32 participants

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Results of Difference Test: Pinot noir

Triad	Treatment	Correct	Incorrect	Total
1	**Control** **T1: He Grand Cru Addition**	**19**	**12**	**31**
2	**T2: Darkberry Addition** **T3: He Grand Cru + Darkberry**	**20**	**11**	**31**
3	**Control** **T2: Darkberry Addition**	**22**	**9**	**31**
4	**Control** **T3: He Grand Cru + Darkberry**	**25**	**6**	**31**
5	T3: He Grand Cru + Darkberry T1: He Grand Cru Addition	13	18	31
6	T1: He Grand Cru Addition T2: Darkberry Addition	14	17	31

Critical values from Kemp et al., (2009)
At 5%=16, 1%=18, 0.1%=20

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Pinot noir: Some Comment Data

Open ended opportunity for participants to include some descriptors around the wines. Those that were “tannin-related” have been sorted and wines that were described with those words were quantified

Words	Control	T1: He Grand Cru Addition	T2: Darkberry	T3: He Grand Cru+ Darkberry
Drier, grippy, tannic, tannin, bitterness, mouthfeel, astringency, bitter	13	13	7	12

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Sensorial Take Aways

- **Pinot noir:**
  - Panelists were correct more often (compared to Cabernet Sauvignon trial)
  - **Differences between wines**
    - **Most pronounced when treatments are compared to control**
    - **Also T2: Darkberry Addition to T3: He Grand Cru + Darkberry**
  - Panelists were not able to discern between T3 (He Grand Cru + Darkberry) and T1 (He Grand Cru) as well as T1 (He Grand Cru) and T2 (Darkberry)
  - Aligned with extractable tannin data
  - Hypothesis: Low tannin variety may be more susceptible to levels of extractable tannin

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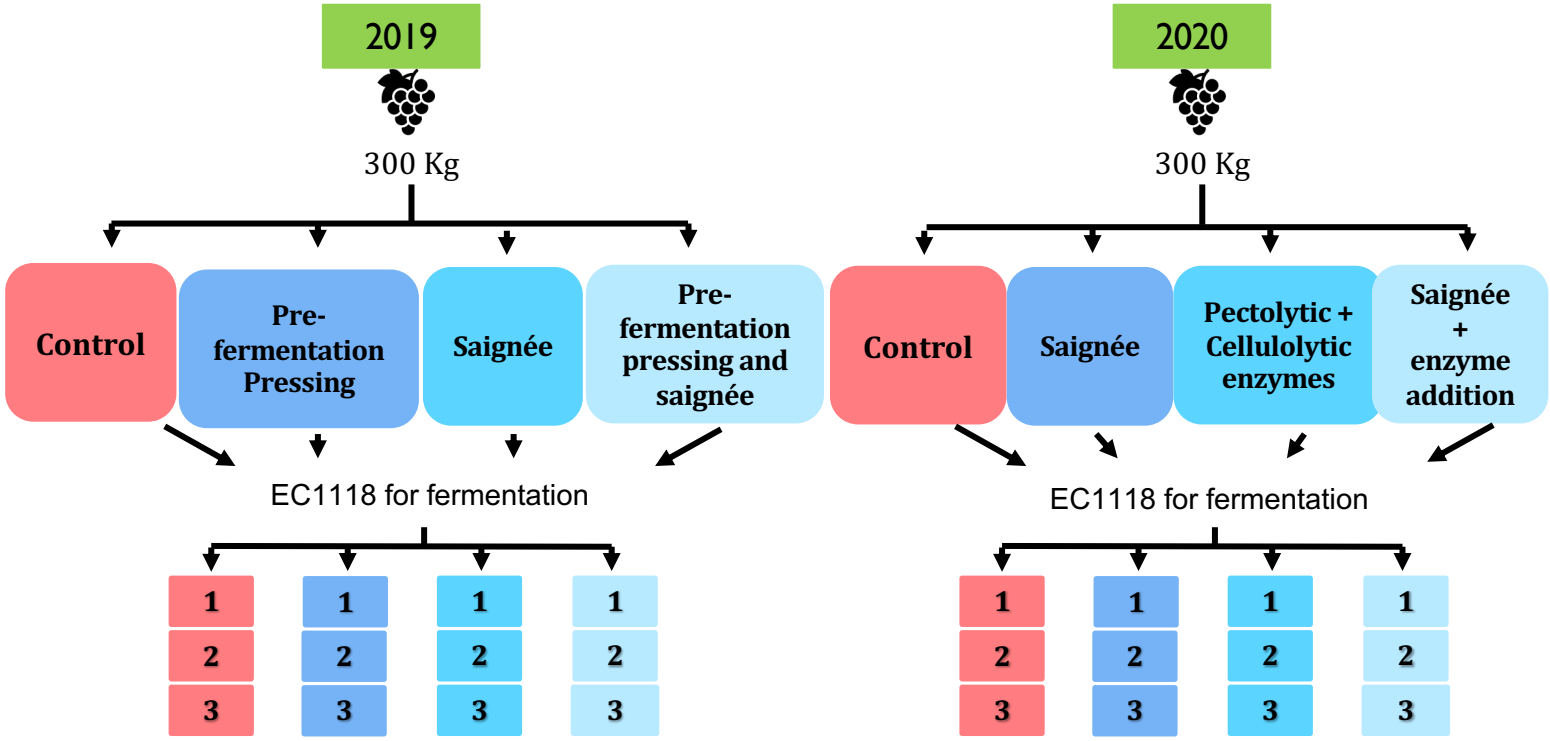
Cabernet Sauvignon: Winemaking Experimental Design



Tannin analysis

- **MCP**
- **Phenolics**

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Cabernet sauvignon: Skin and seed values 2019 / 2020, site 1

Skin and seed tannin concentrations of Cabernet sauvignon at harvest, site 1

2019

	Low	Medium	High	Site 1
Skin	40-512	513-734	735-1900	668
Seed	41-580	581-1126	1127-2025	1184

Skin and seed tannin concentrations of Cabernet sauvignon at harvest, site 1

2020

	Low	Medium	High	Site 1
Skin	40-512	513-734	735-1900	659
Seed	41-580	581-1126	1127-2025	1165

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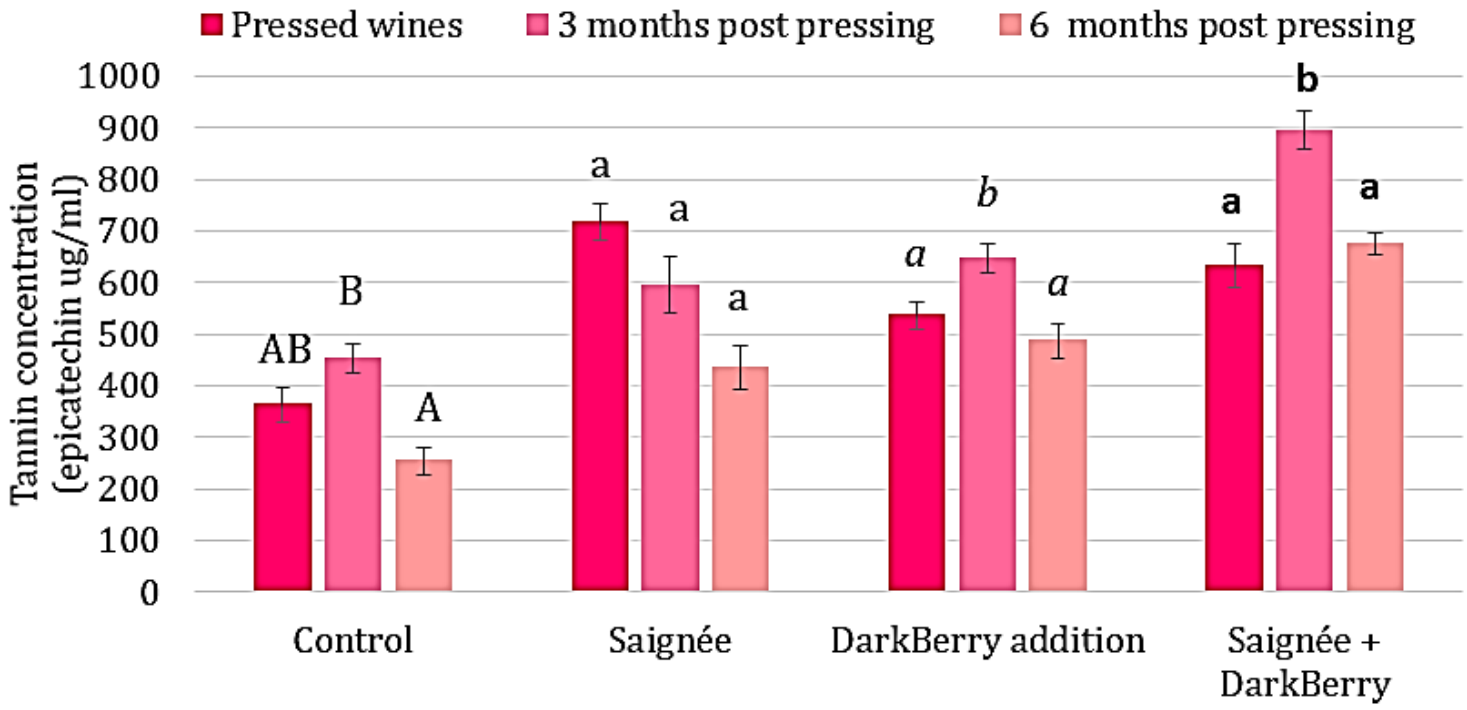
Cabernet sauvignon: Tannin retention over time



Tannin retention better with saignée and enzyme

The combination of saignée and DarkBerry enzyme had higher extractable tannins ($p<0.05$)

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Results of Difference Test: Cabernet sauvignon

Triad	Treatment	Correct	Incorrect	Total
1	Control T1: Saignee	10	22	32
2	**T2: Darkberry Addition** **T3: Saignee + Darkberry**	**16**	**16**	**32**
3	**Control** **T2: Darkberry Addition**	**19**	**12**	**32**
4	**Control** **T3: Saignee + Darkberry**	**16**	**16**	**32**
5	T3: Saignee + Darkberry T1: Saignee	4	28	32
6	T1: Saignee T2: Darkberry Addition	2	30	32

Critical values from Kemp et al., (2009)
At 5%=16, 1%=18, 0.1%=20

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Some Comment Data

Open ended opportunity for participants to include some descriptors around the wines. Those that were “tannin-related” have been sorted and wines that were described with those words were quantified

Words	Control	T1: Saignee	T2: Darkberry	T3: Saignee + Darkberry
More tannin, much bitter, bitterness levels, astringency, mouthfeel, sharp, bitter, drying, prickly, chewy	12	16	22	15

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Sensorial Take Aways

- Cabernet Sauvignon
  - Panelists were correct less often when compared to Pinot noir data
  - Panelists were unable to detect differences in the Saignée method from the control unless there were enzyme added
    - Aligned with extractable tannin data
  - The results from the Darkberry addition + Saignée and Darkberry addition were evenly split amongst panelists
  - Same for Control and T3: Saignée + Darkberry
    - Still considered significantly different, but more difficult for panelists to identify differences
  - More words associated with tannin when compared to PN data
  - These results indicate that the higher tannin varieties may be less perceptibly impacted by the addition of enzyme, as the control wines are already high in perceptible tannin

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Other Sensory Findings

- Li et al., 2020
  - Favourable hedonistic assessment of wine with tannin addition
    - Considerations: appearance; aroma and bouquet; taste and texture; after taste; overall impression
    - This was dependent on the mixture of added tannins
    - These authors report highest rated preference sensory results with tannin mixture of 1:1 ratio of hydrolysable and condensed tannin

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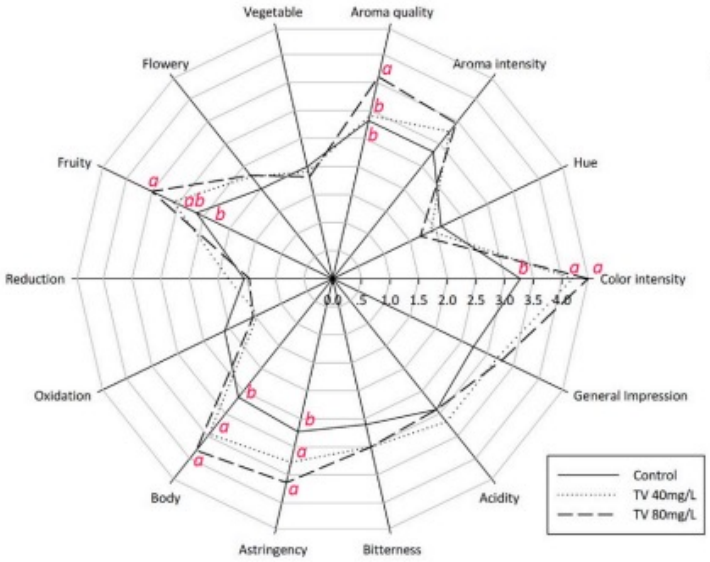
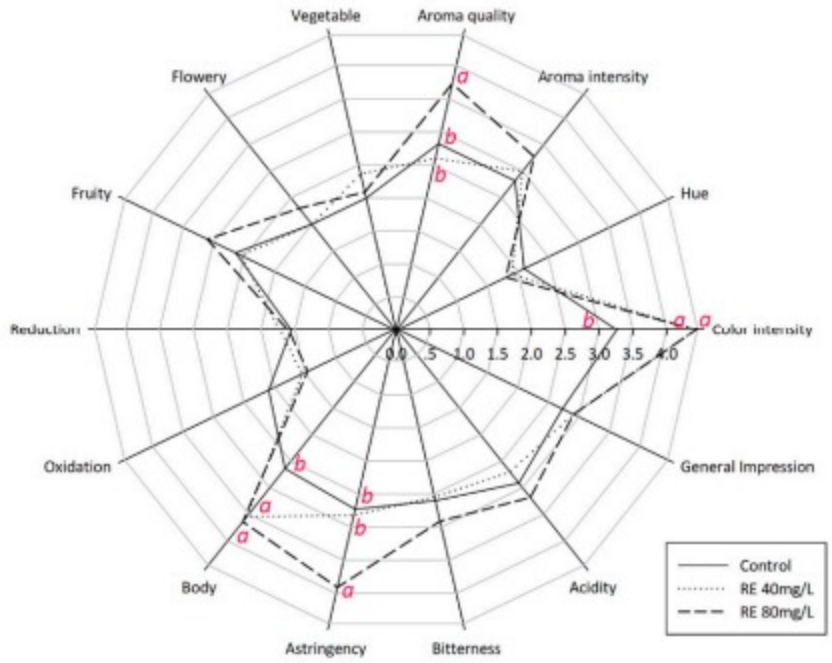
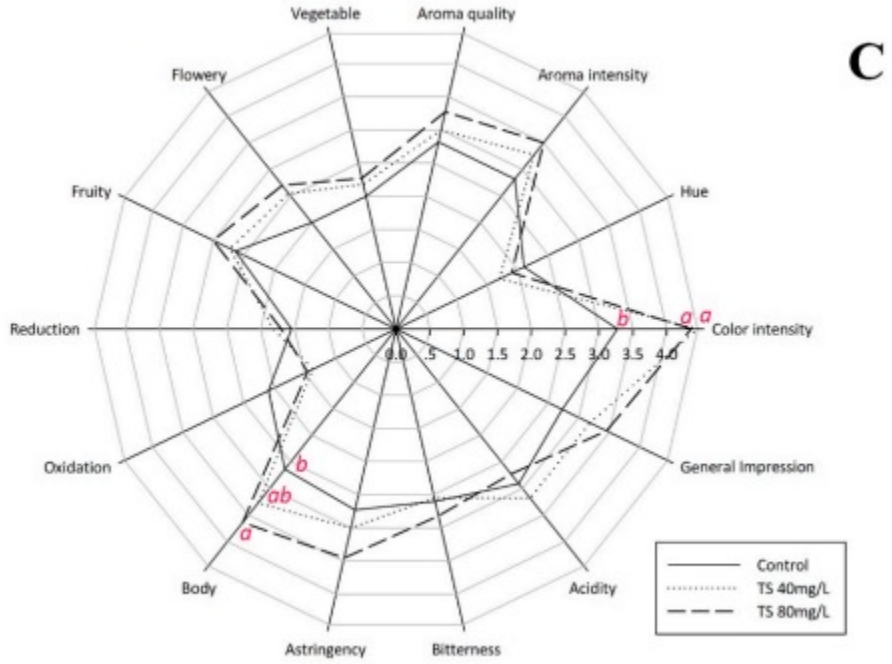
The Effects of Pre-Fermentative Addition of Oenological Tannins on Wine Components and Sensorial Qualities of Red Wine
Chen et al., 2016







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Tannin Management in Winery (Smith et al., 2015)

- Enzyme addition
- Extended maceration

} Increase the amount of tannin in finished wine

- Cold soaking crushed must (not consistent across grape varieties)
- Cap management (submerged cap extracts more tannins than punchdowns)
- Temperature regime during fermentation (increase in temp = increased total tannin extraction)
- Flash détente increased tannin, but were not stable after pressing (cap management important)
- Oxygen management during fermentation
- Saignée or juice runoff can increase tannin
- Yeast selection can influence final tannin

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Future Directions

- Continuing to grow the TanninAlert database will continue to inform the industry
- Further sensory evaluation, based on preliminary information could lead to better understanding the impact of treatments on the wines
  - Descriptive analysis to compare full profiles
  - Consumer preferences to understand full impact of winemaking techniques to manage tannins

Thank You

- Charlene Marcotte, MSc
- Daniel Phillipow, MSc Candidate
- Dr. Belinda Kemp and Dr. Debbie Inglis
- All of the panelists who participated in this project

CRSNG NSERC

Canadian Grapevine Certification Network
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- Andrew Peller Ltd
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- Lawrie vineyards
- Hughes vineyards
- Creekside winery
- Pondview
- 13th Street Winery
- Schenck Farms
- Huebel Grape Estates
- Koop Farms
- George Vineyards
- Fielding Estates
- Arterra

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Thank you!
Questions?