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What's new in the grape and wine program at the University of Minnesota

Katie Cook, Enologist
University of Minnesota

Enology Project Goals

1) **Evaluate the enological potential of new cold-hardy grape cultivars.**

2) **Evaluate and optimize processing methods needed to produce commercial-quality wines from cold-hardy grape cultivars.**

3) **Determine the primary constituents of the color and flavor compounds characteristic of wines made from cold-hardy cultivars.**

4) **Educate regional practitioners and other cold-climate North American industries impacted by UMN releases.**

5) **Contribute to undergraduate, graduate and public education.**

Evaluation of potential new cold-hardy grape cultivars

Evaluation of advanced selections from the breeding program

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Microvinification Trials

- Vineyard watches and new selections are fermented in small carboys
  - Often the fruit source is a single vine, or a panel of 4-6 vines
  - 2-10 liter volume
  - Basic chemistry of juice and wine is tracked over many years

Data Collected in the Winery

- Grapes:
  - Yield, cluster weight, berry weight
- Juice samples:
  - Brix, TA, pH, YAN (NH_3 and NOPA), Malate, Spectral analysis (color, phenolics)
- Wine Samples:
  - Residual Sugar, Malate (reds), Alcohol, SO_2, TA, pH, Spectral analysis (color, phenolics), Sensory

1000's of wine analyses are performed each year!

Enological Challenges with Cold-Hardy Grapes

- High total acidity (often coupled with high pH)
- High Potential Alcohol (Brix)
- “Inkiness” in red cultivars (highly pigmented)
- Low tannin and/or non-extractable tannin

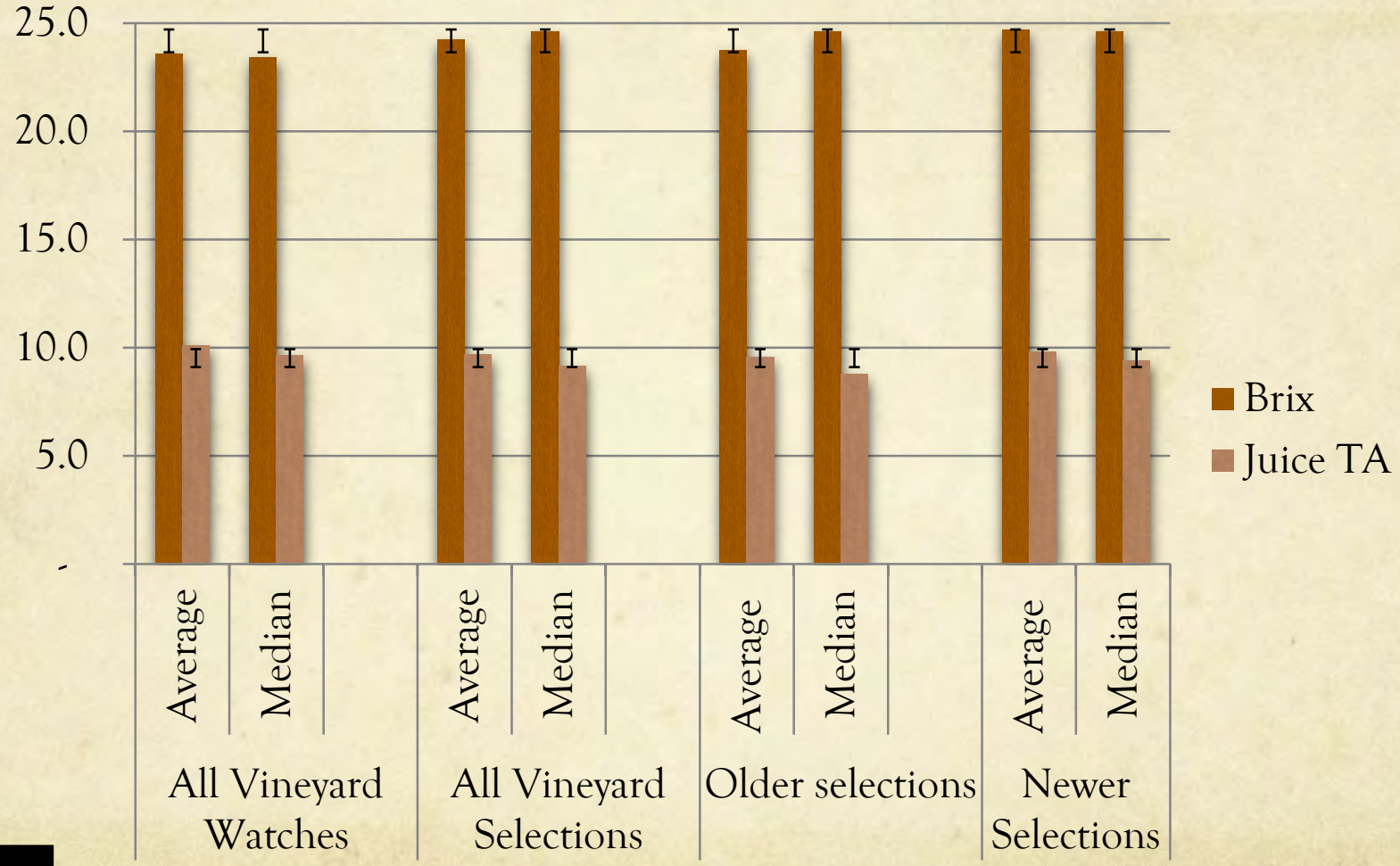
Evaluations in 2013

Vineyard watches		
1-2-8.4	18-6-1.3	21-2-5.8
1-3-12.7	18-6-2.3	21-3-7.5
3-5-3.3	18-6-5.7	21-6-4.4
3-18-8.1	18-6-6.4	21-11-12.8
10-29-1.5	18-6-13.7	23-7-5-5.6
10-40-8.7	18-8-11.9	23-11-4.7
10-41-3.4	18-8-12.7	
18-5-15.9	18-15-3.1	

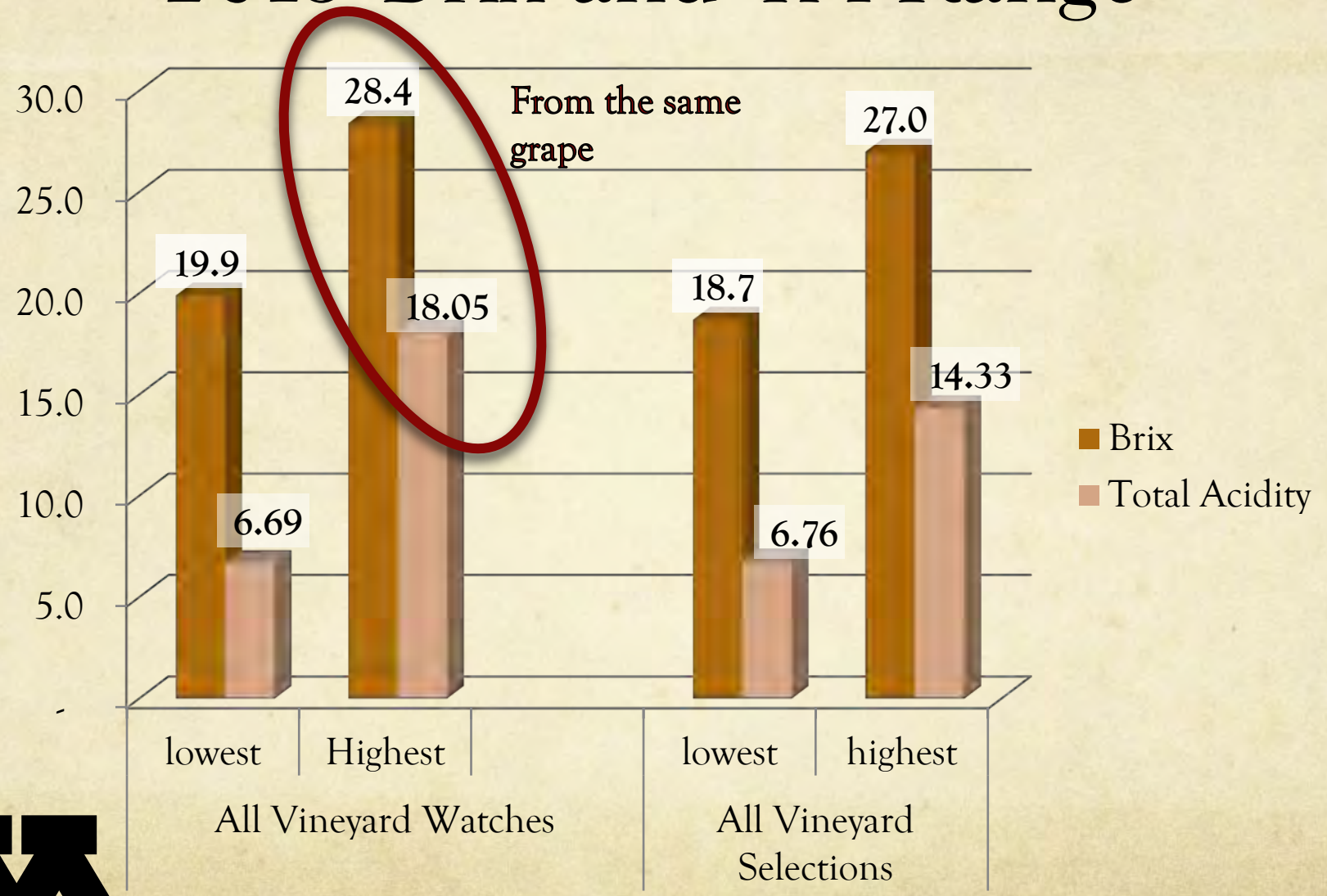
Vineyard Selections			
MN 1214	MN 1271	MN 1280	MN 1305
MN 1220	MN 1258	MN 1282	MN 1306
MN 1241	MN 1259	MN 1284	MN 1310
MN 1245	MN 1262	MN 1285	MN 1311
MN 1246	MN 1265	MN 1288	MN 1314
MN 1250	MN 1266	MN 1293	
MN 1251	MN 1268	MN 1302	

Each Individual represents a genetically unique grapevine or group of vines

2013 Average Brix and Total Acidity



2013 Brix and TA Range



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VitisGen Project

- 5-year (2011-16) project funded by the USDA-National Institute of Food and Agriculture (NIFA) Specialty Crops Research Initiative
- Combines the expertise of breeders, geneticists, pathologists, physiologists, chemists, enologists, computational biologists, sociologists, economists, and the grape industry
- 12 research institutions

USDA United States Department Of Agriculture Agricultural Research Service

Cornell University

Oklahoma City University

FAMU

Oklahoma State University

Cornell University Cooperative Extension

Missouri State University

Mississippi State University

University of Minnesota

SDSU

UC Davis University of California

Dalhousie University

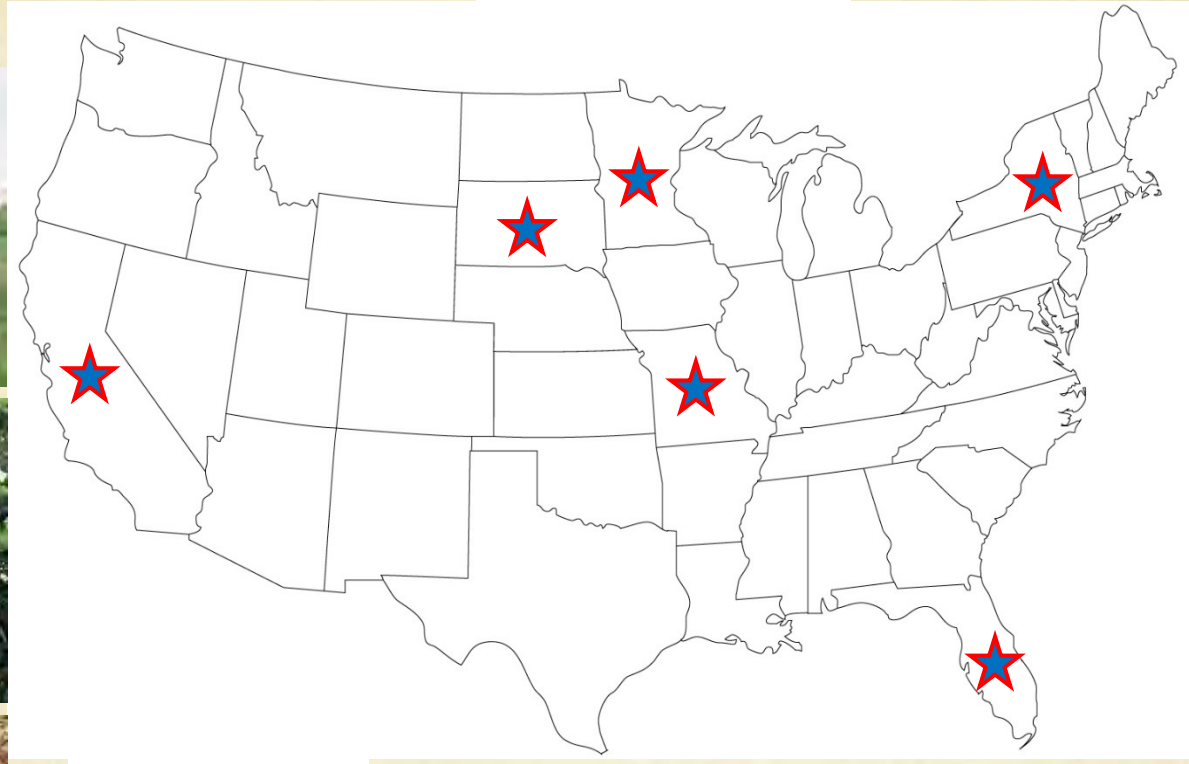
*Vitis*Gen Project Objectives

Overall project goal: To address industry needs via application of new technology to grape variety development.

1. Identify top priority traits and document their value
2. Develop new DNA markers linked with important traits
3. Apply markers to accelerate cultivar improvement
4. Enhance communication between industry, researchers, and consumers; develop educational resources in breeding and genetics



VitisGen unites breeding programs nationwide



Additional phenotyping efforts

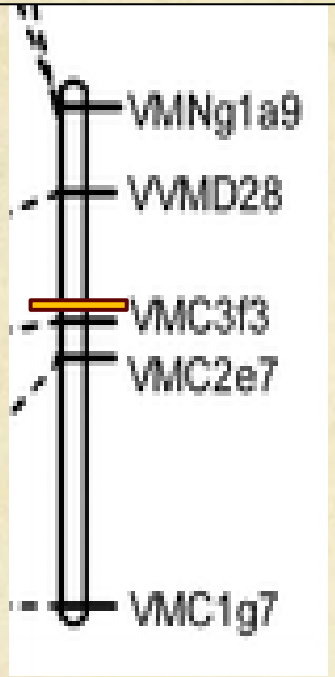
- Black rot, downy mildew, powdery mildew, phomopsis, anthracnose, foliar phylloxera, and nematode resistance

- Flower type and flowering time

- Berry size, berry shape, berry color, skin color, and seedlessness

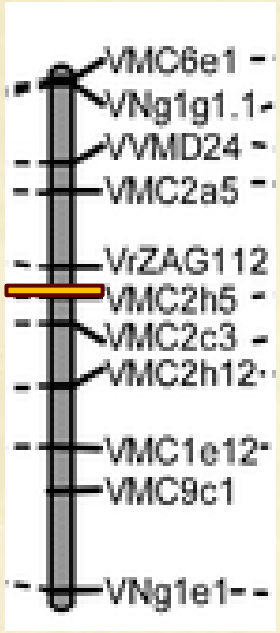
- Perform phenotypic analyses using the *VitisGen* populations
- Integrate phenotypic analyses with genotypic data to identify marker-trait associations

Genotype-by-Sequencing
High Marker Density on a Chromosome
to Precisely Map Genes



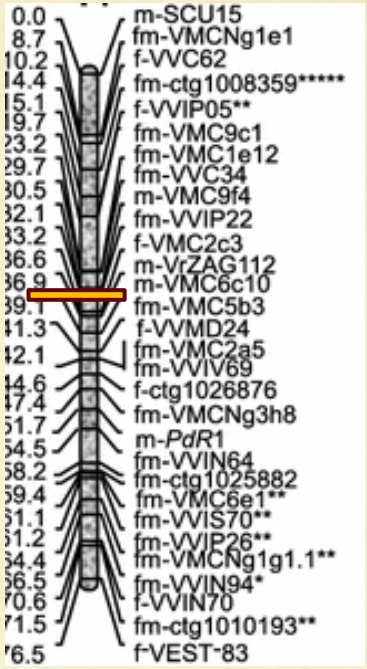
5 markers per chromosome = 95 total

2000



11 markers per chromosome = 209 total

2005



30 markers per chromosome = 570 total

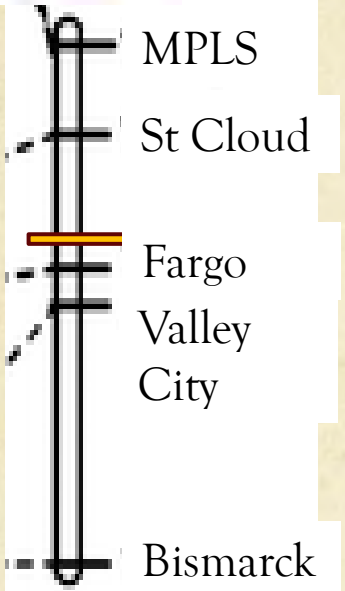
2010

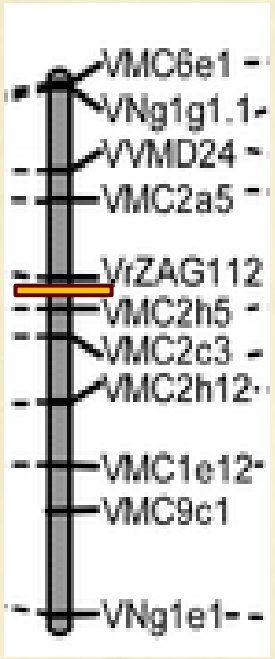
VitisGen goal

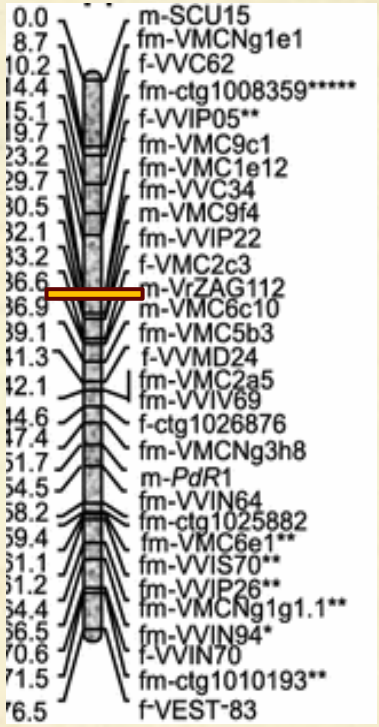
2,632 markers per chromosome = 50,000 total

2015

Find:
Hancock Concrete on I-94







Hancock Concrete Mile 6.3 I-94 Glyndon, MN

DNA-Informed for Sex Type in Breeding Using Markers Grape

Photo by J. Ogrodnik

Marker-assisted Breeding

Seedling Selection

- FH x FH crosses: collect leaves from seedlings in greenhouse or nursery and screen DNA for sex gene
- Cull 25% seedlings that are FF before planting in vineyard
- Save resources that would have been wasted on female vines

Evaluate processing methods

Winemaking methods to produce quality wines from cold-hardy grapes

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Yeast Trails with Cold-Hardy Grapes

- One of the most asked questions by winemakers is yeast recommendations for new cultivars
- One of the most difficult questions as an enologist to give a response
  - Juice Chemistry
  - Desired wine chemistry
  - Grape quality – primary aromas?
  - Desired wine style

The Northern Grapes Project is funded by the USDA's Specialty Crops Research Initiative Program of the National Institute for Food and Agriculture, Project #2011-51181-30850

2012 Yeast Trial for Cold-Hardy Grapes

Frontenac	Frontenac Gris	Marquette	La Crescent
ICV GRE	Lalvin DV10	ICV GRE	Lalvin DV10
Lalvin Rhône 4600®	Anchor Vin13	ICV D254®	Vitilevure Elixir
ICV Opale®	Anchor NT 116	Levuline BRG	Cross Evolution®

- Yeasts were chosen based on their compatibility with challenging chemistry of cold-hardy cultivars
- Wanted to enhance certain classes of aroma compounds
- Same trial was repeated on fruit from NY and VT

2012 Yeast Trial for Cold-Hardy Grapes

- Intends to be a 3-year study pending Farm Bill Renewal
- DV10 and ICV GRE are “neutral” yeasts that will be used as a control over the three vintages
- Two different commercial yeast strains will be used for each cultivar to compare against the control

Each fermentation is replicated for a total of 24 different wine lots for each vineyard site

Sensory Studies

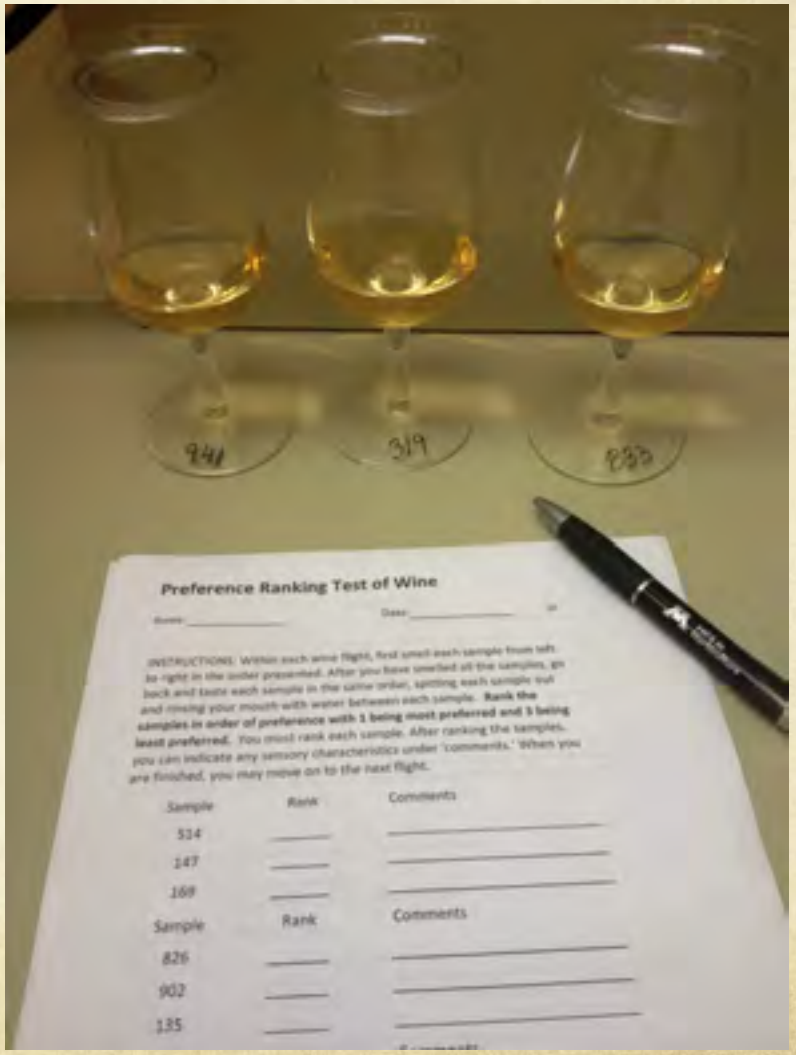
- Wines bottled in 2013 were part of a sensory evaluation to determine whether there was a different in preference for the finished wines
- Descriptive analysis of all fermentation lots from each site will be performed at Cornell University

Preference Study

- We recruited a panel of 27 judges
  - All were familiar with wine made from cold-hardy grapes
  - 16 men and 11 women
  - Age range from 26 to 74 with a median age of 50

Preference Study

- Judges scored the wines in order of preference, with **1=most preferred**, and **3=least preferred**
- Total points for each wine were tallied.
- A lower score indicates a higher overall preference (more #1 ranks) by the judges.
- Statistical analysis was done using the Basker Critical Values for Rank Sum.



Results

	Rank Sum
Frontenac – ICV GRE	49 a
Frontenac – ICV OPALE®	50 a
Frontenac – Rhône 4600®	56 a

	Rank Sum
La Crescent – DV10	63 a
La Crescent – Elixir	52 a
La Crescent – Cross Evolution®	47 a

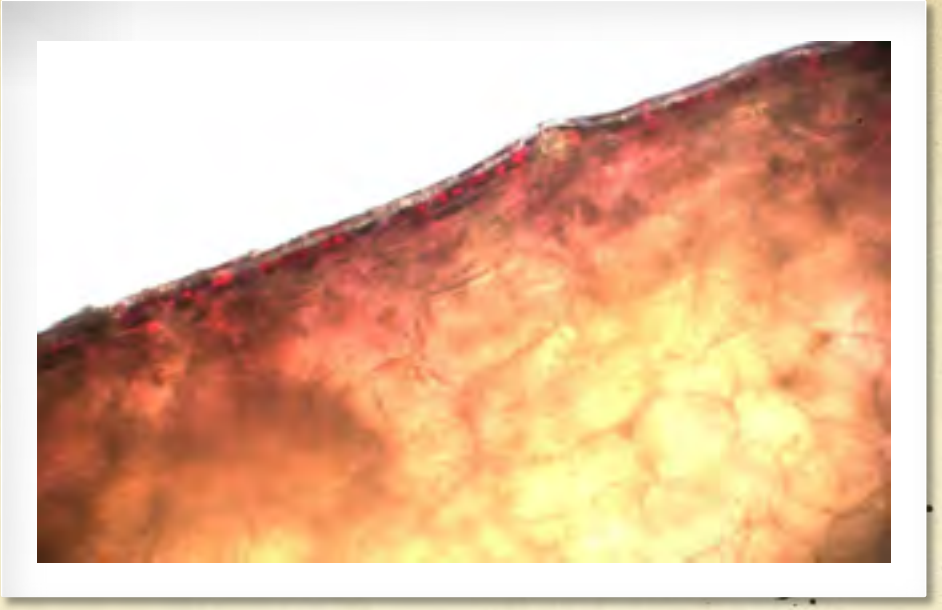
	Rank Sum
Marquette – ICV GRE	54 a
Marquette – D254®	54 a
Marquette – ICV BRG	54 a

	Rank Sum
Frontenac Gris – DV10	55 a
Frontenac Gris – NT 116	52 a
Frontenac Gris – Vin 13	55 a

No difference in preference was found for any of the yeast strains used in the trial

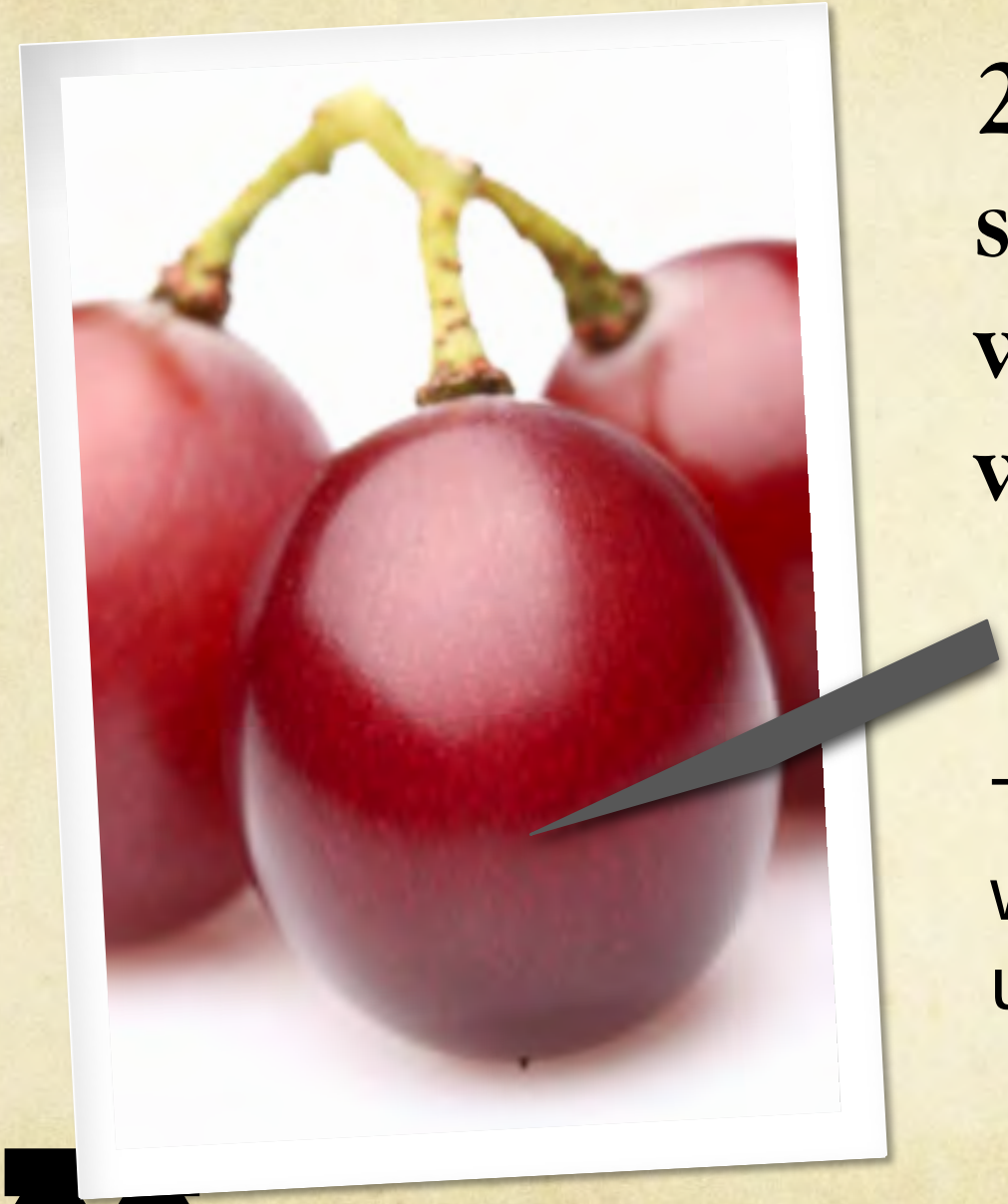
What the Results Mean

- Doesn’t mean that the wines were not different!
- Individuals found the wines to be quite different, but over the panel of 27 people, there was no consensus over ***preference***
- Individual preference didn’t translate to a group consensus for preference
- Any of the yeasts used in the trial would give good outcomes for the finished product



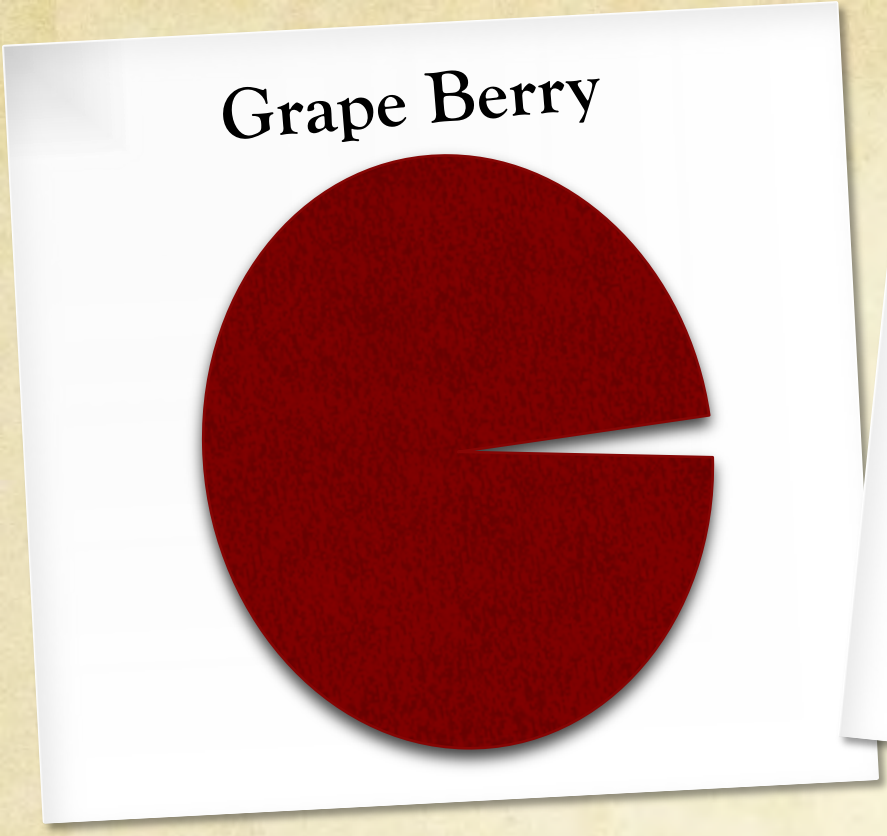
Evaluation of Color and Flavor Compounds

Characteristic to wines made from new cold-hardy grapes



2-mm cross sections of grape were removed with a razor blade

These Cross-Sections were then observed under a microscope



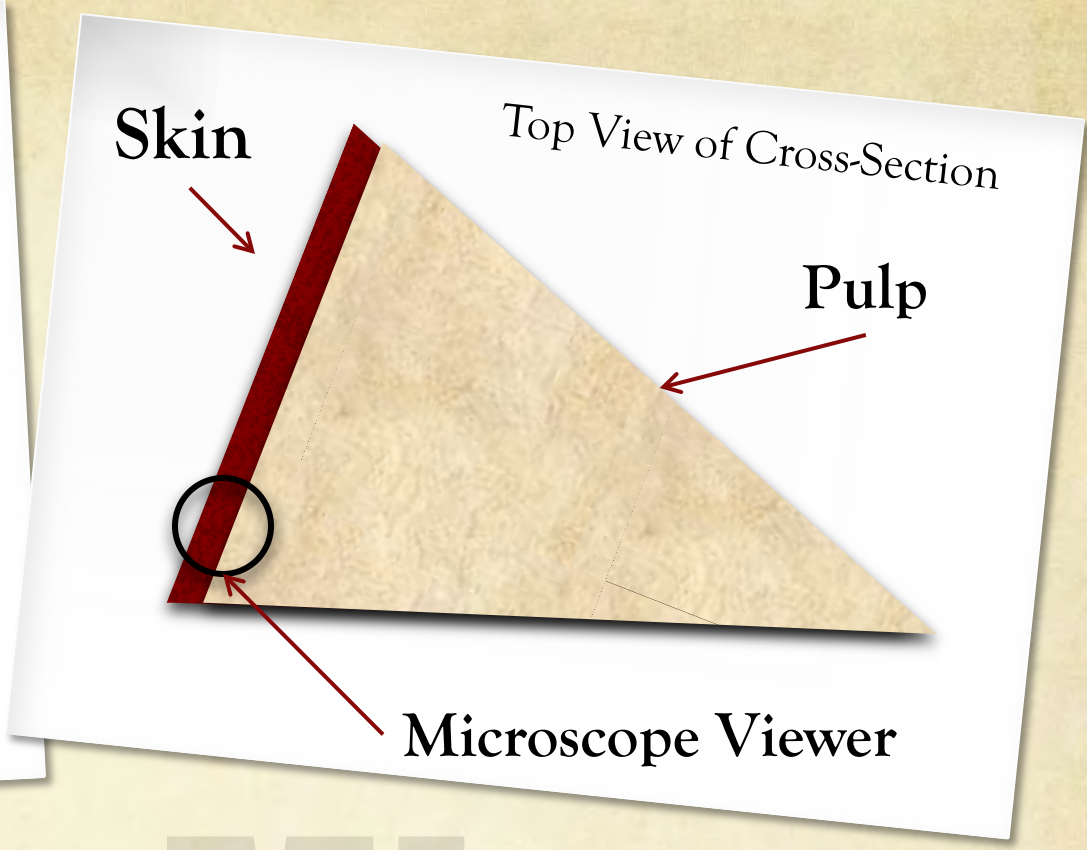


Diagram of Cross-Section

Thank you to Dr. Chengbin Chen for helping with dissections.

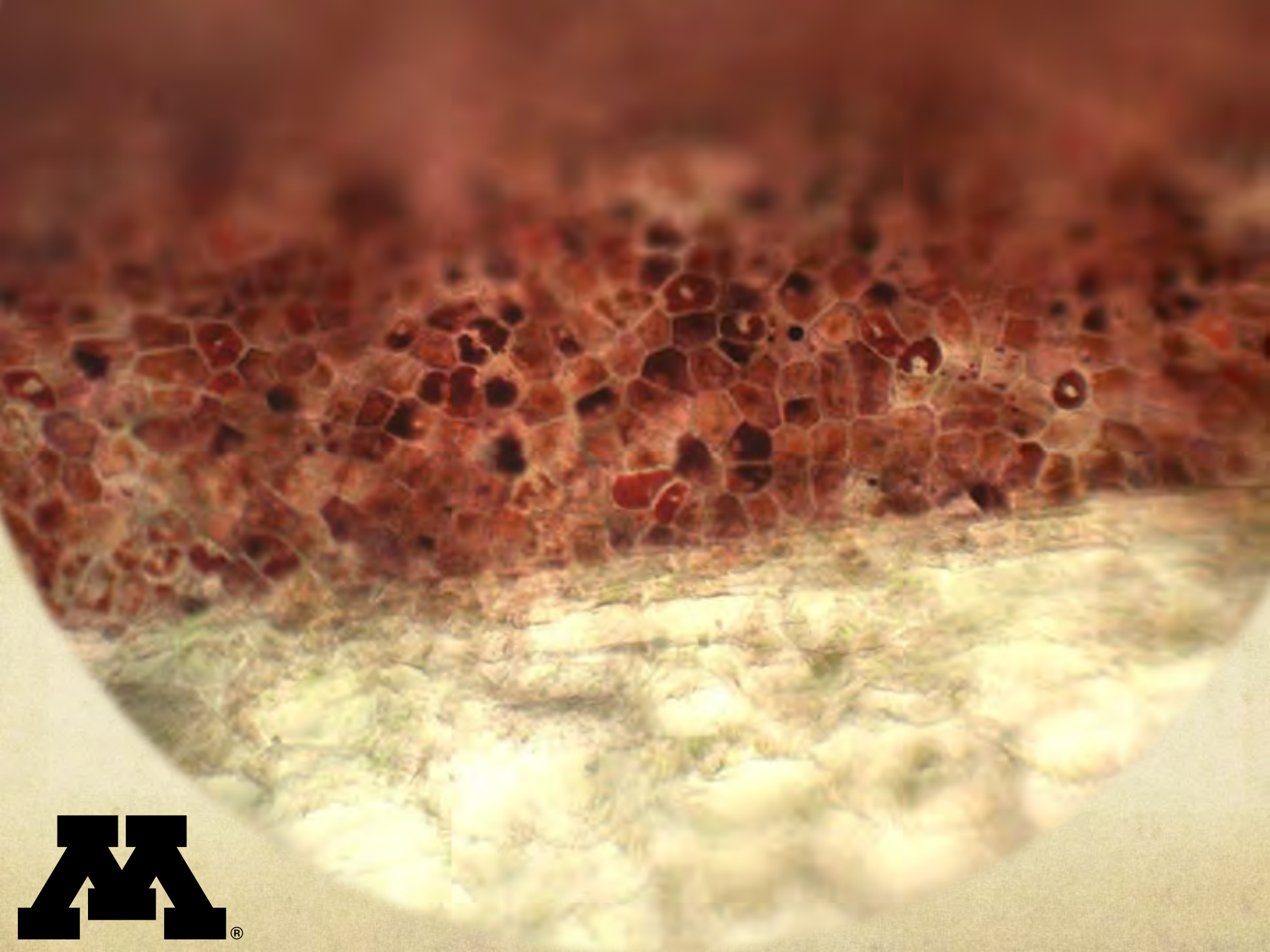
Skin layer of cells

- Small, polygonal shape
- Contain Color (anthocyanin)
- Anthocyanin inclusions

Pulp layer of cells

- Large, longitudinal cells
- No color
- No anthocyanin inclusions

Cross Section of Pinot Gris




Skin Layer
Pinot Gris at Veraison

Alicante Bouschet Ripening

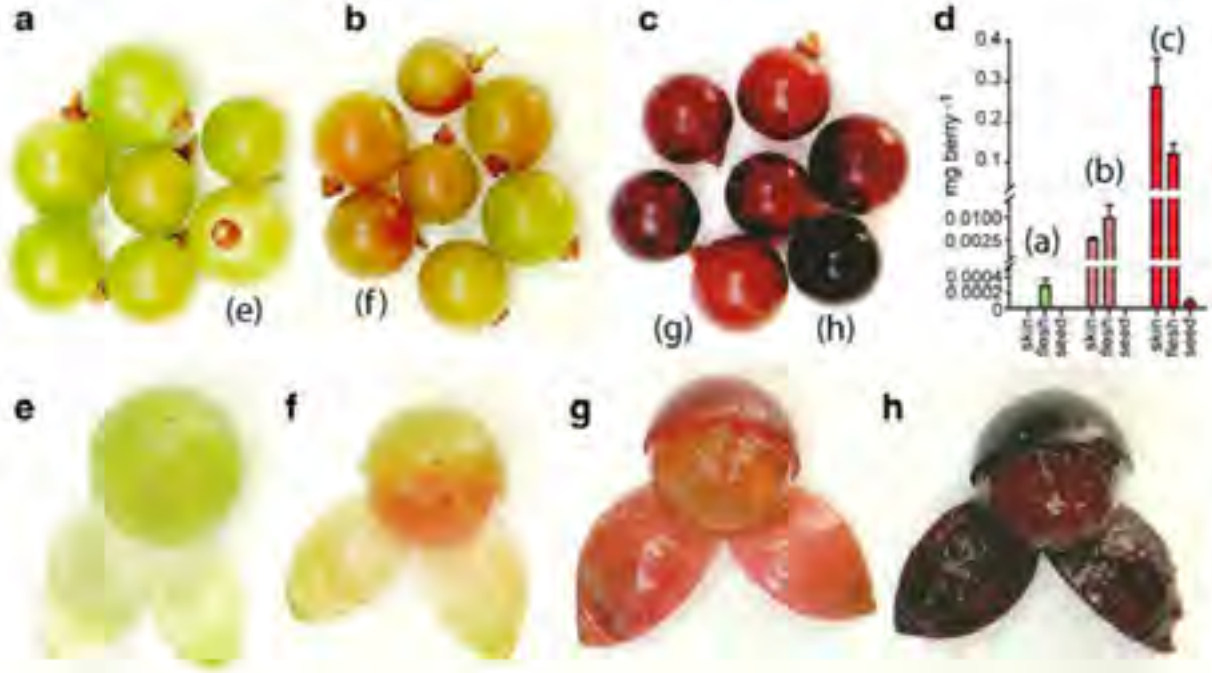
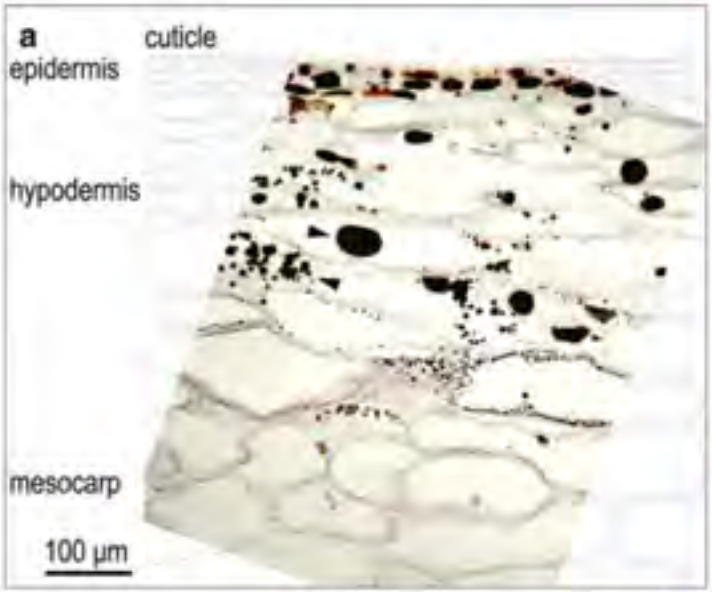


Fig. 1 Pigmentation of the Alicante Bouschet fruit in asynchronous berries collected at 67 DAA. Pictures of intact (**a** through **c**) and dissected (**e** through **h**) berries, and total anthocyanin content (**d**) in skin, flesh, and seed of green berries (**a**), reddening berries (**b**), and red berries (**c**). *Diagonal ticks* on the y axis indicate breaks along the y-scale

Falginella, L., G. Di Gaspero, S. D. Castellarin. (2012). Expression of flavonoid genes in the red grape berry of 'Alicante Bouschet' varies with the histological distribution of anthocyanins and their chemical composition. Planta 236:1037–1051

Alicante Bouschet Ripening



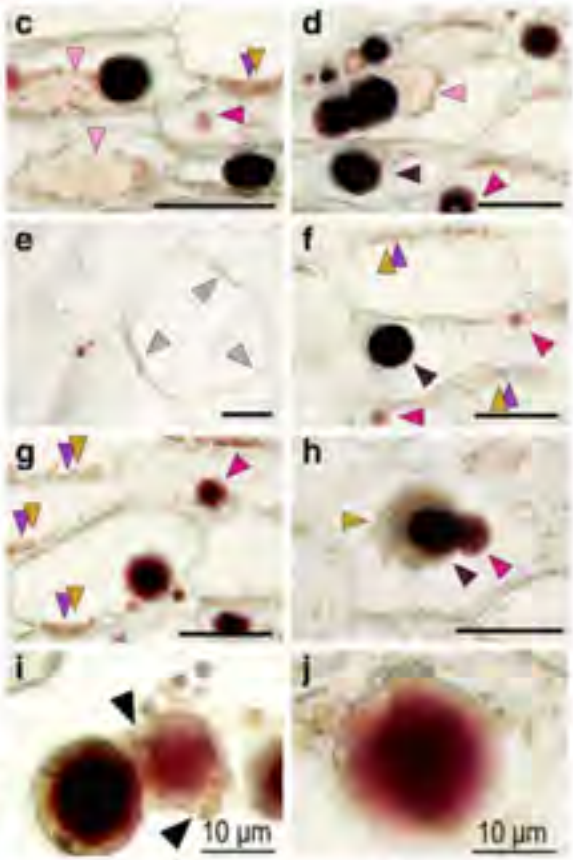
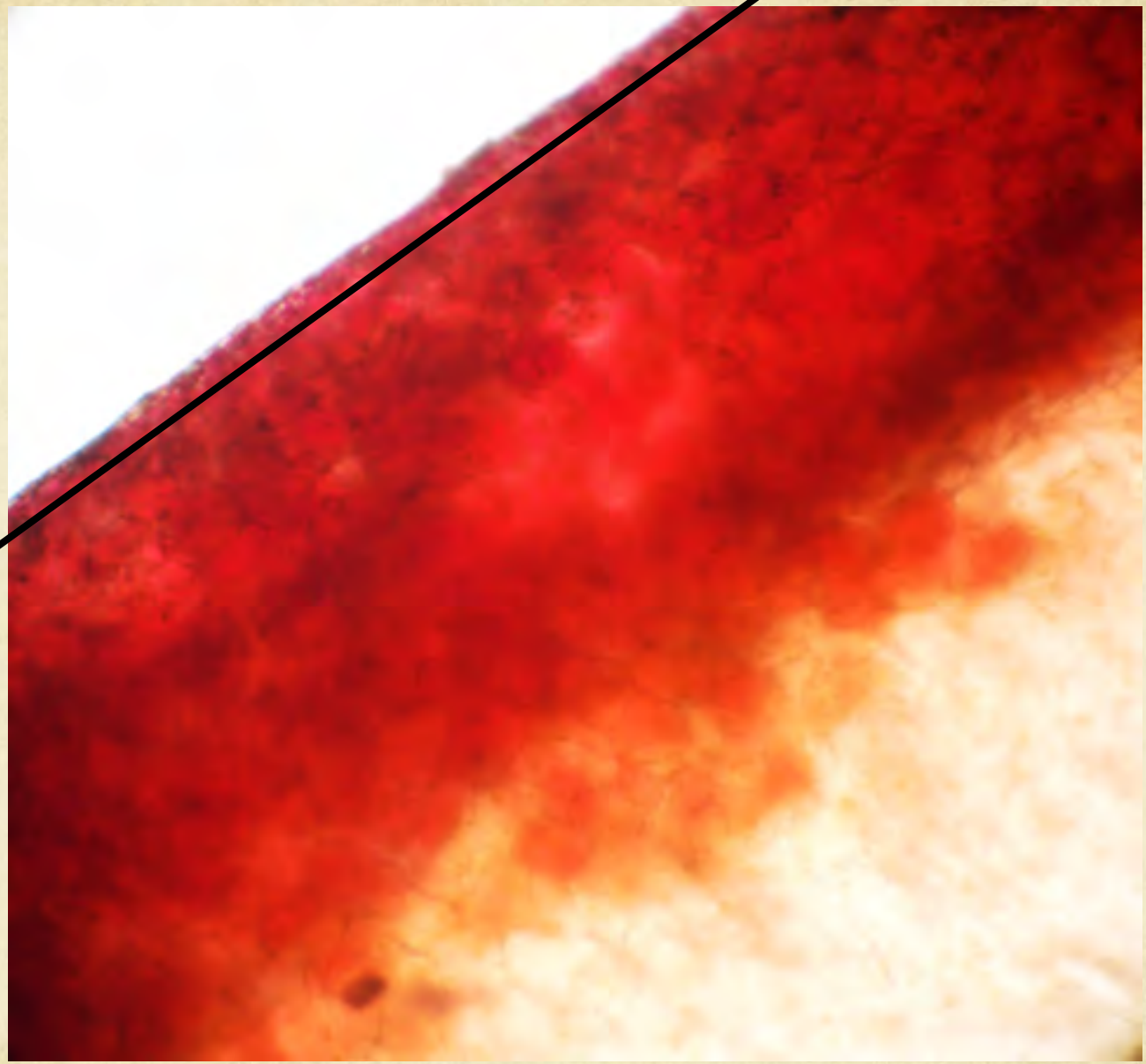
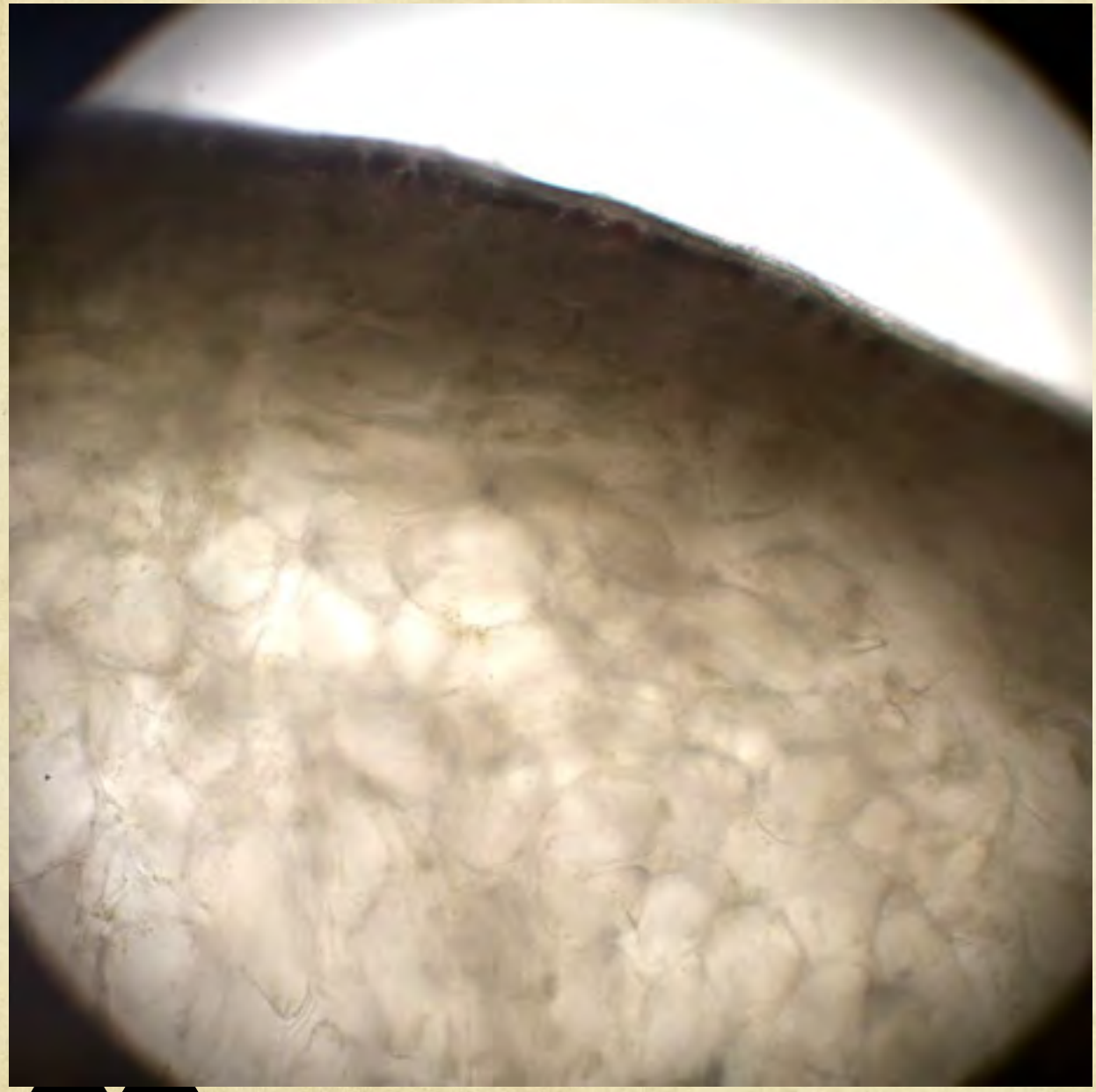


Fig. 3 Accumulation of anthocyanin bodies in the outer pericarp of Alicante Bouschet. Diagram of cell layers overlaid with a 200× magnification of the transverse section of the fruit at 87 DAA (*panel* **a**), magnified micrographs with *blue and pink arrowheads* indicating anthocyanin bodies with different hues (**b**), formation of anthocyanin bodies in cells located ~100 to 500 µm below the epidermis (**c–j**), and coalescence of anthocyanin bodies (**h–j**) in a mature berry at 112 DAA. *Coloured arrowheads* indicate the central vacuole (*pink arrowheads*) and increasingly larger vesicles as described in the main text (*grey*, *brown*, *violet–red*, *purple*, *deep-purple arrowheads*); *black arrowheads* indicate small vesicles in physical contiguity with larger coalescences. *Bars* in **c–h** represent 50 µm



Frontenac at Veraison



Frontenac Gris at Veraison

No anthocyanin inclusions in the pulp cells


Frontenac Gris at Harvest

What this means for Frontenac Gris

- Pulp of Frontenac Gris is not entirely "colorless"
- When pressing grapes from FG to make a white wine, care should be taken to minimize the extraction of color
  - Whole-Cluster Pressing
  - Gentle extraction
  - Press fractioning – use juice collected at lower pressure for whites, higher pressings for rosé or for blending

Descriptive Analysis Studies of berry ripening

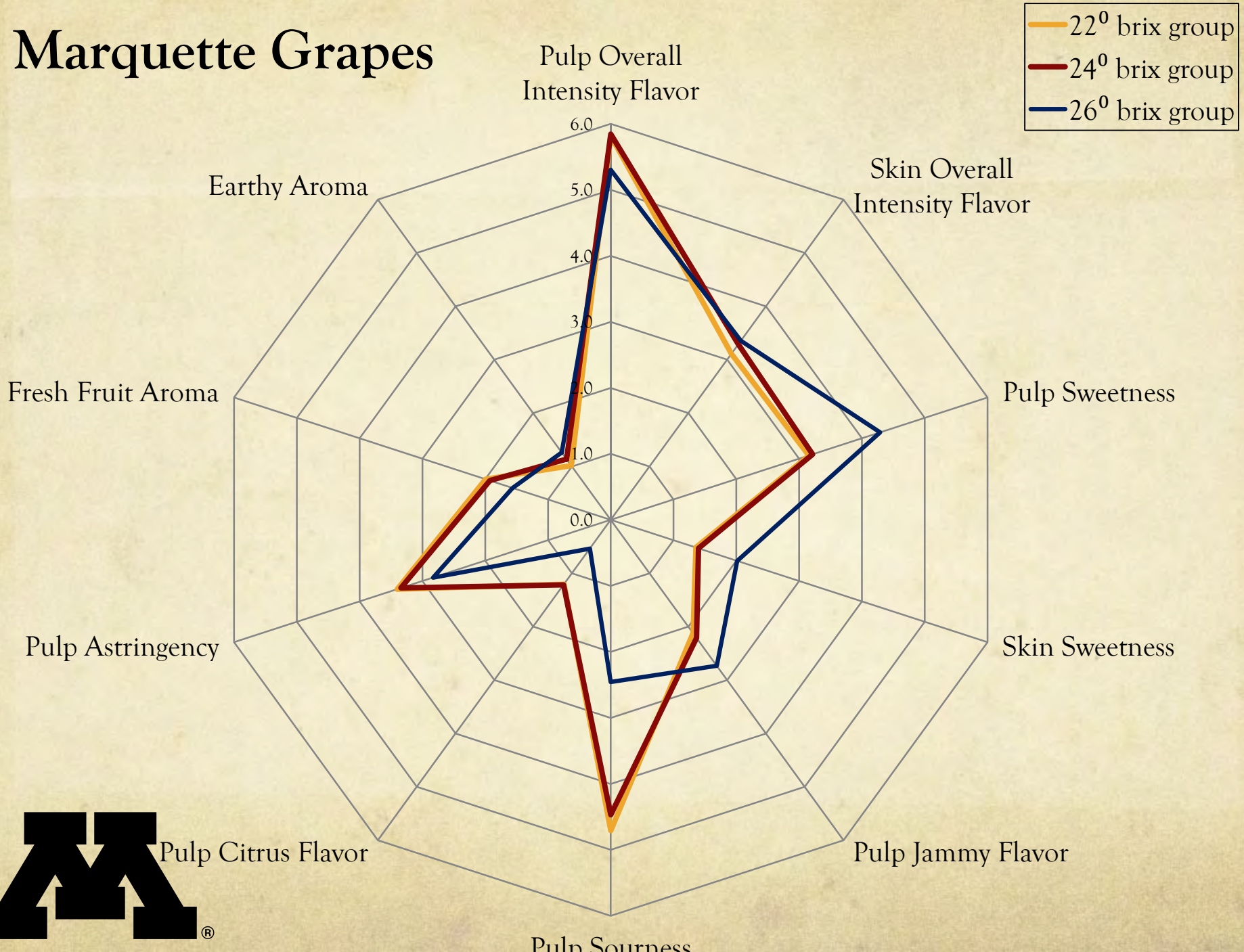
Sensory study for the Northern Grapes Project

Emily Del Bel and Dr. Zata Vickers

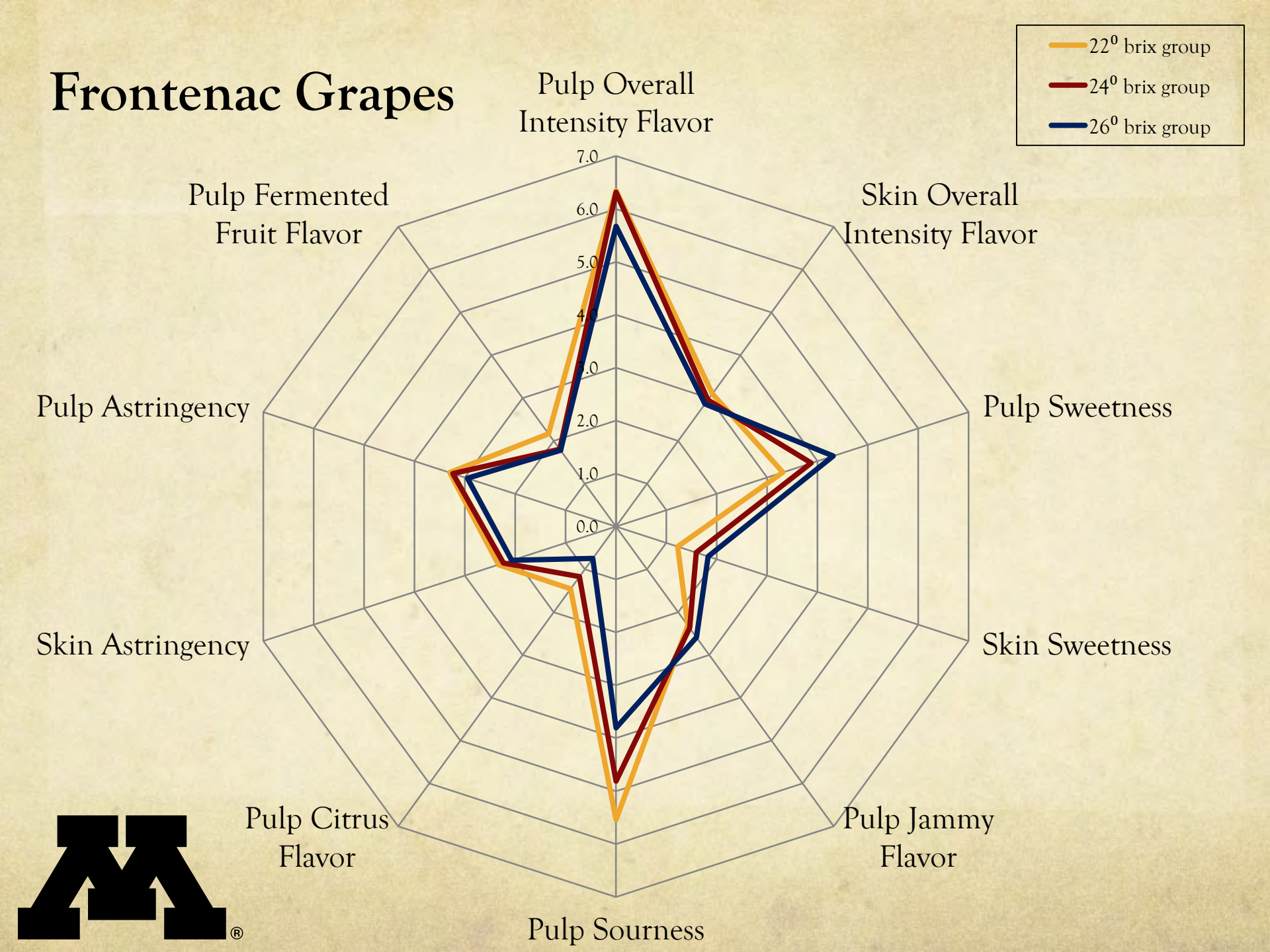
Berry Descriptive Analysis

- Panel:14 trained panelists
  - 9 females and 5 males, (ages 21-60)
  - All PROP tasters
  - Previous citric acid and butanol scale training
  - Able/willing to consume alcohol

Marquette Grapes



Frontenac Grapes



Education and Outreach Efforts

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http://enology.umn.edu

Thank you!

Winemaker/lab manager, Nick Smith

… Also to Raina Eikaas and David Wett

Thank you!

Jim Luby, Fruit Breeding

Peter Hemstad, Grape Breeder

John Thull, Vineyard Manager

Jenny Thull, Vineyard Crew