IOWA STATE UNIVERSITY

Extension & Outreach

Tannins in winemaking with hybrids

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Outline

- Iowa grape and wine industry
- What are the challenges?
  - Color stability
  - Ageability and mouthfeel

- Winemaking techniques applied
  - Accentuated Cut Edges
  - Whole clusters fermentation

- Other techniques in progress

IOWA WINE BY THE NUMBERS

IOWA WINE GROWERS ASSOCIATION

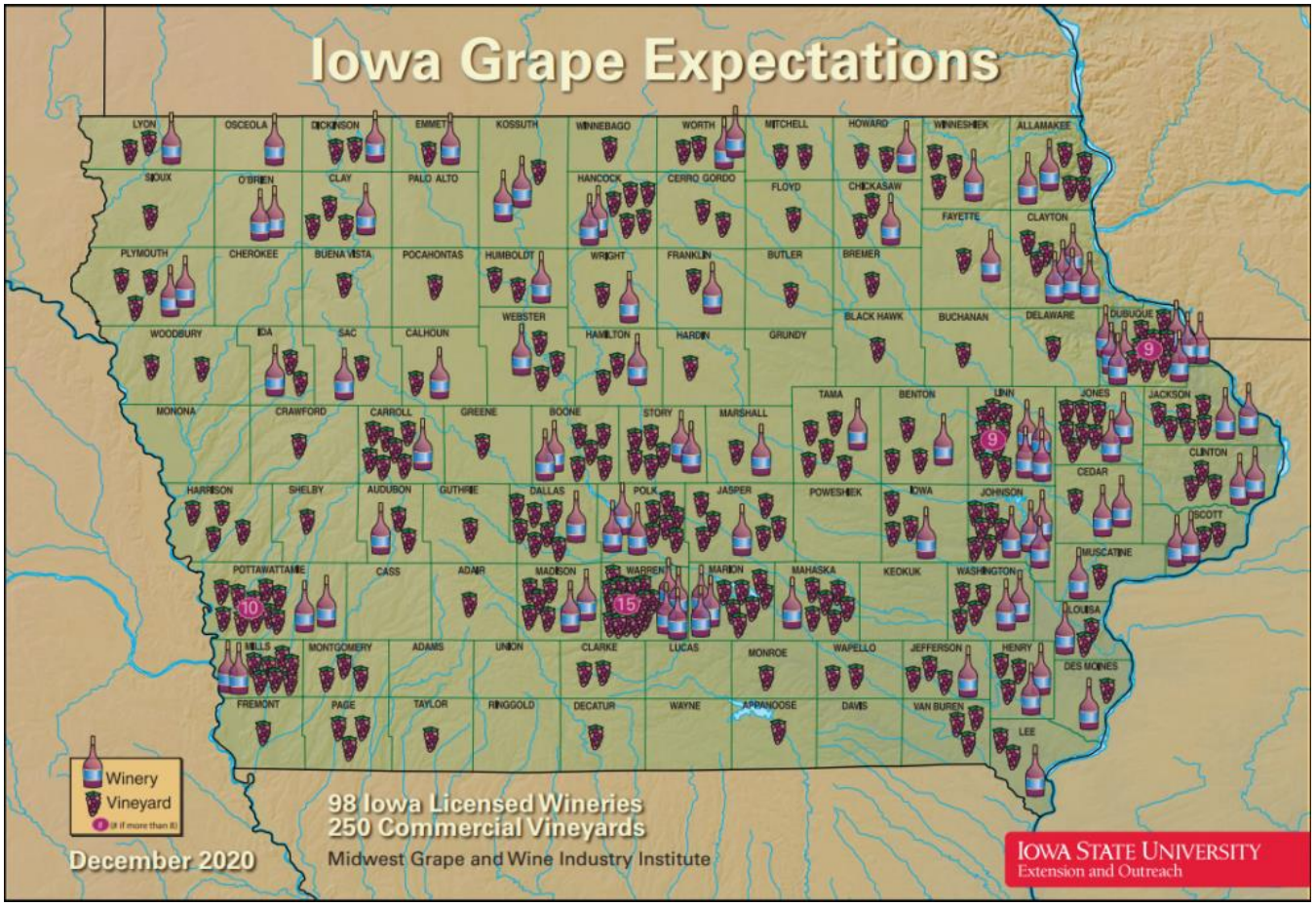
nearly 100 wineries

more than 250 vineyards

1,300+ acres of grapes

2 American Viticultural Areas

40+ Cold-Climate Grape Grown



Some cultivars:

Brianna
Edelweiss
La Crescent
La Crosse

Frontenac
Marquette
Petite Pearl
St Croix

What is the ultimate goal?

High quality wine but what does it mean?

Very subjective BUT is:

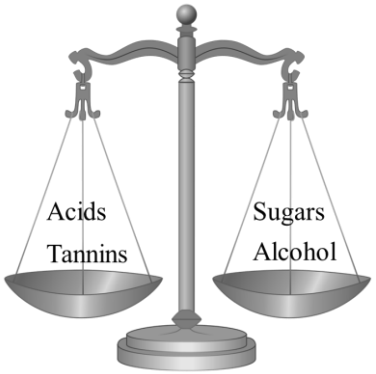
A wine the consumer like, which does:

-look good

-smell good

-taste good

What is the ultimate goal?



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-not have one component overpowering the wine

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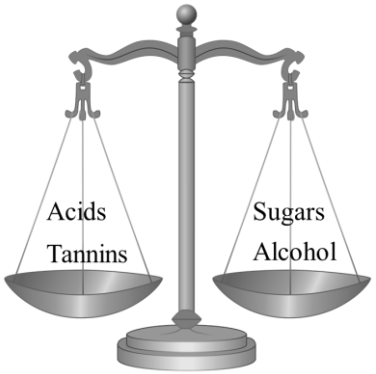

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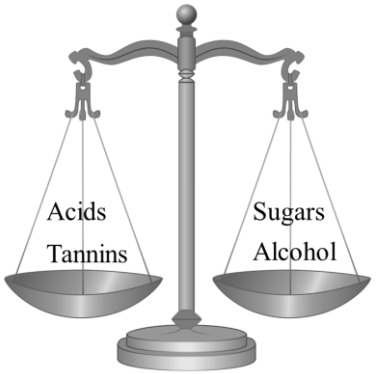

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Growing conditions and challenges

Harsh cold winter

High vigor

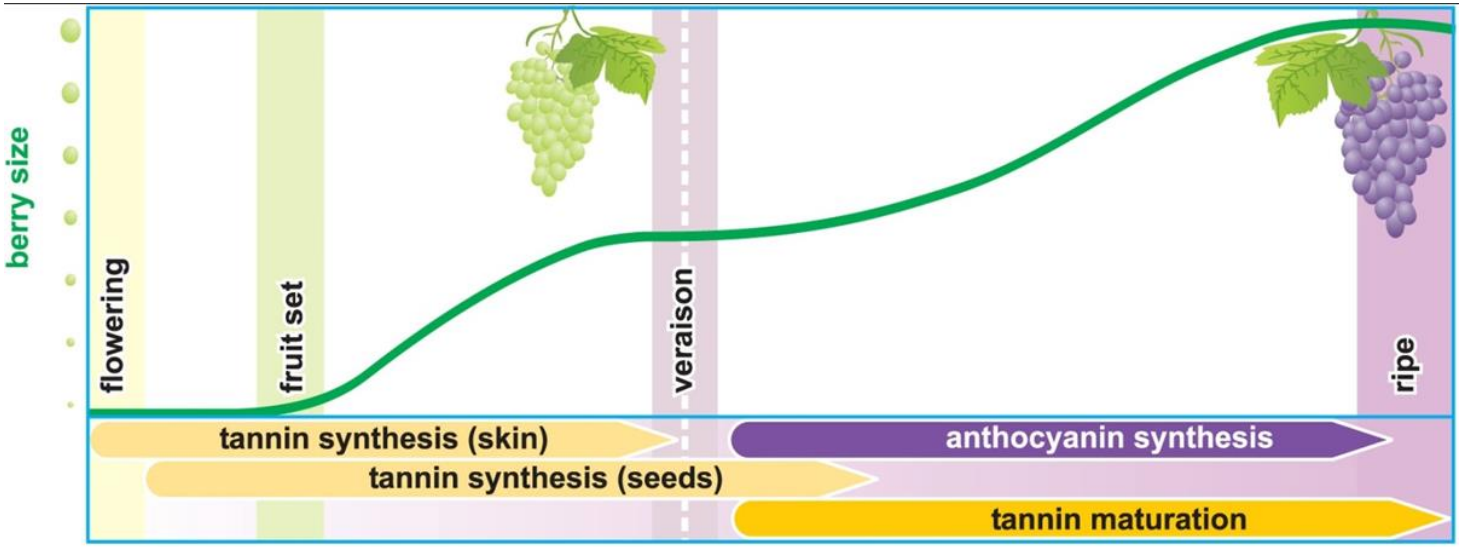
Hot/humid summers

Short growing season

Different maturity (basic chemistry vs. phenolics)

- High pH and high TA
- Pectins-rich flesh
- Pathogenesis-related proteins

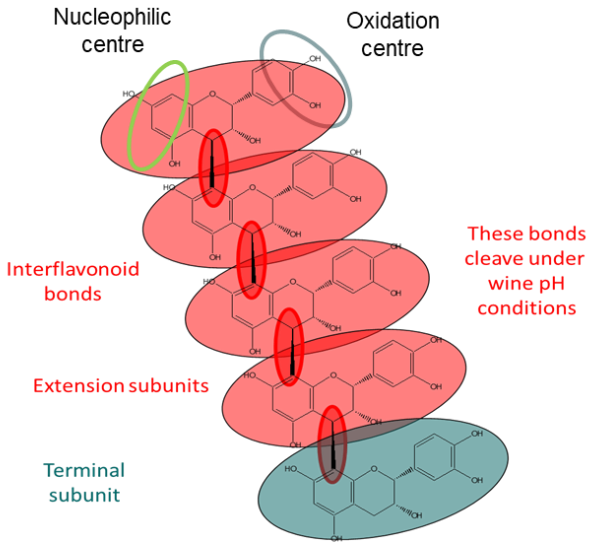
Biosynthesis of phenolic compounds



-High anthocyanins content (in skins and flesh)

-**Tannin content**

Condensed tannins



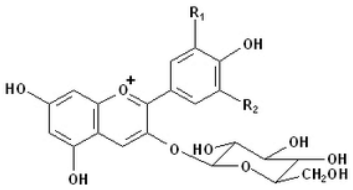
- From skins, seeds and stems of grapes
- They are responsible for:
  - astringency mouthfeel,
  - ageability of wine (protection against oxidation) and,
  - color stability

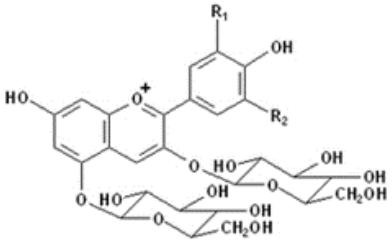
- Can bind to polysaccharides, proteins
- Can bind to and form new pigments with anthocyanins
- Can react with oxygen

"**Red wines allocated to higher market value grades have higher total phenolics and higher tannin concentrations**" Mercurio et al., 2010 JAFC, Vol 58

Anthocyanins

Mono and di-glucosides
(up to 6 g/L)





R_1=H	R_2=H	Pelargonidin-3-*O*-monoglucoside
R_1=OH	R_2=H	Cyanidin-3-*O*-monoglucoside
R_1=OH	R_2=OH	Delphinidin-3-*O*-monoglucoside
R_1=OCH_3	R_2=H	Peonidin-3-*O*-monoglucoside
R_1=OCH_3	R_2=OH	Petunidin-3-*O*-monoglucoside
R_1=OCH_3	R_2=OCH_3	Malvidin-3-*O*-monoglucoside

Cyanidin-3,5-diglucoside
Delphinidin-3,5-diglucoside
Malvidin-3,5-diglucoside
Peonidin-3,5-diglucoside
Petunidin-3,5-diglucoside

Figure 4: *Color of the diglucosidic form of five common wine anthocyanins at 0.1 mM in model wine.*

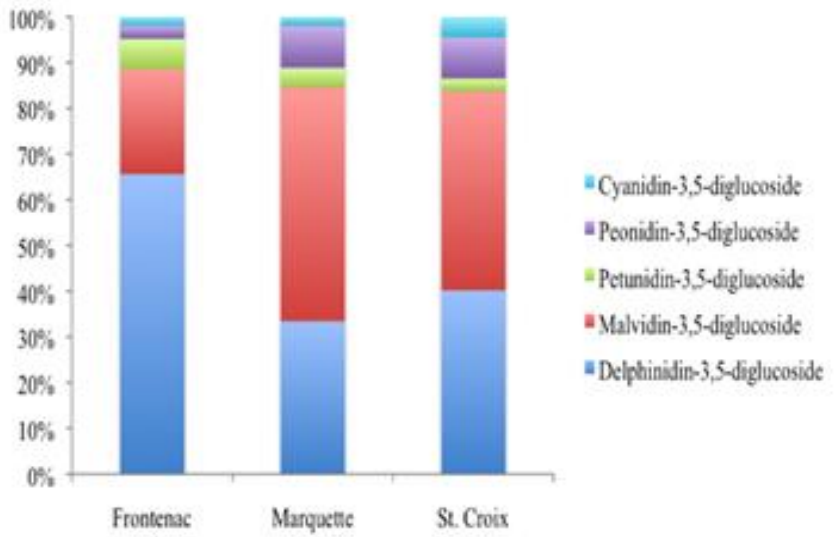
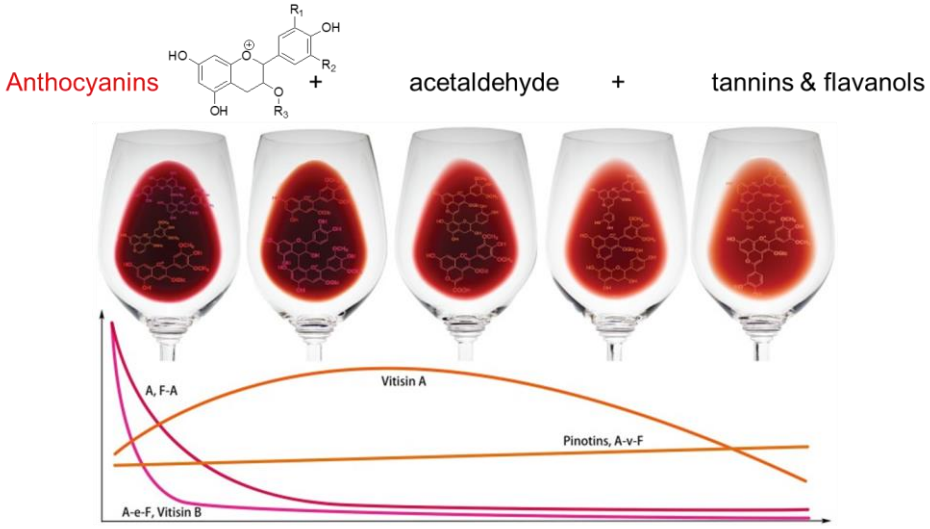


Figure 5: *Average proportions of five types of anthocyanin diglucosides in juices from sample grapes.**

Burtch et al., 2016

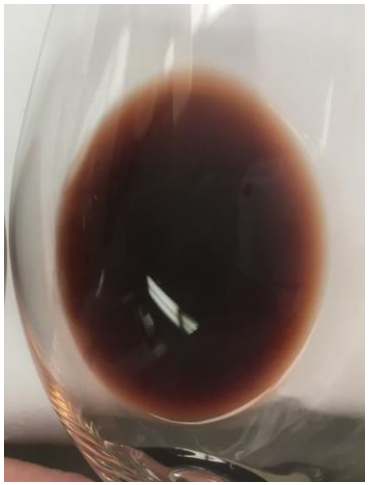
Color stability

With oxygen (not too much!)
With anthocyanin < tannins



Zhang et al., 2021, Food Chemistry, 339.

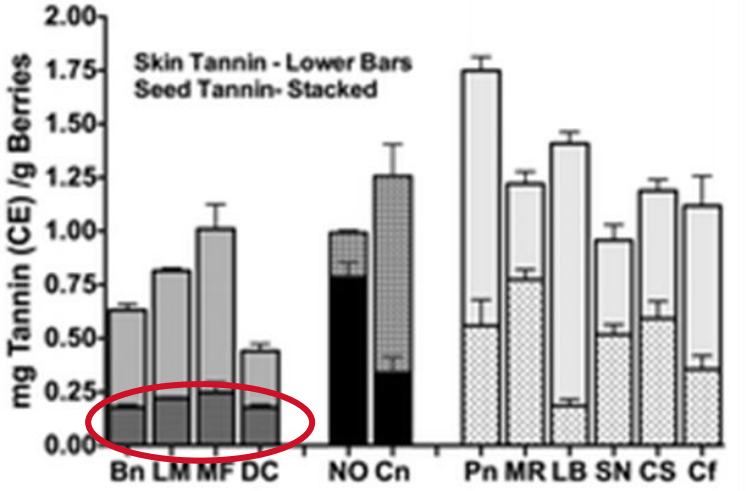
With too much oxygen
With anthocyanin > tannins

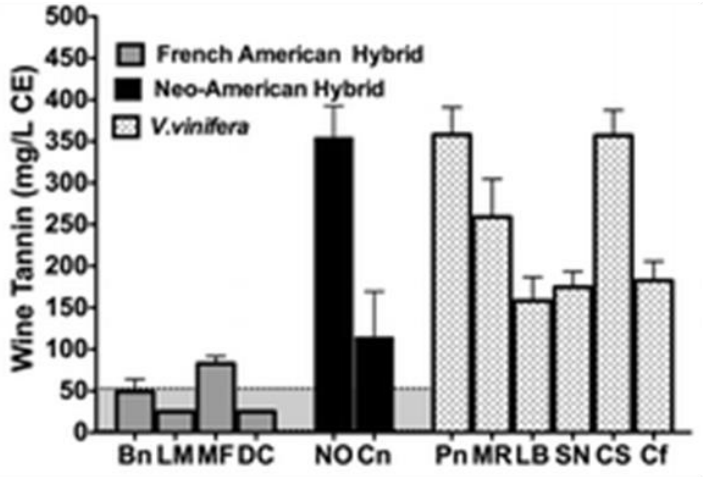


Wines	Marquette	Marechal Foch	Pinot noir	Cab. Sauvignon
Tannins (mg/L)	48	76	540	2274
Anthocyanins (mg/L)	255	151	221	471

Carew et al., 2013, JAFC; Manns & Mansfield, 2013 Journal of Food Science

Challenges of interspecific cold-hardy grape cultivars





Bn, Baco noir; LM, Leon Millot; MF, Marechal Foch; DC, DeChaunac; NO, Noiret; Cn, Corot noir; Pn, Pinot noir; MR, Merlot; LB, Lemberger; SN, Sangiovese; CS, Cabernet Sauvignon; Cf, Cabernet franc.

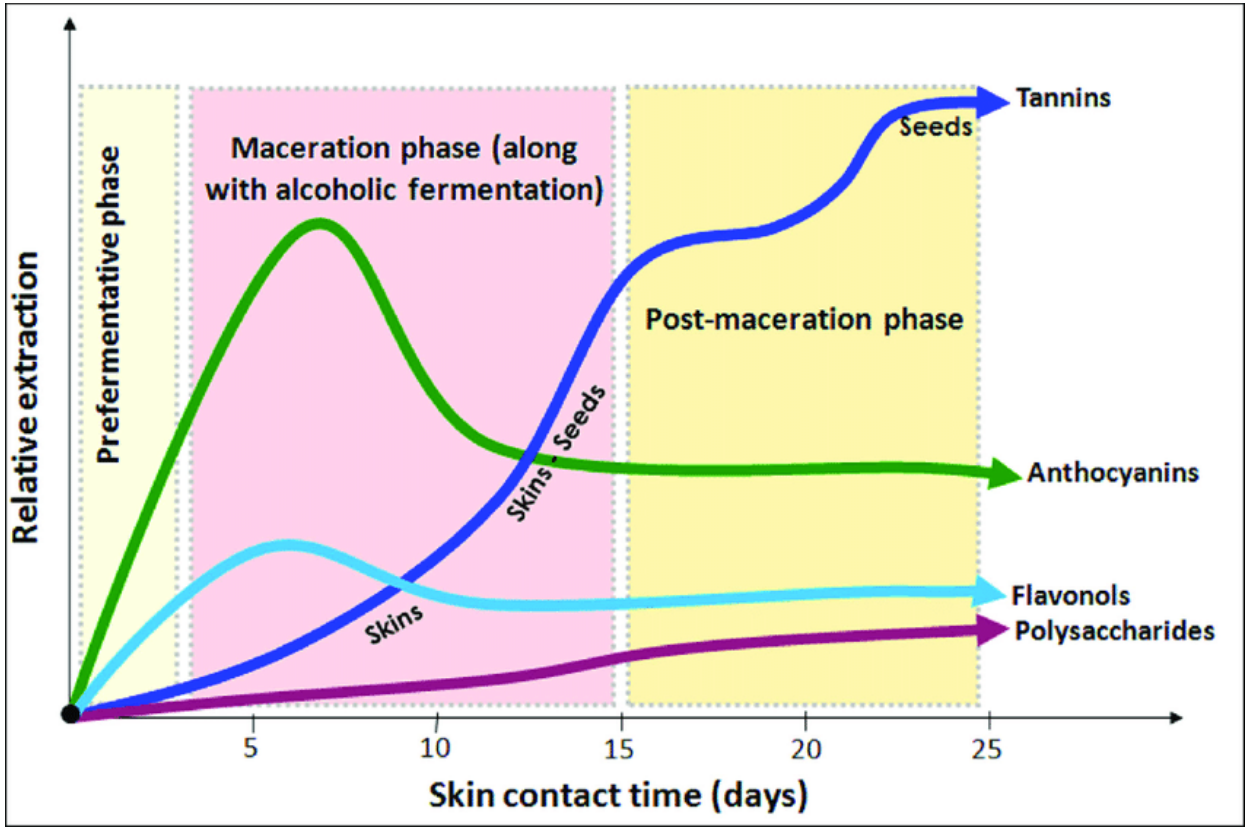
-In Hybrid grapes: Less skin tannins than in *V. vinifera* grapes

-In Hybrid wines: Less tannins than in *V. vinifera* wines

Why and How to get more tannins to improve red wine quality?

Watrelot 2021, Molecules, Vol.25 (9); Springer and Sacks 2016, JAFC, Vol. 64, 43

Extraction during winemaking



https://www.researchgate.net/publication/259646070_Maceration_Part_1_Focus_on_Phenolics

Could we extract tannins from skins? Accentuated Cut Edges maceration

Skin Particle Size Affects the Phenolic Attributes of Pinot noir Wine: Proof of Concept

Angela M. Sparrow,[1]* Richard E. Smart,[2] Robert G. Dambergs,[3] and Dugald C. Close[1]

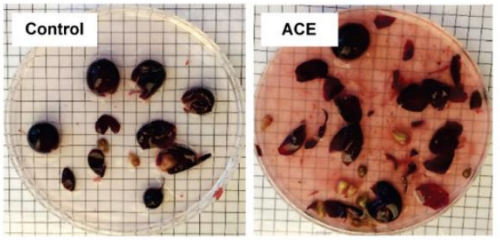


Figure 3 Skin fragmentation in Control and Accentuated Cut Edge (ACE)-treated musts.

Image: Sparrow and Smart. 2017. https://www.asevcatalyst.org/content/catalyst/1/3/88.full.pdf

- Pinot noir grapes. ACE applied after crushing to cut grape skins into small fragments

=> increased tannin concentration by 6-fold, wine color density by 25% in wines six months post-bottling.

Goal: Improve the extraction of phenolic compounds and tannins from grape skins rather than seeds in cold-hardy grapes.

Could we extract tannins from skins?

Open Access Article

Effect of the Application Time of Accentuated Cut Edges (ACE) on Marquette Wine Phenolic Compounds

by Yiliang Cheng [1], Jennifer Rae Savits [2] and Aude Annie Watrelot [1,*]

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[2] Midwest Grape and Wine Industry Institute, Iowa State University, 536 Farm House Lane, Ames, IA 50011, USA
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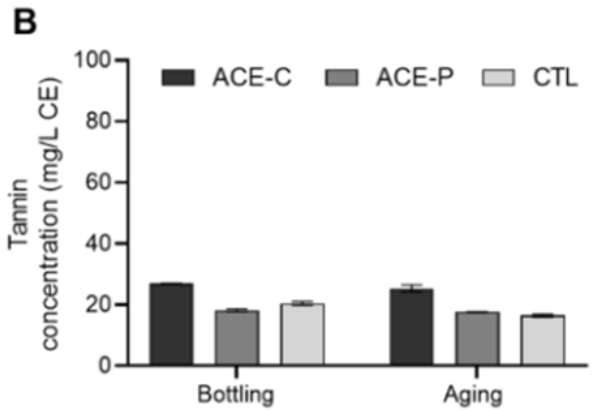
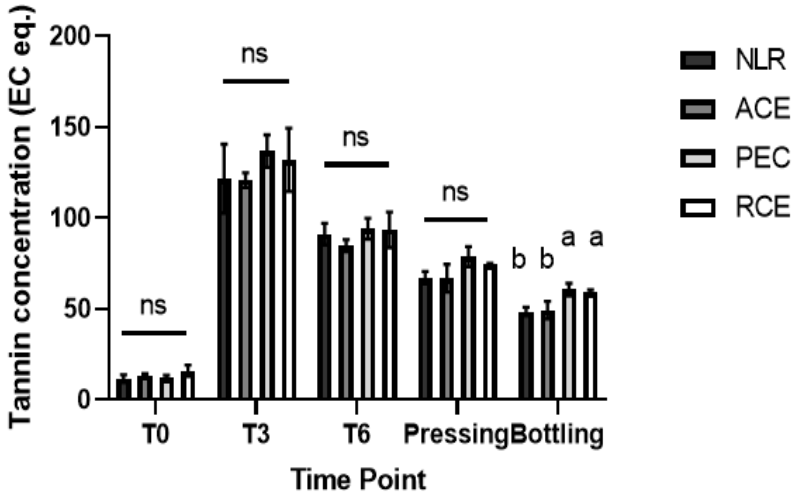
Molecules **2022**, *27*(2), 542; https://doi.org/10.3390/molecules27020542





- ACE did not improve extraction of tannins
- Low tannin retention in Marquette wines

Could we extract tannins from stems?

Stems rich in water and fibers

Phenolic compounds content in red grape stems:

0.3 – 38 g of gallic acid equivalent / kg stems

Addition of whole clusters in *V. vinifera*:

- Affect pH and TA (extraction of K^+ ions from the stems)
- Can cause color loss (adsorption of anthocyanins onto stems) (Suriano et al., 2015)
- WC 25% and 50 % increased tannin content in Primitivo wine (Suriano et al., 2016)
- WC 50 % and 100 % increased tannin content (Casassa et al., 2021) and decrease in anthocyanin content (Wimalasiri et al., 2021) and increase in green/vegetative, spicy, woody aroma

Whole clusters fermentation

Marquette-Iowa (M-ISU)
Harvest: 1 Sept. 2021
pH 3.41 | TA 9.7 g/L | °Brix 26.1

Marquette-Minnesota (M-UMN)
Harvest: 10 Sept. 2021
pH 2.91 | TA 9.8 g/L | °Brix 25.7

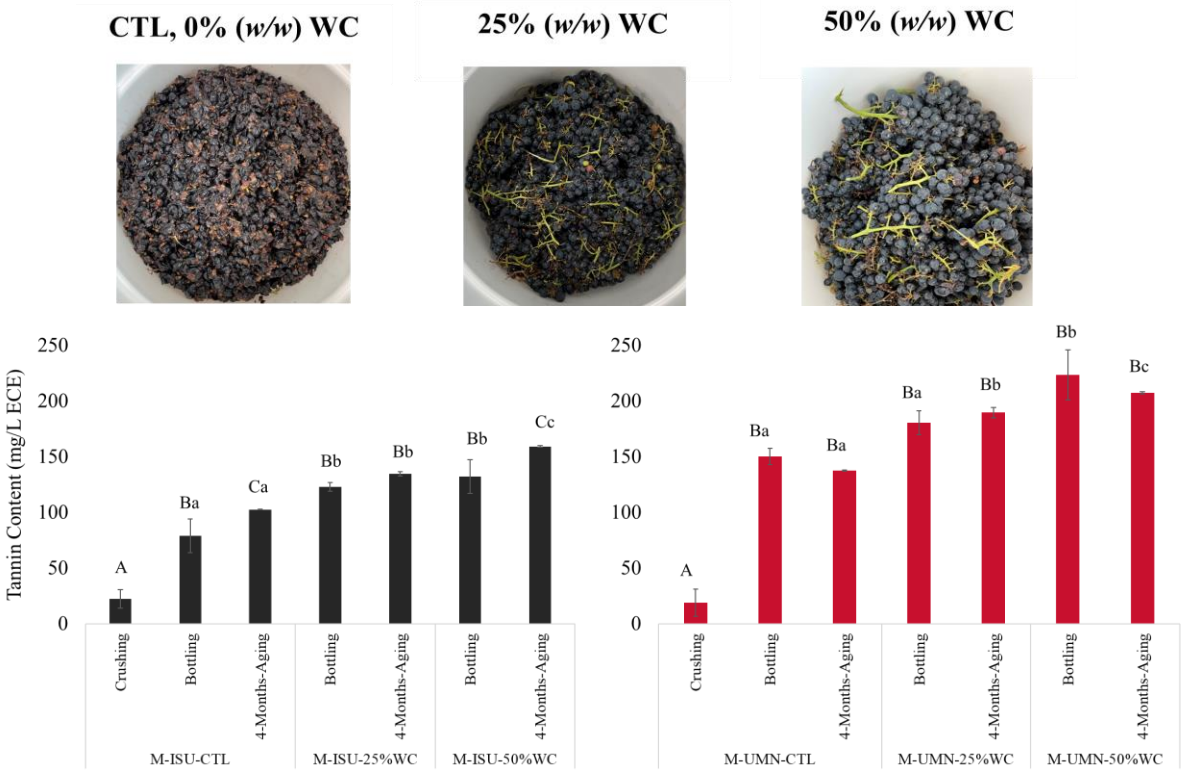


Figure 2: Tannin content (mg/L (-)-epicatechin equivalent) for each condition at each time point for M-ISU and M-UMN. Uppercase letters designate statistical significance between time points for each condition. Lowercase letters designate statistical significance between conditions at each time point.

50% WC significantly increased tannin content in Marquette wines by 31-55%.

After tasting by winemakers (n=30):

UMN 50%WC wine was preferred.

Gapinski et al., 2022. *Submitted* Food and bioprocess technology journal

Other techniques?

Pre-fermentation:

- Saignée: Draining free run from must to change the skin to juice ratio.
- Thermovinification: heating treatment of must/flash release (heating at 95° C for 5 minutes and vacuum to cool down)

=> Could promote extraction of tannins and retention

- Bentonite treatment
- Addition of enzymes

During fermentation:

- Cap management (punch-down/pump-over/auto-fermenters).
- Temperature of fermentation (hot vs. cold)

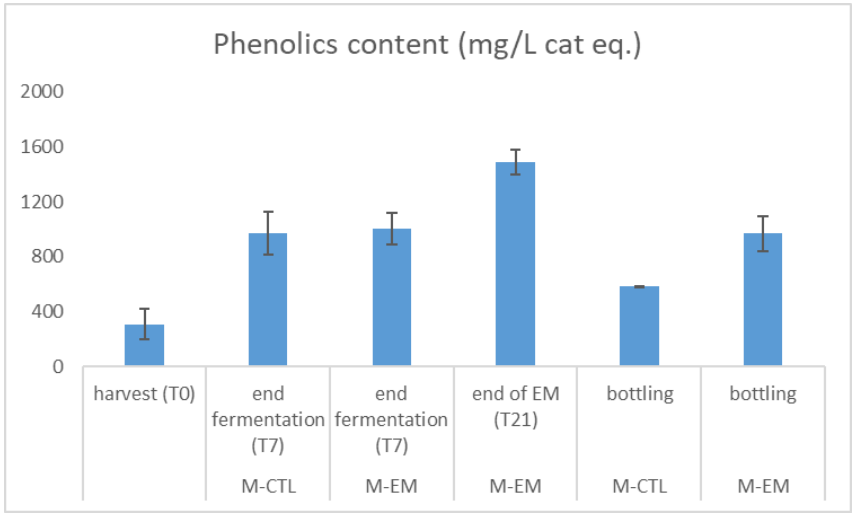
Cheng et al., 2022. *Molecules*, 27, 3482; Nicolle et al., 2019. Food Chemistry 277, 438-447; Watrelot & Norton, Molecules 2020, 25, 2110

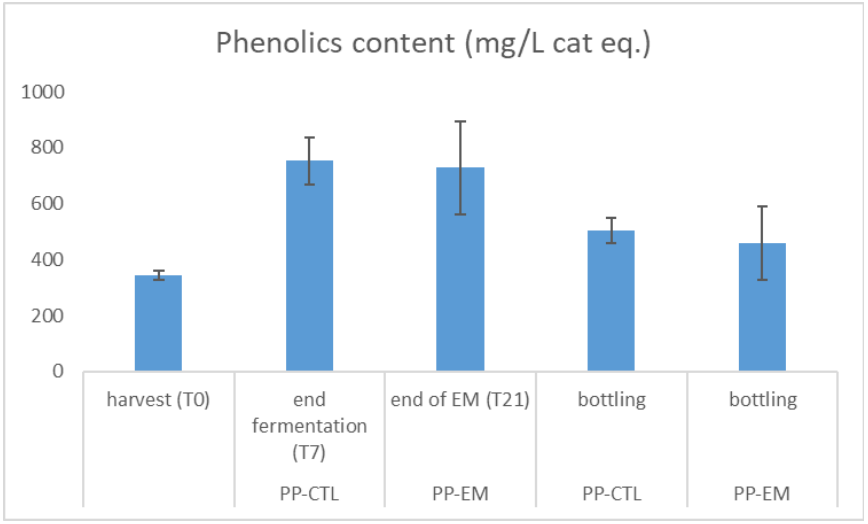
Other techniques?

Post-fermentation:

- Extended maceration (longer time) is desirable to promote extraction (especially from seeds).

⇒ Ongoing work on ‘Marquette’, ‘Petite Pearl’ and ‘Crimson Pearl’





⇒ Profile of extraction of phenolics does not follow the same pattern between Marquette and Petite Pearl cultivars

⇒ What about tannin extraction?

Other techniques?

Post-fermentation:

- Micro-oxygenation before or post-MLF: O_2 is bubbled into wine (into a stainless steel tank) to mimic what usually happens when wine is stored in a barrel.

- Addition of enological tannins

⇒ need more than 1.2g/L of commercial tannin! Frederickson et al., 2020. *AJEV*, 71: 62-69

- Blending

Watrelot et al., 2019. *Food Chemistry* 297, 124923; Gambuti et al., 2019. *AJEV* 70(3), 323-331; Frederickson et al., 2020. *AJEV*, 71: 62-69

What is the ultimate goal?

High quality wine !

-looks good (color stable)

-smells good (no defect/no oxidation)

-tastes good (mouthfeel)

- Ratio of tannins to anthocyanins is not optimal in “hybrid” wines

Challenges to extract tannins from cold-hardy grape cultivars and to retain them !

⇒ Biosynthesis of skin tannins vs. seed tannins?

⇒ Due to skin thickness ? Pectins and/or proteins?

Thank you!

- Yiliang Cheng
- Alex Gapinski
- Carmen Vavra
- Lucas Buren
- Lindsey Bouska
- Emily Kuelbs

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- Drew Horton (University of Minnesota)
- IWGA and MGWII

- Anne Zwink, Soldier Creek winery
- Zach Bott, Fireside winery
- Bob Wersen and Jonita Boyer, Tassel Ridge winery

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Any questions?

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