The Chemical Nature of Red Wine Mouthfeel

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Oregon State University

Outline

- Background & objective
- Methods -> see poster
- Results
  - Polysaccharide composition
  - Sensory analysis
- Summary & next steps

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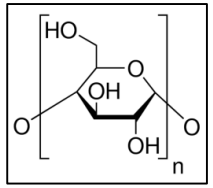
Background & objective

Sensory characteristics of red wine

- Aroma → volatiles
- Taste
- **Mouthfeel (texture)** } non-volatiles
  - Phenolics, tannins → astringency
  - <u>Mouthfulness</u>? Body? Rich? Complexity?
    - Glycerol (sweet), pH (sour), ethanol… **Polymers?**

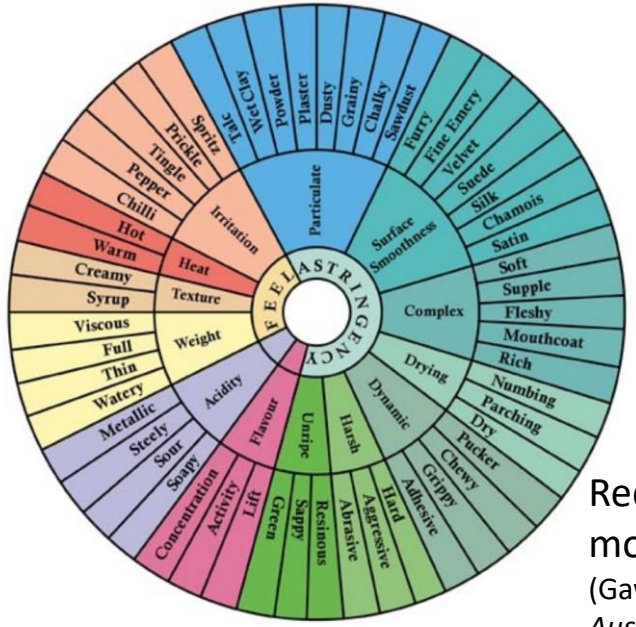
→ **Objective**: Analysis of red wine **<u>poly</u>**<u>saccharides</u>

- Composition
- Molecular size
- Sensory impact



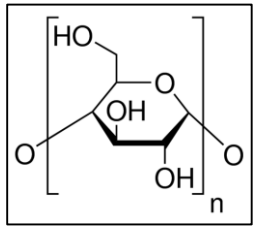
→ **Goal**: Better understanding of non-volatile sensory-active compounds in red wine to <u>control wine quality</u>

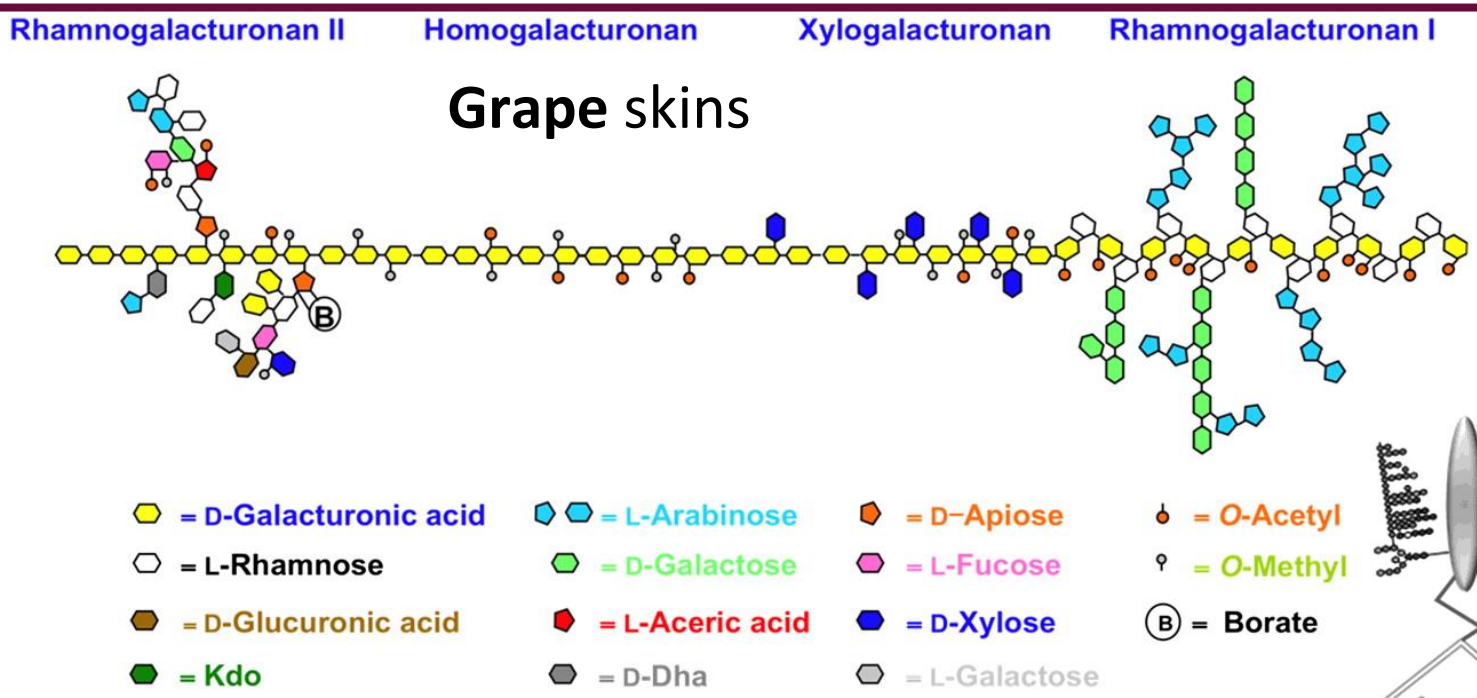
- Origin? Impact? Interactions? Control?



Red wine mouthfeel wheel (Gawel et al, 2000, *Austr J Grape Wine R*)

Red wine polysaccharides

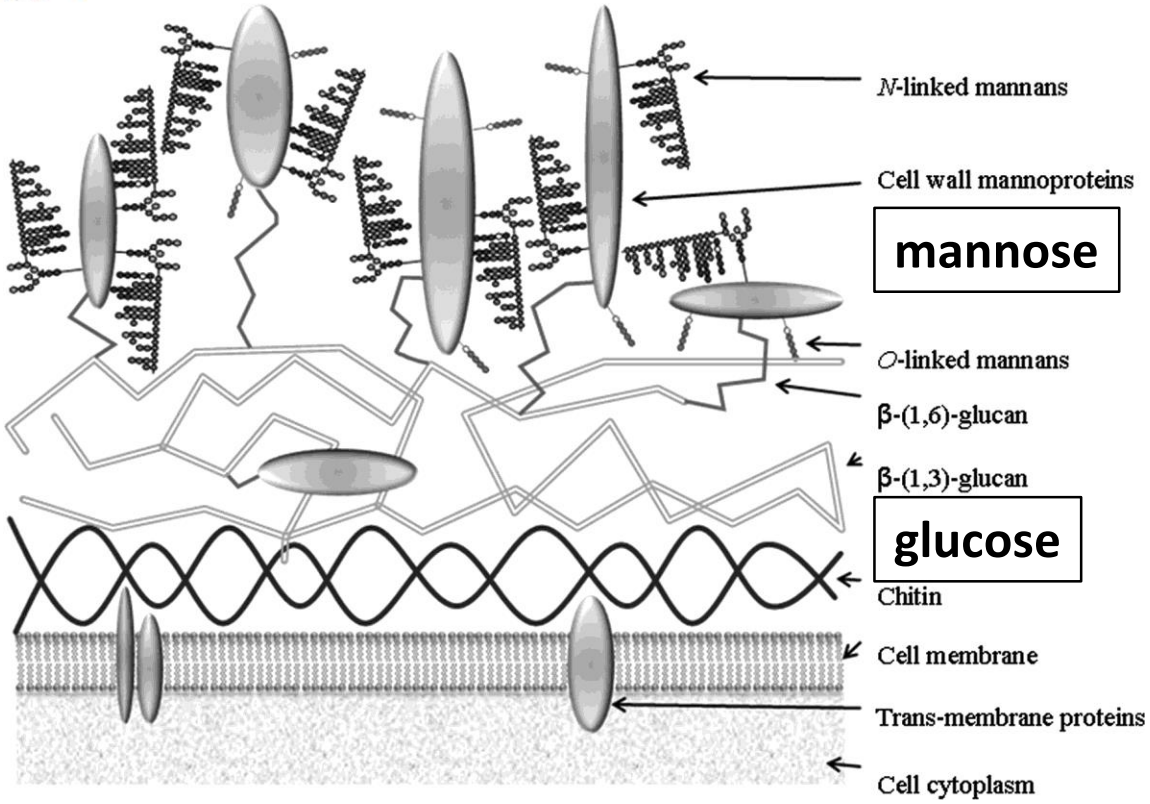




Grape skins

Schematic structure of **pectins** (Harholt et al, 2010, *Plant Physiol)*

Schematic structure of **yeast** cell wall
(Grubb et al, 2008, *Infect Immun*)

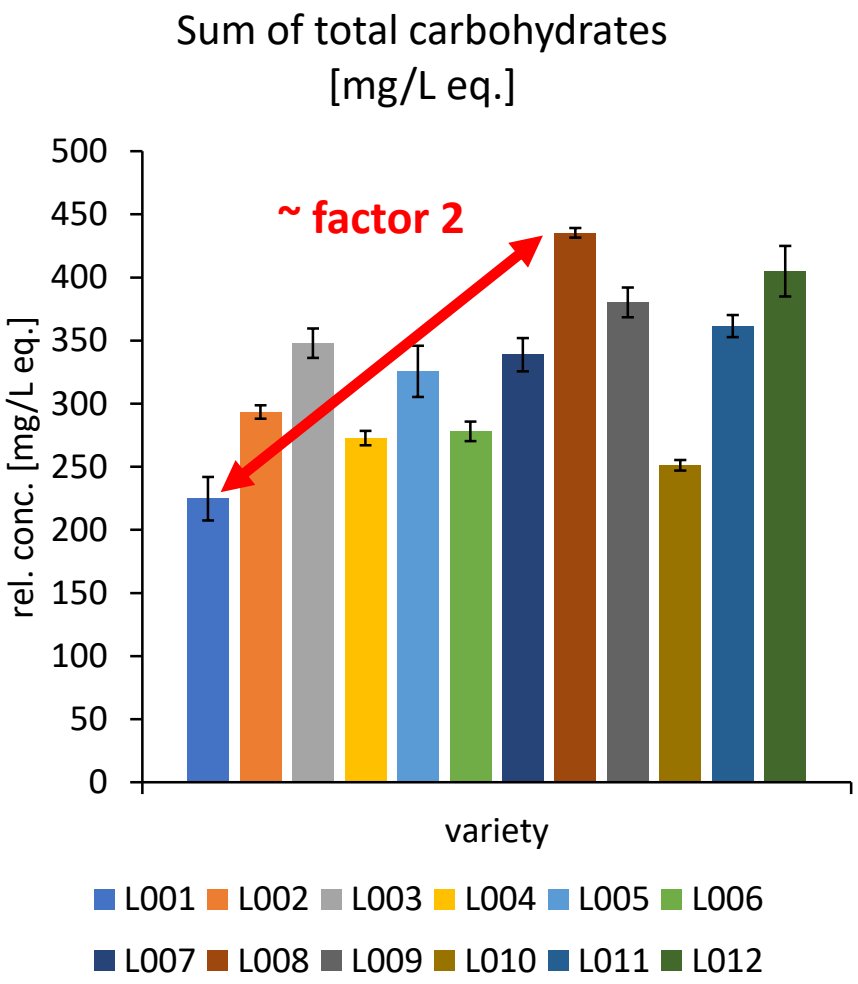


→ **Highly versatile**

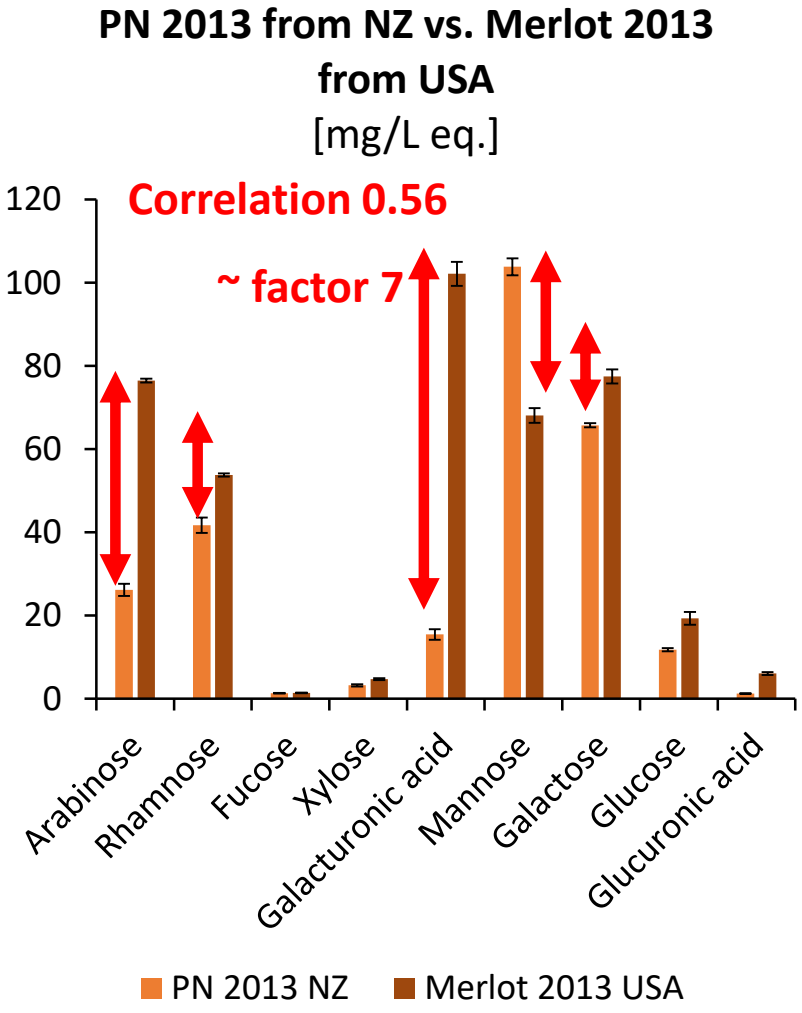
- **Composition**
- **Molecular size**

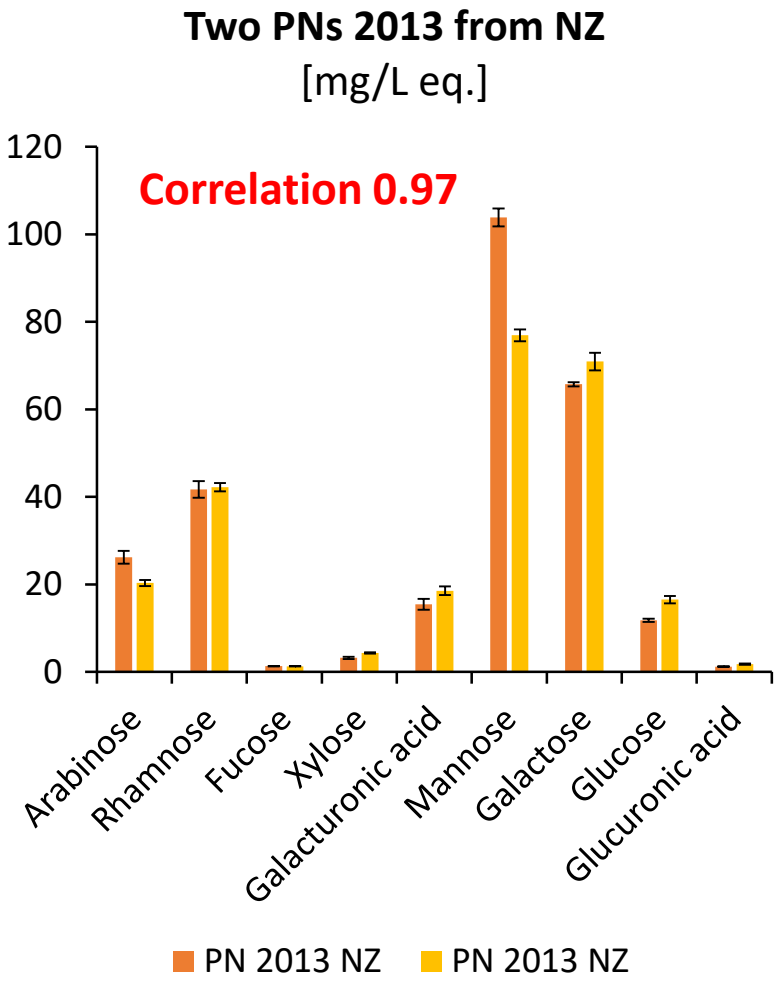
Varietal selection

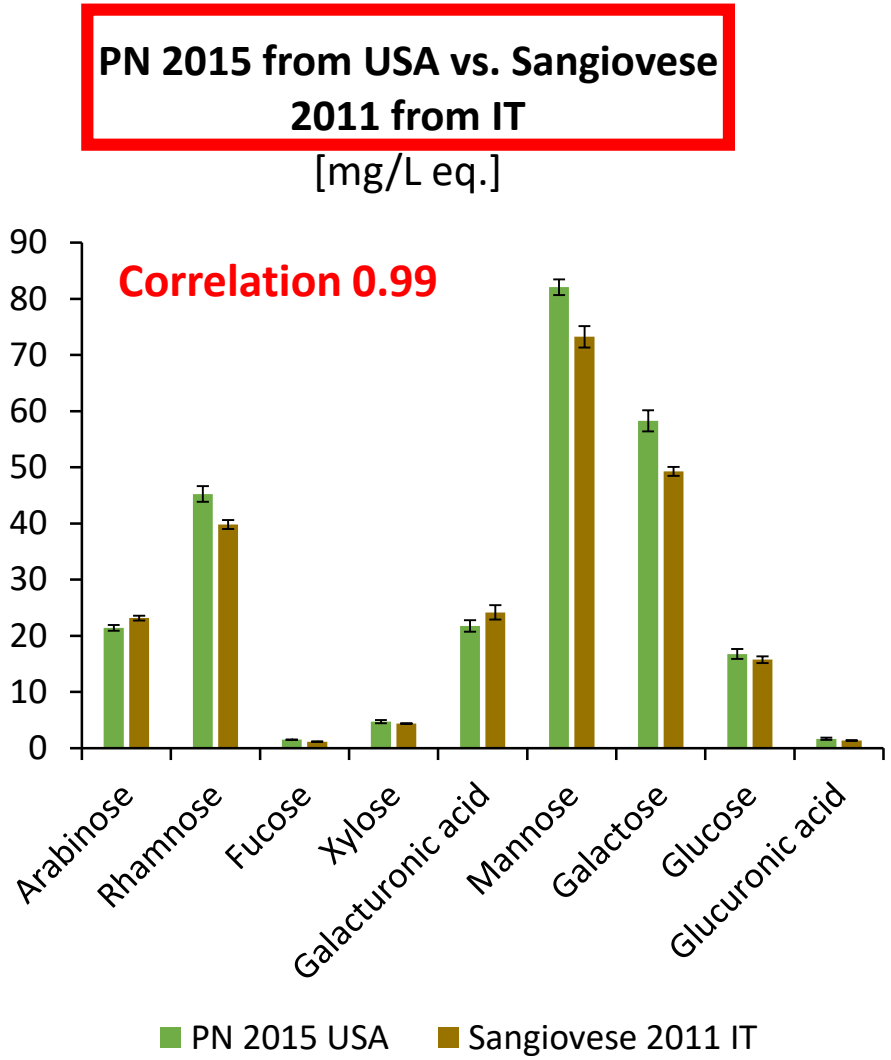
L001	**Shiraz**, Barossa Valley, Australia
L002	**Pinot Noir** 2013, Marlborough, New Zealand
L003	**Shiraz** 2014, Rhone, France
L004	**Pinot Noir** 2013, Central Otago, New Zealand
L005	**Gamay** 2015, Beaujolais, France
L006	**Pinot Noir** 2015, CA, USA
L007	**Grenache** 2014, CA, USA
L008	**Merlot** 2013, CA, USA
L009	**Malbec** 2015, Mendoza, Argentina
L010	**Sangiovese** 2011, Chianti, Italy
L011	**Zinfandel** 2014, CA, USA
L012	**Cabernet Sauvignon** 2013, CA, USA



Varietal selection







Oregon Pinot Noir

- Wine selection:
  - To keep "background" variability as low as possible:
    - Pinot Noir
    - Oregon
    - Same vintage (2015)

→ Two groups of Oregon Pinot Noir (2x n = 12)

- Scores and MF descriptions in wine rating magazines: Wine Spectator, Wine Enthusiast

<u>Group 1:</u> firm, harsh, coarse, grippy, gritty, nubby, powdery, tart, unripe, green…

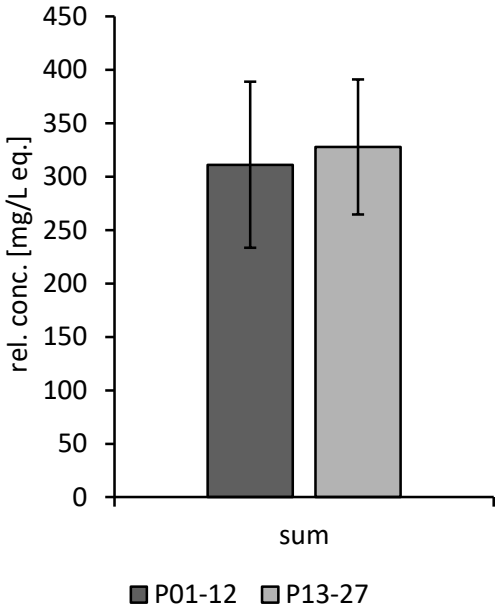
<u>Group 2:</u> velvety, silky, satiny, soft, smooth, refined, polished, rich, ripe, full, balanced, complex…

- Expert opinions based on preliminary studies (e.g., OWRI wine panel)
- Price (group 1: $10-15; group 2: $30-100)

Oregon Pinot Noir

- Two groups of Oregon Pinot Noir (2x n = 12)

Sum of total carbohydrates [mg/L eq.]



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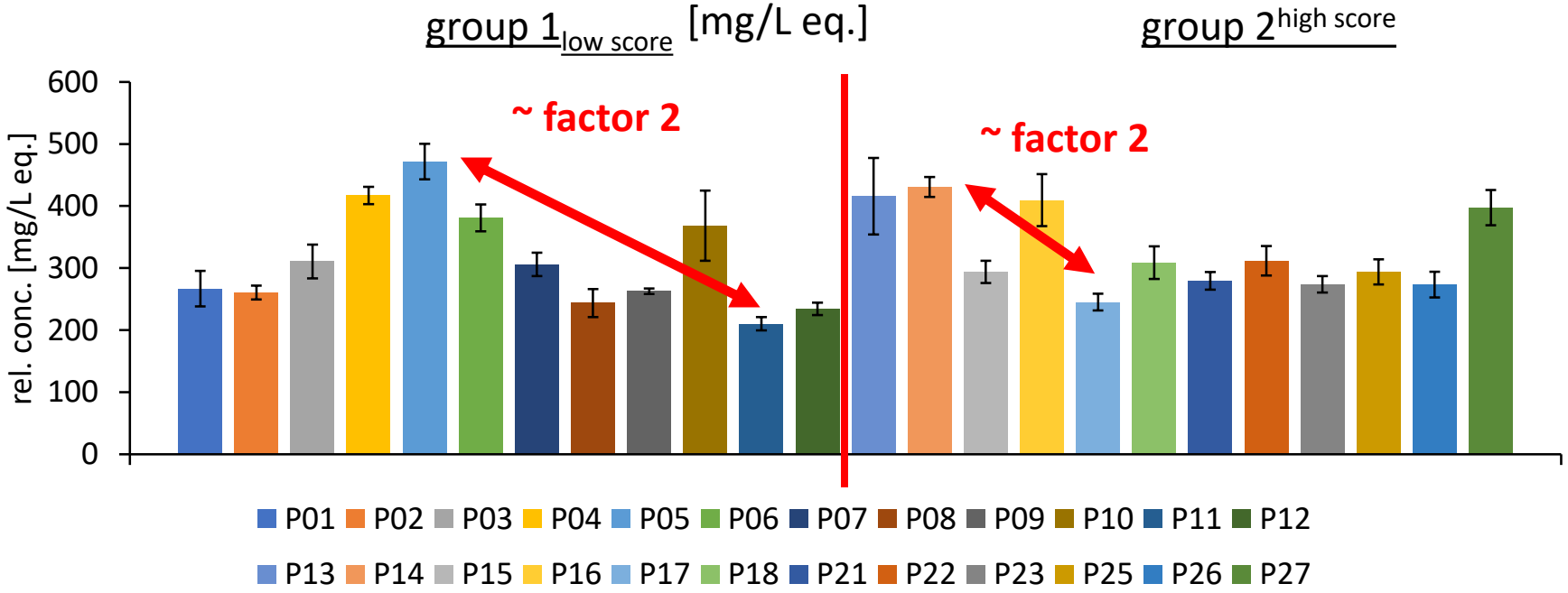
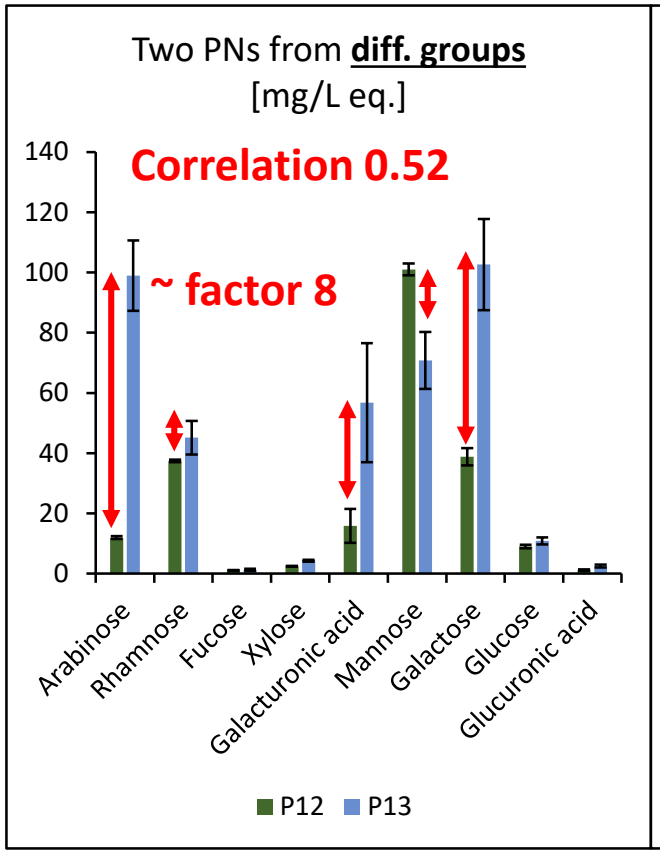
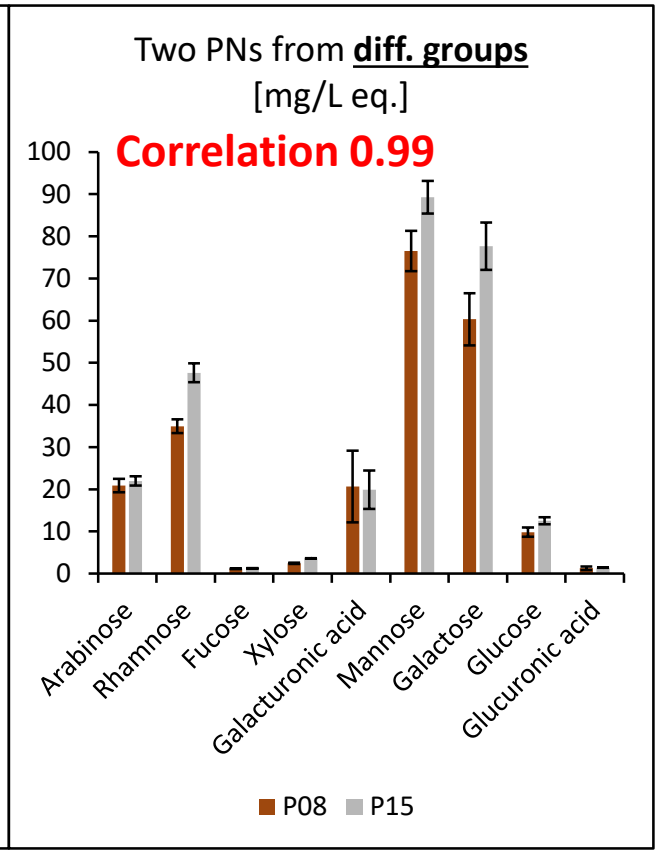


Oregon Pinot Noir

- Correlation
  - Across the two groups: 0.52 – 0.99
  - Within group 1$^{\text{low score}}$: 0.60 – 0.99
  - Within group 2$^{\text{high score}}$: 0.53 – 0.99
  - cf. varietal selection: 0.56 – 0.99

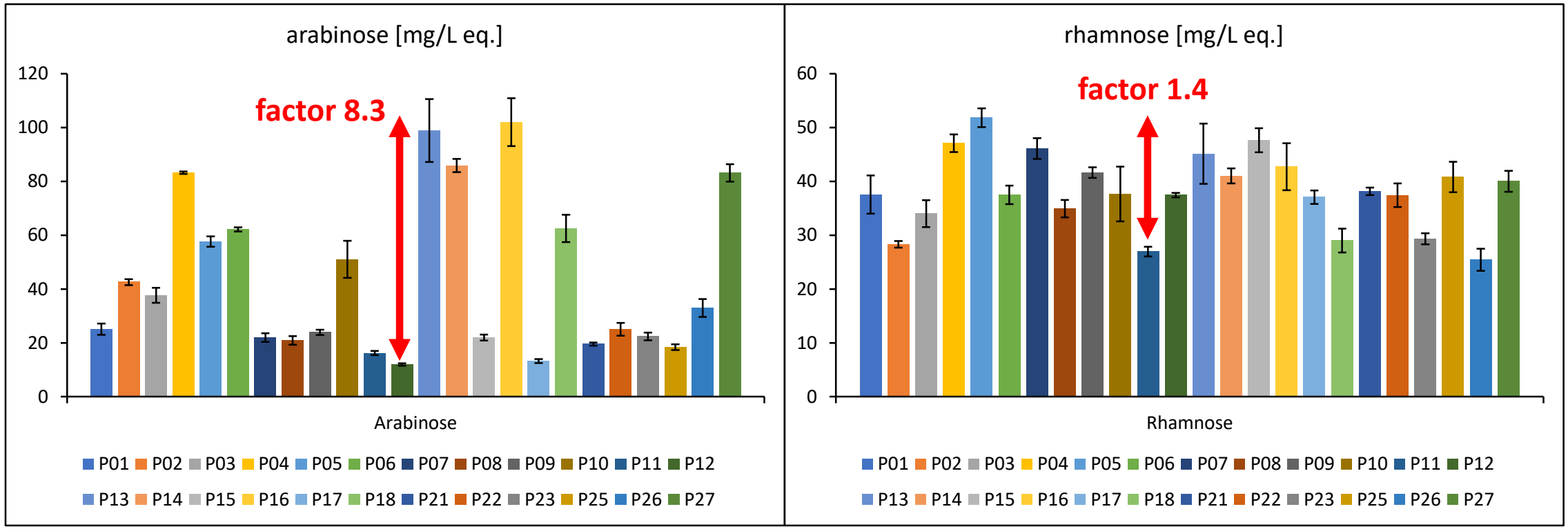




→Neither PS content nor composition lines up with wine scores/price/mouthfeel descriptions.

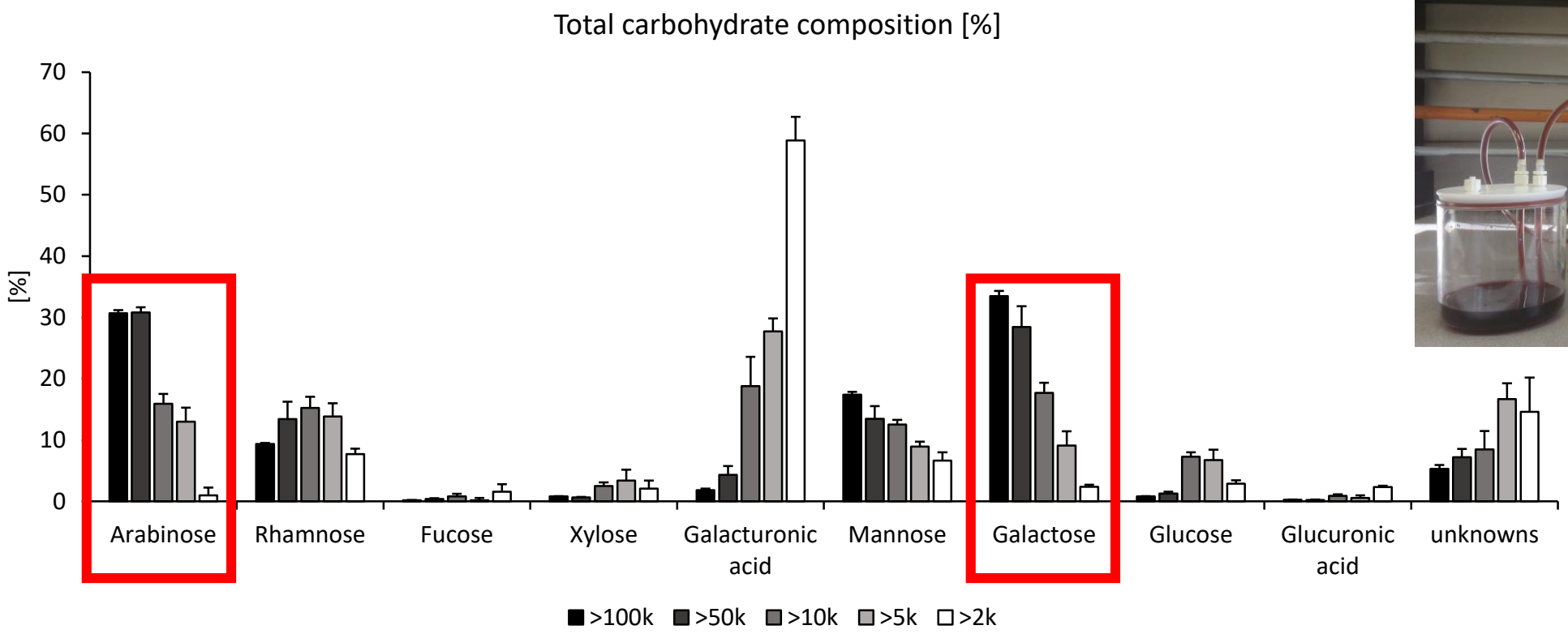
→The same extent of PS variability within OR PNs as in different varieties worldwide.

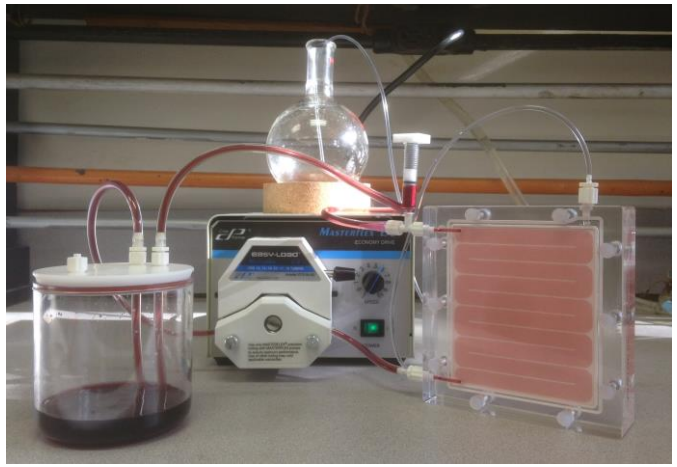
Oregon Pinot Noir



Arabinose portion is one of the main drivers of variability.

Molecular weight fractions of Pinot Noir

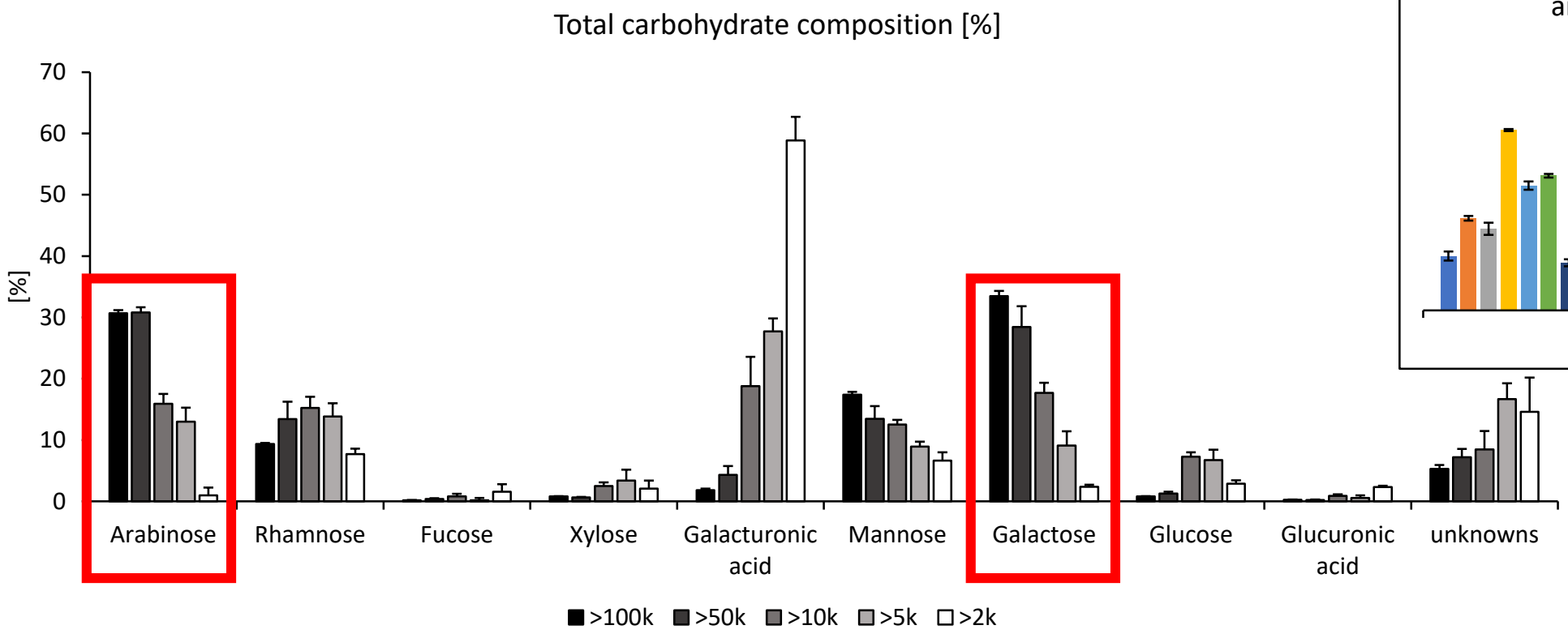


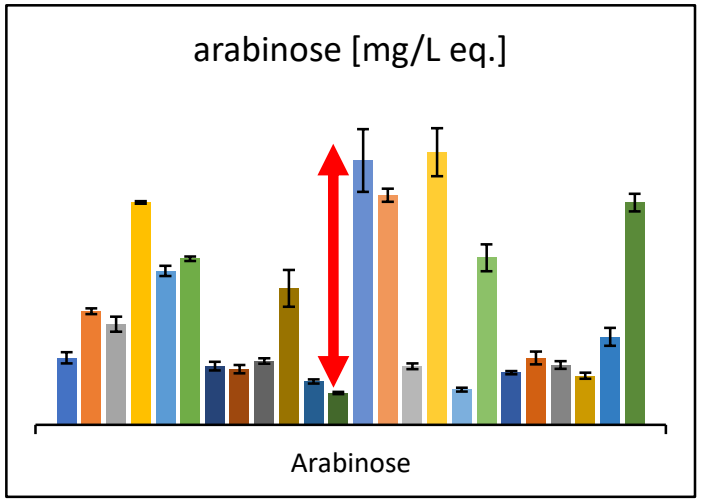


>100 >50 >10 >5 >2

- High mol. size (100 & 50 kDa): arabinose, galactose, mannose
- Lower mol. size (10, 5 & 2 kDa): galacturonic acid, glucose
- Rhamnose consistent

Molecular weight fractions of Pinot Noir





>100 >50 >10 >5 >2

- High mol. size (100 & 50 kDa): arabinose, galactose, mannose
- Lower mol. size (10, 5 & 2 kDa): galacturonic acid, glucose
- Rhamnose consistent

Summary I

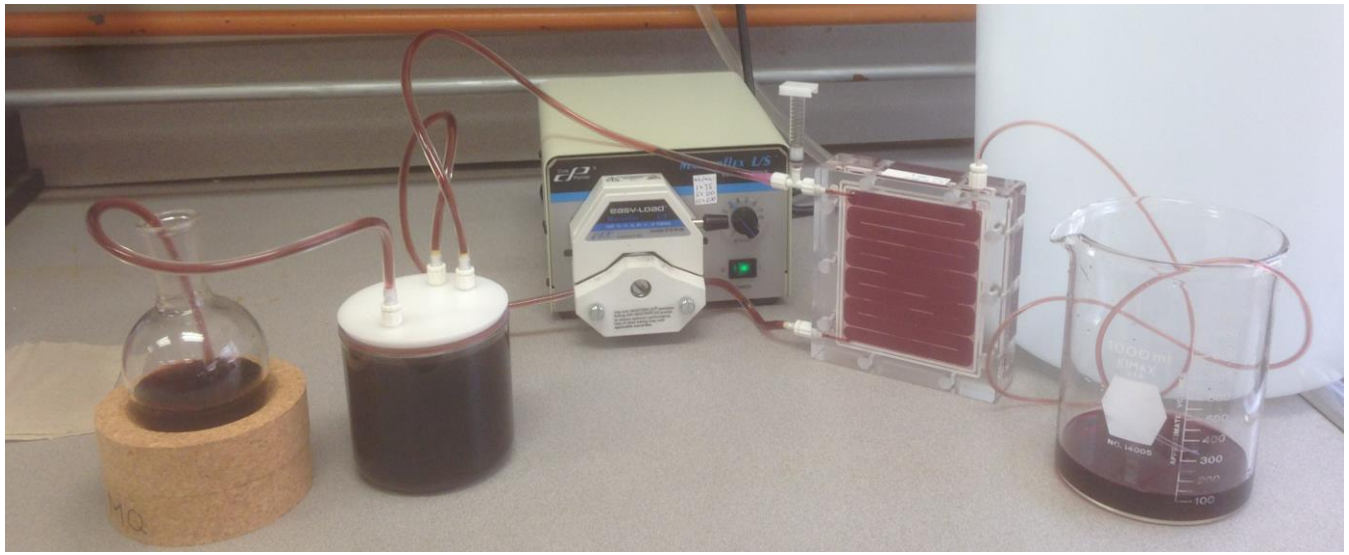
- **<u>Polysaccharide composition:</u>**
  - Higher variation in monomers (x8) than in the sum (x2)
  - Oregon 2015 Pinot Noirs varied to the same extent as red wines from different varieties, growing regions, and vintages
  - Also, PNs recognized for their mouthfeel showed the same variability as PNs from the lowest price segment
  - Monomers with highest variation are arabinose, galactose, and galacturonic acid
  - With higher molecular size, shares of arabinose and galactose increase

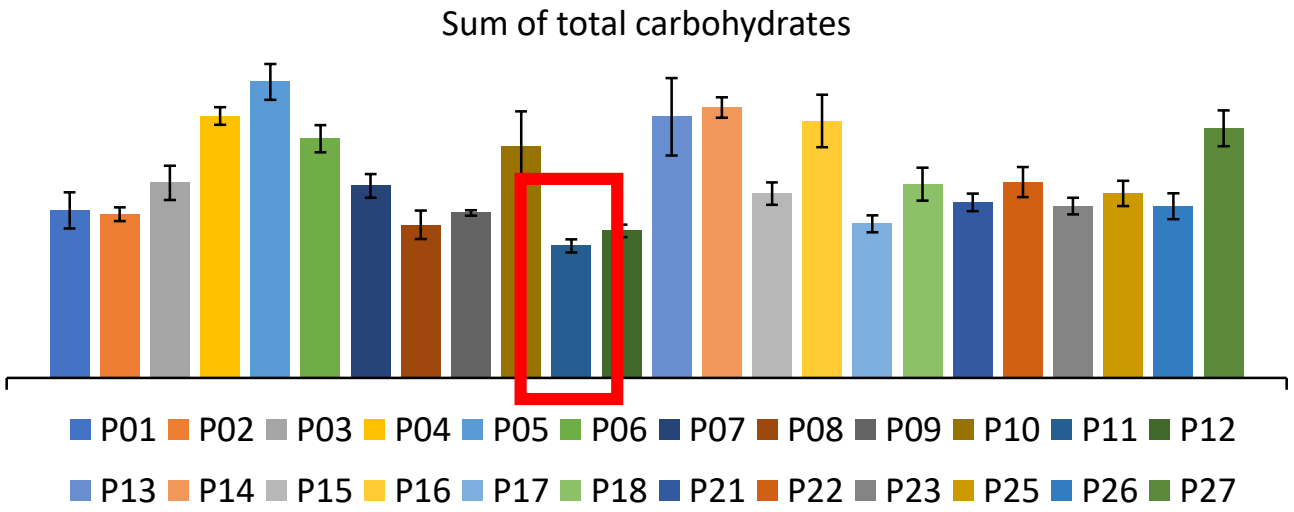
Next: Sensory study

Influence of molecular size on mouthfeel

- Preparation of red wine polysaccharides (= “ethanol precipitated colloids”):
  - **High molecular weight: above 100 kDa**
  - **“Lower” molecular weight: 10 – 100 kDa**
- Interactions? → model wine = real wine
  - OR PN with lowest polysaccharide content was spiked with an additional 1 g/L:
    - **Control**
    - **Control + HMW 1 g/L (high MW)**
    - **Control + LMW 1 g/L (low MW)**

→ **Sensory: wine consumer panel (n=40)**
- Triangle tests: aroma & mouthfeel (discriminative)
- Check all that apply (descriptive)





Influence of molecular size on mouthfeel

- Triangle test:

Aroma

			portion correct [%]
Control	vs.	LMW	
Control	vs.	HMW	
LMW	vs.	HMW	

Influence of molecular size on mouthfeel

- Triangle test:

Aroma

			portion correct [%]
Control	vs.	**LMW**	**34.6***
Control	vs.	HMW	33.3
LMW	vs.	HMW	**37.0***

* $p < 0.05$

Influence of molecular size on mouthfeel

- Triangle test:

Aroma

			portion correct [%]	descriptors
Control	vs.	**LMW**	**34.6***	red berries
Control	vs.	HMW	33.3	
LMW	vs.	HMW	**37.0***	dried fruits

* $p < 0.05$

Influence of molecular size on mouthfeel

- **Aroma**:

			portion correct [%]	descriptors
Control	vs.	**LMW**	**34.6***	red berries
Control	vs.	HMW	33.3	
LMW	vs.	HMW	**37.0***	dried fruits

* $p < 0.05$

- **Mouthfeel**:

			portion correct [%]
Control	vs.	LMW	
Control	vs.	HMW	
LMW	vs.	HMW	

Influence of molecular size on mouthfeel

- **Aroma**:

			portion correct [%]	descriptors
Control	vs.	**LMW**	**34.6***	red berries
Control	vs.	HMW	33.3	
LMW	vs.	HMW	**37.0***	dried fruits

* $p < 0.05$

- **Mouthfeel**:

			portion correct [%]
Control	vs.	LMW	30.8
Control	vs.	**HMW**	**40.7***
LMW	vs.	HMW	25.9

* $p < 0.05$

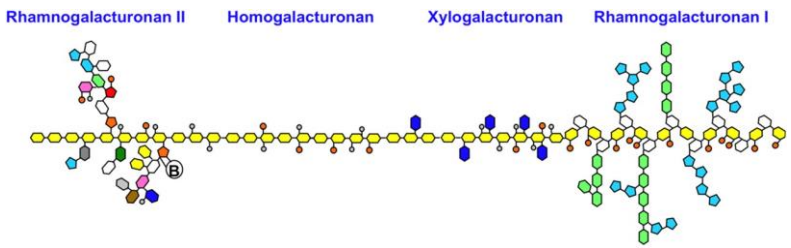
→ Low MW fraction slightly altered aroma perception

→ High MW fraction influenced mouthfeel

Summary II

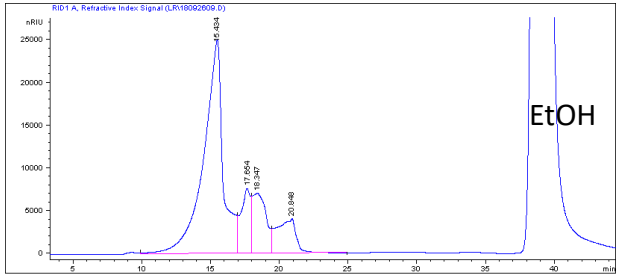
- Polysaccharide composition:
  - Higher variation in monomers (x8) than in the sum (x2)
  - Oregon 2015 Pinot Noirs varied to the same extent as red wines from different varieties, growing regions, and vintages
  - Also, PNs recognized for their mouthfeel showed the same variability as PNs from the lowest price segment
  - Monomers with highest variation are arabinose, galactose, and galacturonic acid
  - With higher molecular size, shares of arabinose and galactose increase
- **Low MW fraction slightly altered aroma perception**
- **High MW fraction influenced mouthfeel**

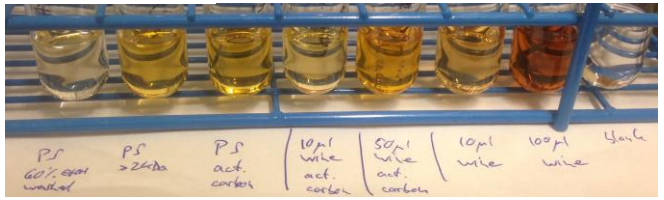
Next steps

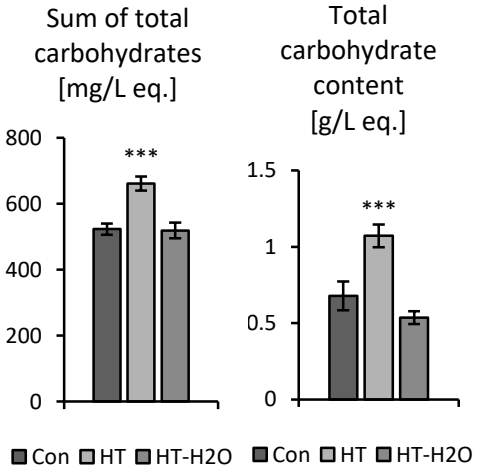


- Extend the sensory study
- In-depth analysis of polysaccharides: structure, linkage, exact molecular size…
- Quick colorimetric assay for polysaccharide content
- Hang time → see poster

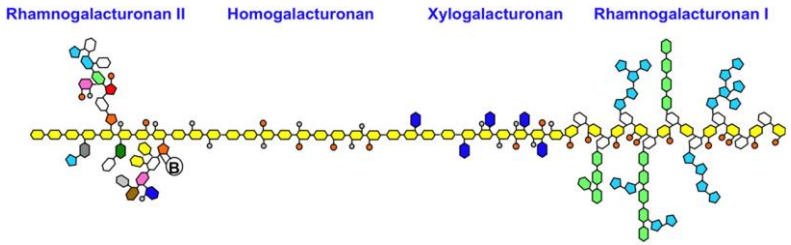
Total polysaccharides above 2 kDa





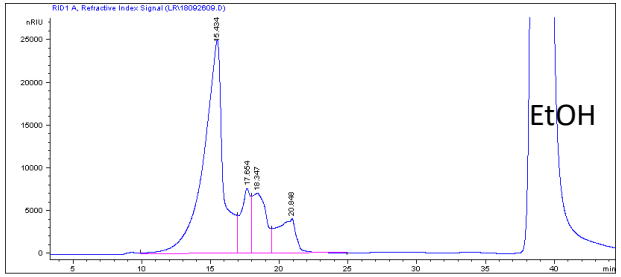


Acknowledgements



- OWRI for funding
- PIs: Elizabeth Tomasino
  James Osborne
  Michael Qian
- Sensory: Kim Phan
  Angelica Iobbi
  Aubrey DuBois
- Lab: Max Brau
  Sam Aragon

Total polysaccharides above 2 kDa



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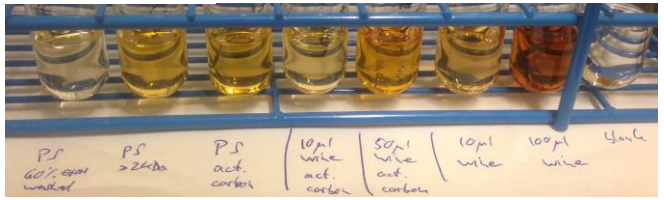

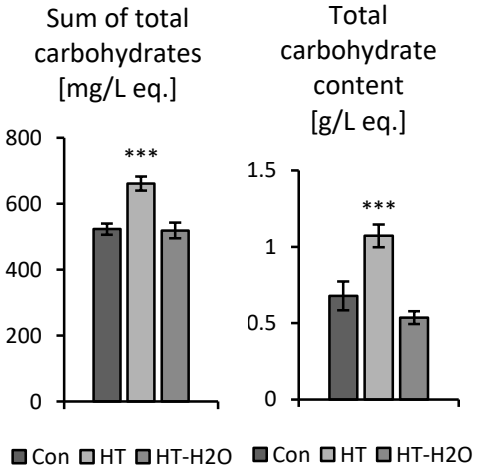

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Oregon Wine Research Institute