Sparkling winemaking: Forming foam and flavour

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Cool Climate Oenology & Viticulture Institute
Brock University

Introduction

1. Background
2. Foam terminology
3. Sparkling wine research studies by CCOVI in Ontario (Traditional Method)

- Press fractioning
- Bentonite use for sparkling wine production
- Disgorging - Gushing
- *Dosage*

Background to CCOVI research trials

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- Growth in sparkling wine production in Ontario and across Canada – British Columbia, Nova Scotia, Quebec.
- Winemakers desire for information and options for each stage of winemaking.
- We started at the end stage: *Dosage* project came first!
- Projects include viticulture to finished sparkling wine.
- Remember: Do NOT treat grapes in the vineyard or the base wine in the same way you do a still white wine!

Sparkling wine research at CCOVI
Traditional Method

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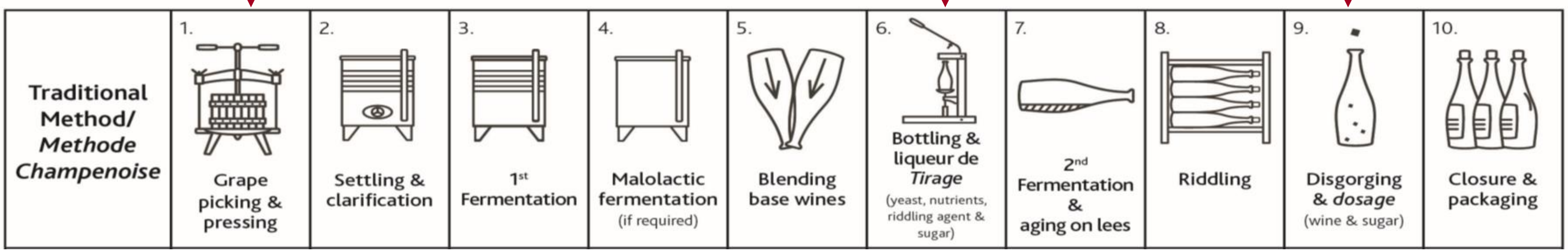
- ✓ Press fractions
- ✓ Bentonite + proteins
- ✓ Gushing
- ✓ *Dosage*



Trius Winery

Château des Charmes

Trius Winery

Trius Winery

Tawse Winery

Bottling: Fielding Estate Winery

Fielding Estate Winery

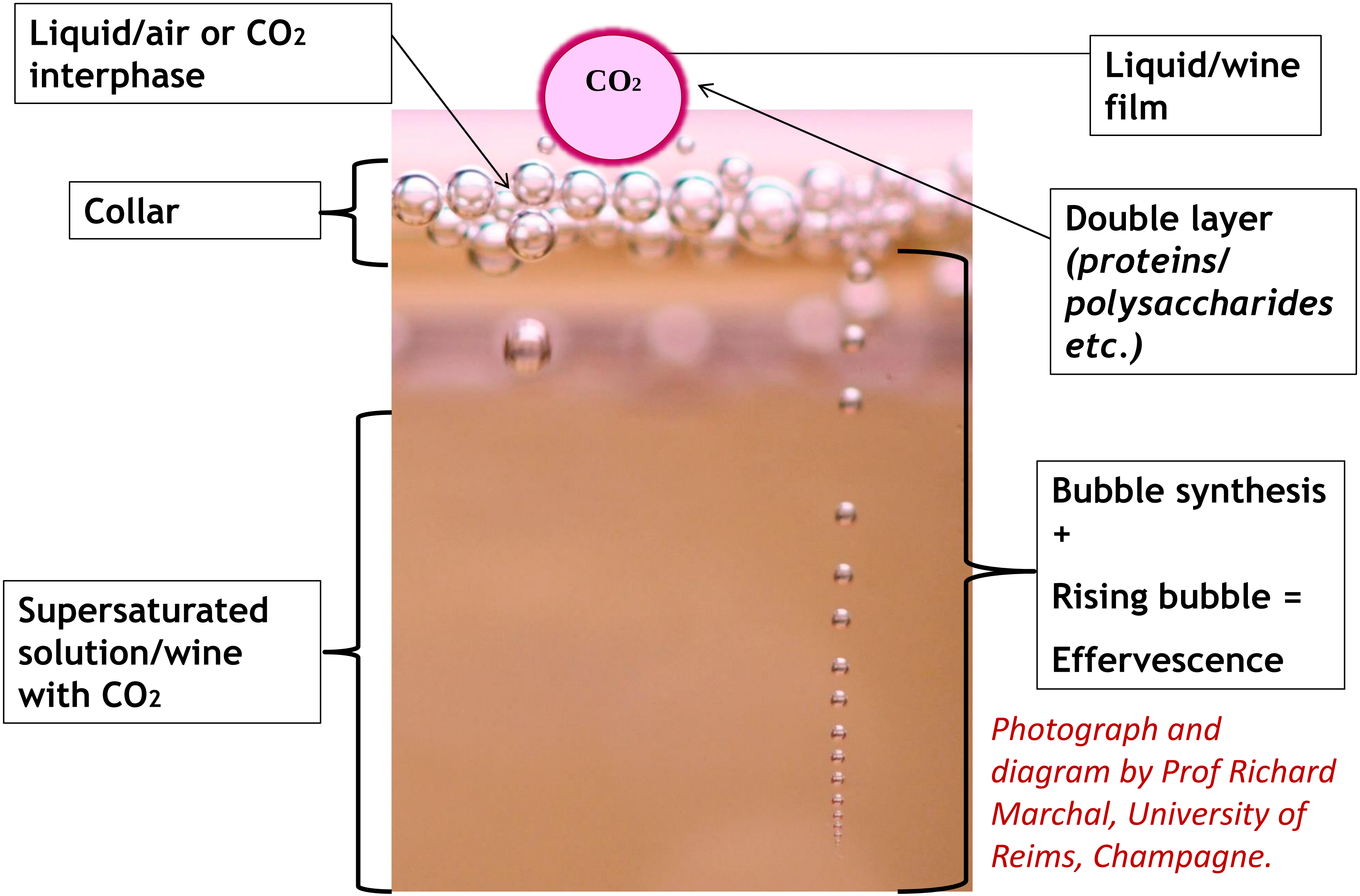
Disgorging: Millesime Sparkling Wine Processing Inc.

Foam terminology used in this webinar

- **Foam height (FH): the height of foam upon pouring the wine.**
- **Foam stability time (FS): the time the bubbles take to entirely collapse/foam disappears.**
- **Various methods and equipment used for foam analysis** ***(not included in this webinar)***

Foam height

Foam, bubbles and effervescence terminology



Photograph and diagram by Prof Richard Marchal, University of Reims, Champagne.

More to foam than CO_2!!!

Proteins
Amino acids
Lipids
Polysaccharides
Glycerol
Biogenic amines
Polyphenols
Ethanol
Organic acids
Sulfur dioxide

Botrytis Cinerea/ gluconic acid
Sour rot?

Poor effervescence **Sustained effervescence**

Grape variety
Pectic enzymes
Fining
Filtration

Glass type/care
Temperature

Chemical composition, production processes and serving conditions that influence foam

Photograph by Prof Richard Marchal, University of Reims.

Berry, juice & wine composition = foam quality

Proteins

- Low concentration in wine = principal compounds associated with foam properties of sparkling wines
- Base wines contain a grape-derived proteins while mannoproteins come from yeasts during lees aging

Highest foamability when grape & yeast proteins combined = suggesting a synergistic interaction between yeast mannoproteins and grape proteins (different molecular weights).

Important proteins

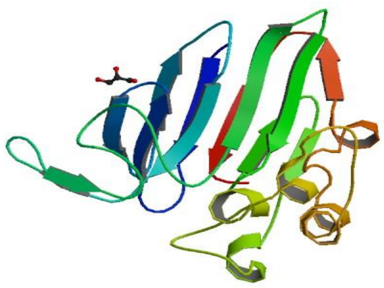
- **Chitinase & grape thaumatin-like proteins (TLPs) important in recent foam studies & most abundant yet cause haze in white wines.**

Don't bentonite fine your base wine!

- **Ultra-filtered wines deprived of larger molecules did not produce any measurable foam** *(Aguié-Béghin et al.2009)*

Don't filter base wine to 0.45 microns!

Structure of haze forming proteins in white wines: *Vitis vinifera* thaumatin-like proteins (TLPs)

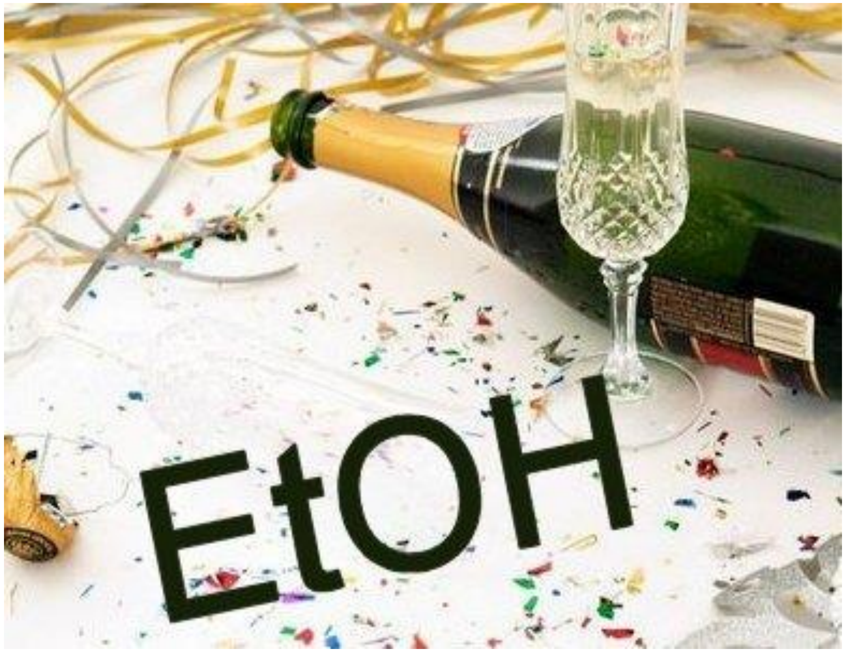


(Marangon et al. 2014)

Other foam affecting compounds

- Ethanol

1) °Brix levels too high at harvest
2) Incorrect sugar calculations at bottling for desired pressure level
3) Check residual sugar levels before bottling



Other foam affecting compounds

➢ Acid type

- ✓ Tartaric acid - positive effect on foam height
- ✓ Malic acid - increases foam height but not stability
- ✓ Lactic acid - increases foam stability but not height
- ✓ Gluconic acid - effects height & stability

➢ Phenolic compounds

Other foam affecting compounds

Fatty acids and lipids

- Fatty acids have been found to only affect foam when the ethanol level is below 5% v/v %.

Sulphur Dioxide (SO_2)

- Decreases foam height & stability

NO optimal concentrations of these compounds for sparkling white, rosé or red wines is available!

Harvest

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- Sugar and acid levels are important in sparkling grapes and the sugar to acid ratio (°Brix:TA g/L index)

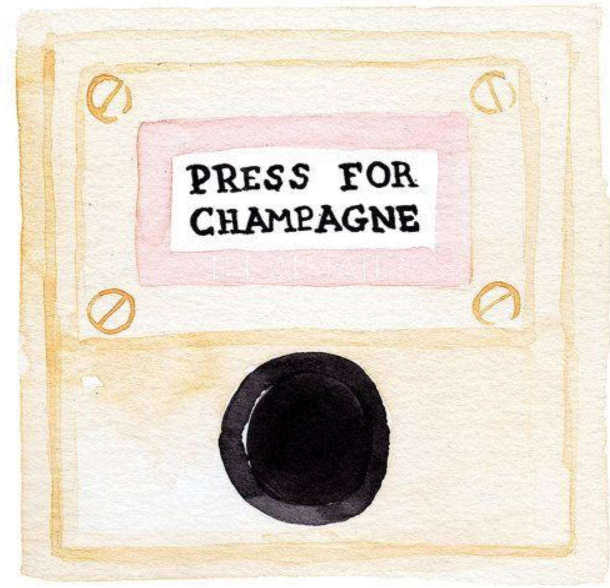
- Ratio of **4:5.5** produces wines with optimal foamability.

- Grapes picked at more mature ripeness levels produce wines with less foaming ability

Press fractioning for quality sparkling wines…………………..

Making white sparkling wine from red grapes

- Cool temps/Press straight after picking
- Whole bunch pressing
- Gentle, gradual increase in pressure
- Low juice extraction
- Press fractioning



Champagne pressing (based on 4000kg grapes)

- Cuvee = 20.5hL
- Tailles = 5hL (1^{st} taille -3hL + 2^{nd} taille 2hL)
- 3^{rd} taille 1-2hL distillation

Optimising press fractions (Clone 115)

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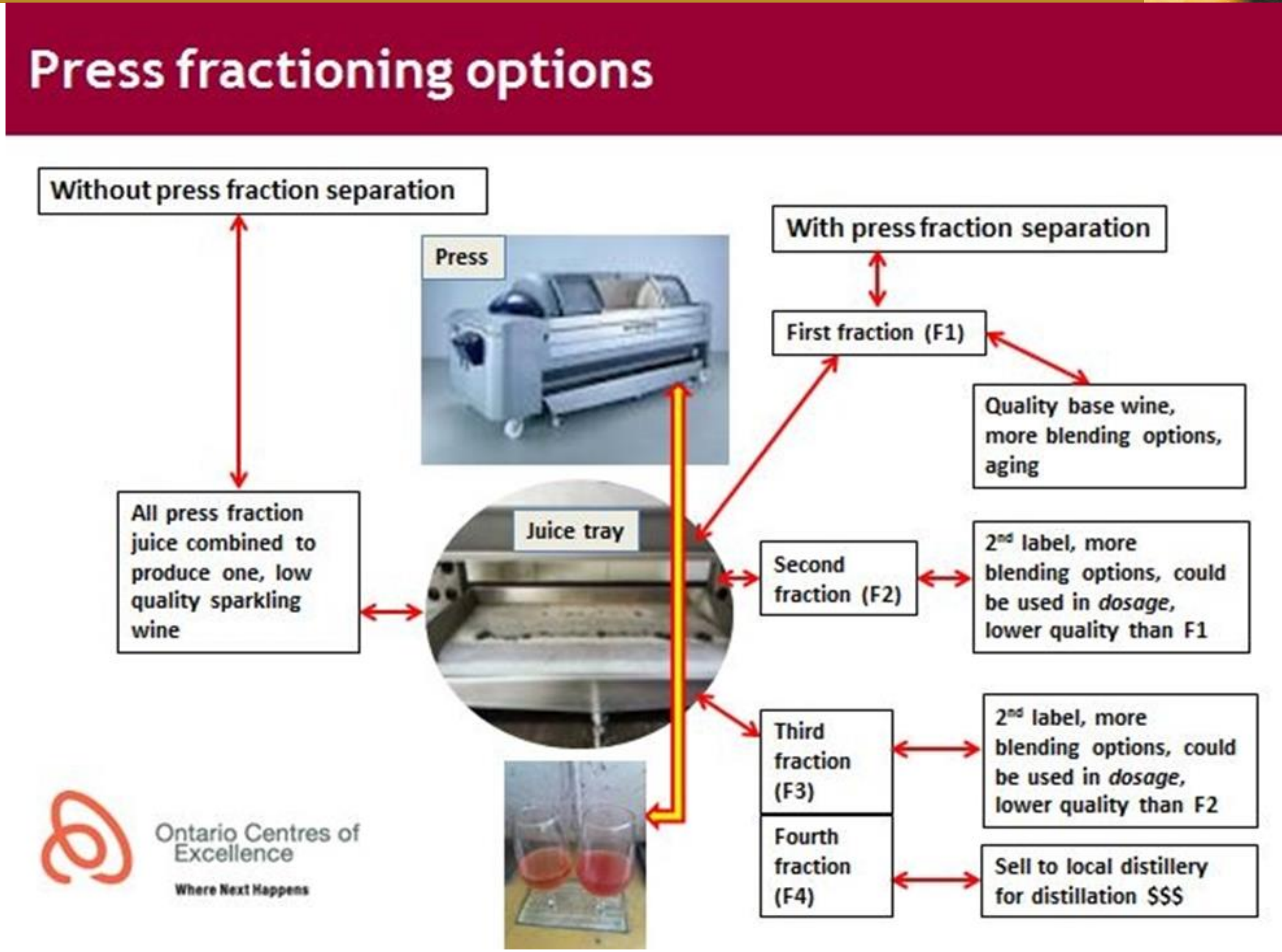
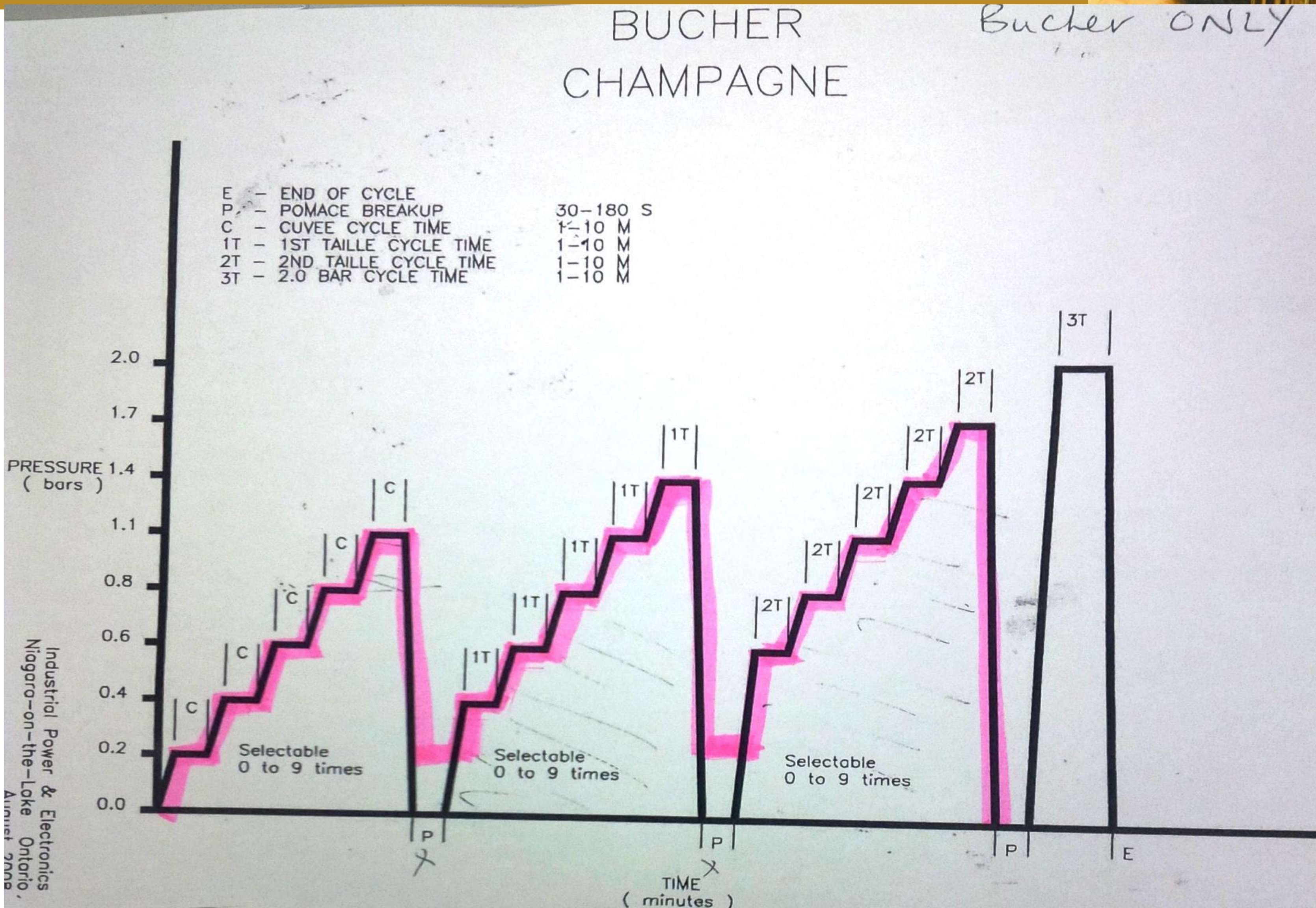


Press fractions
CLONE 115 (Dijon clone)



Experimental winemaking method

- Pinot noir - Clone 115
- Whole bunch pressed
- Wine taken from tap before hitting the tray - middle of each cycle
- No enzymes added
- 30 ppm SO2
- Winemaking in triplicate – no MLF
- Chemical analysis of juice & wine pH, TA (g/L), Brix, fre & total SO2, ethanol, Nitrogen, turbidity, glucose, fructose, residual sugar, malic acid, heat stability, tartrate stability, total phenolics, conductivity & potassium.
- EC118 both fermentations
- *Tirage* same for all fractions (calculated on residual sugar & target of 24 g/L for 2^{nd} fermentation

Press fraction juice and wine composition

(Analysis at every stage of winemaking but pre-fermentation and pre-bottling data presented today)

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Press fraction juice analysis

Press Fraction	Brix	TA (g/L)	pH	Total YAN (mg N/L)	Malic acid (g/L)	Turbidity (NTU)	Acetic acid (g/L)
PF1	18.5	**8.3**	3.12	153	**3.9**	267	<0.01
PF2	18	**7.5**	3.19	154	3.6	297	<0.01
PF3	18	**6.3**	**3.39**	**160**	3.4	261	<0.01
Significance	NS	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	NS

Press fraction juice and wine composition

(Analysis at every stage of winemaking but pre-fermentation and pre-bottling data presented today)

Press fraction base wine analysis (prior to bottling)

Press fraction	Alcohol (% v/v)	TA (g/L)	pH	Total YAN (mg N/L)	Residual sugar (mg/L)	Malic acid (g/L)
PF1	10.6	7.7	2.9	10.3	0.12	3
PF2	10.6	6.8	3.1	11.6	0.12	3
PF3	10.7	6.0	3.4	14.5	0.23	3
Significance	NS	< 0.0001	< 0.0001	< 0.0001	< 0.0001	NS

PRESS FRACTIONING:
Sparkling wine research at CCOVI

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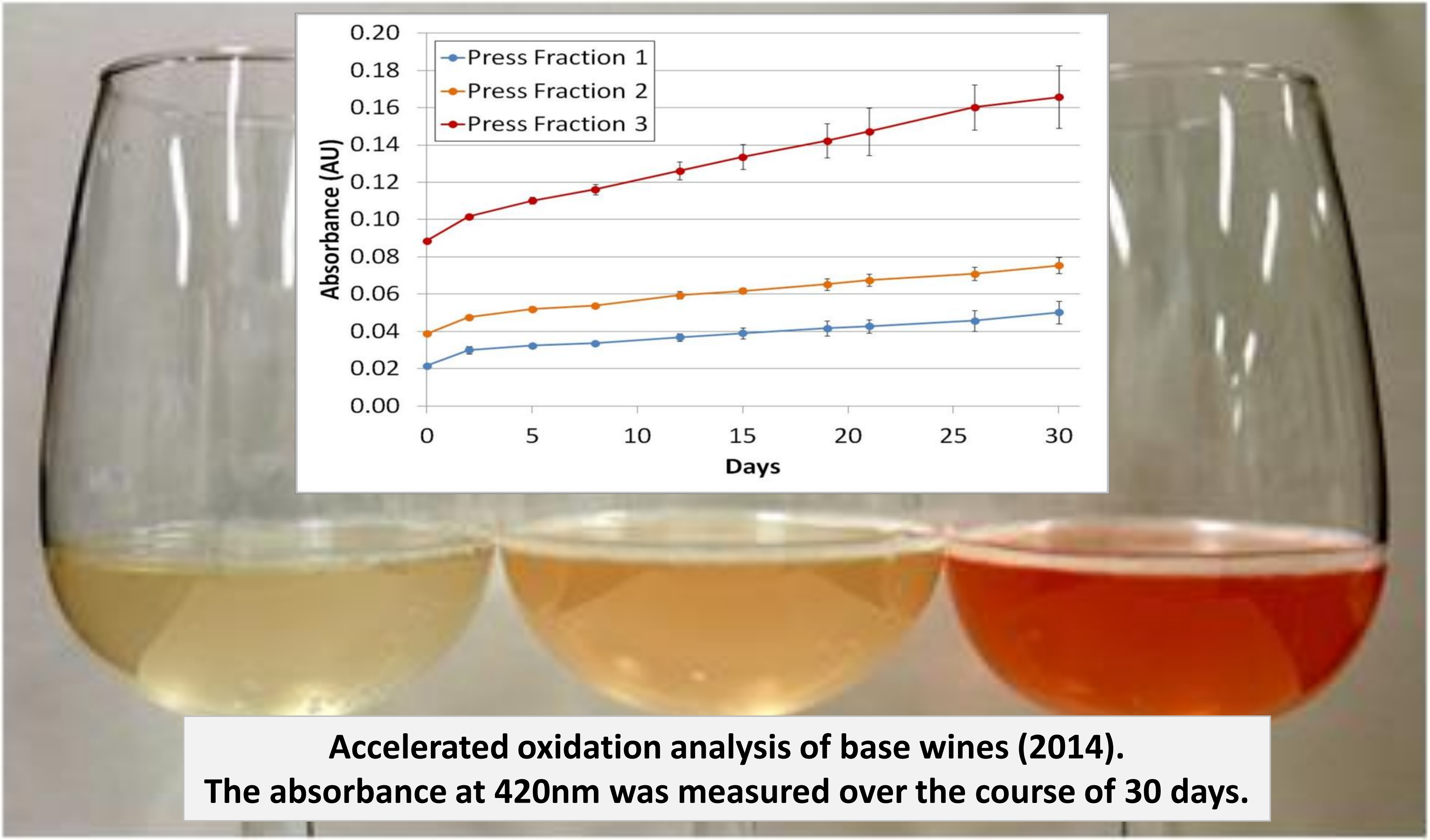

Accelerated oxidation analysis of base wines (2014).
The absorbance at 420nm was measured over the course of 30 days.

Phenolic compounds in press fractions(Pinot noir clone 115)

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Ontario Centres of Excellence
Where Next Happens

Trius WINERY

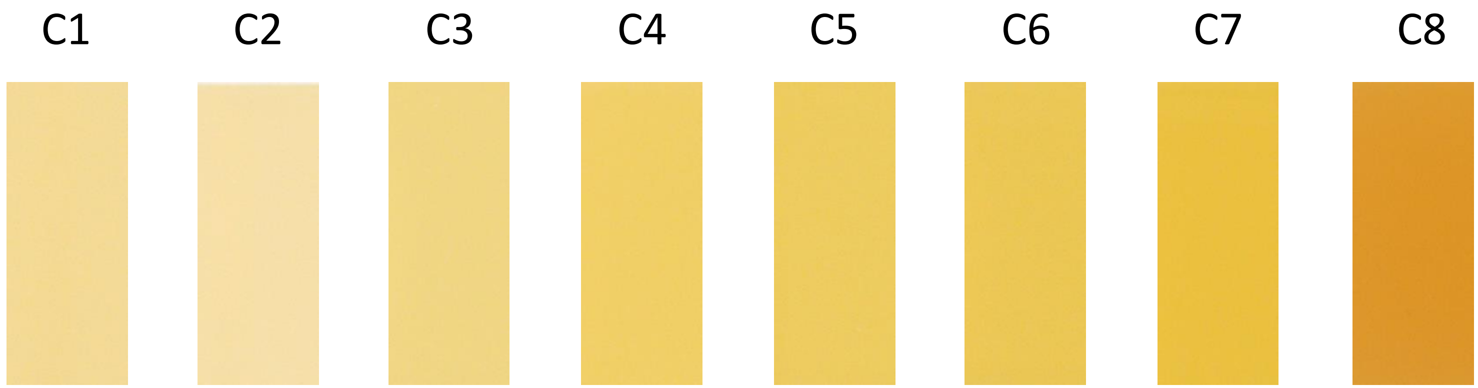
Press fraction 1: Sparkling wine with highest acidity, lowest pH, light colour and highest foam stability

Press fraction 2: Sparkling wine with medium acidity, medium pH and medium colour

Press fraction 3: Sparkling wine with lowest acidity, highest pH and darkest colour

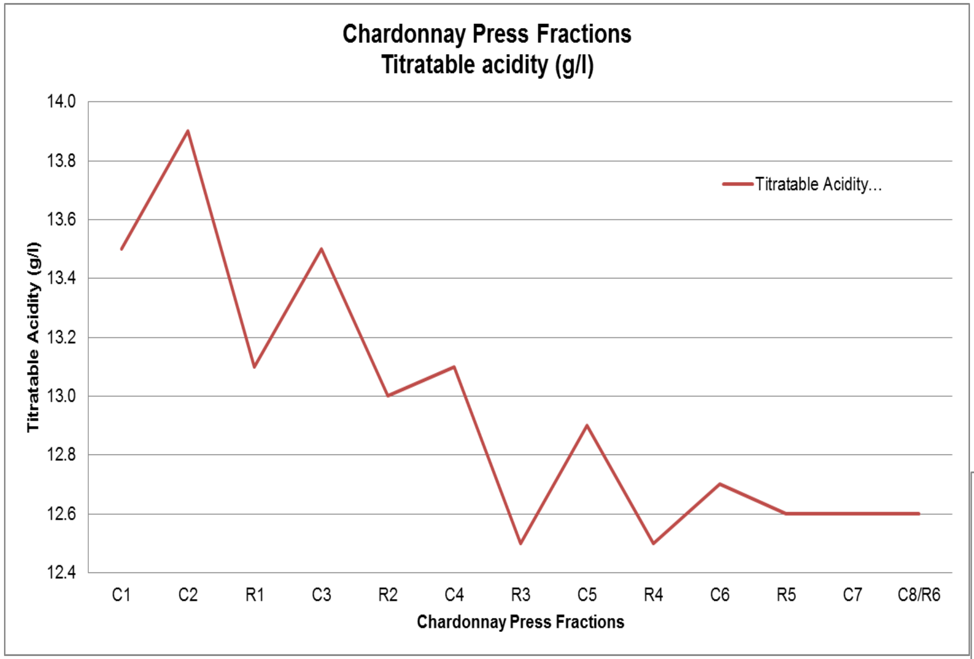
Grape must colour change during pressing

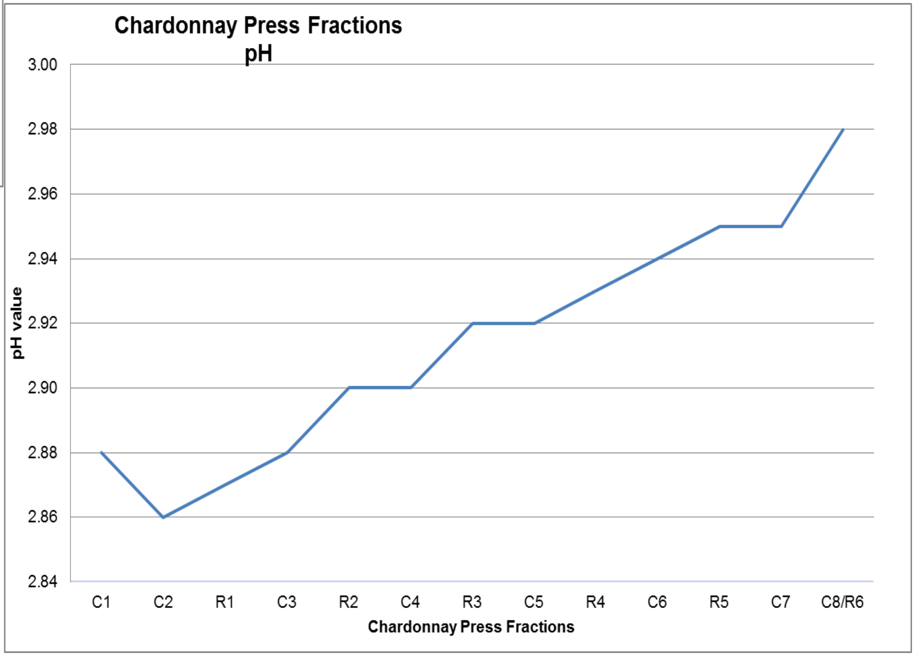
South of England, Chardonnay – 09/2010



Kemp et al. 2012

Chardonnay must analysis (UK) during pressing: pH and TA (g/L)





Kemp et al. 2012

Pressing

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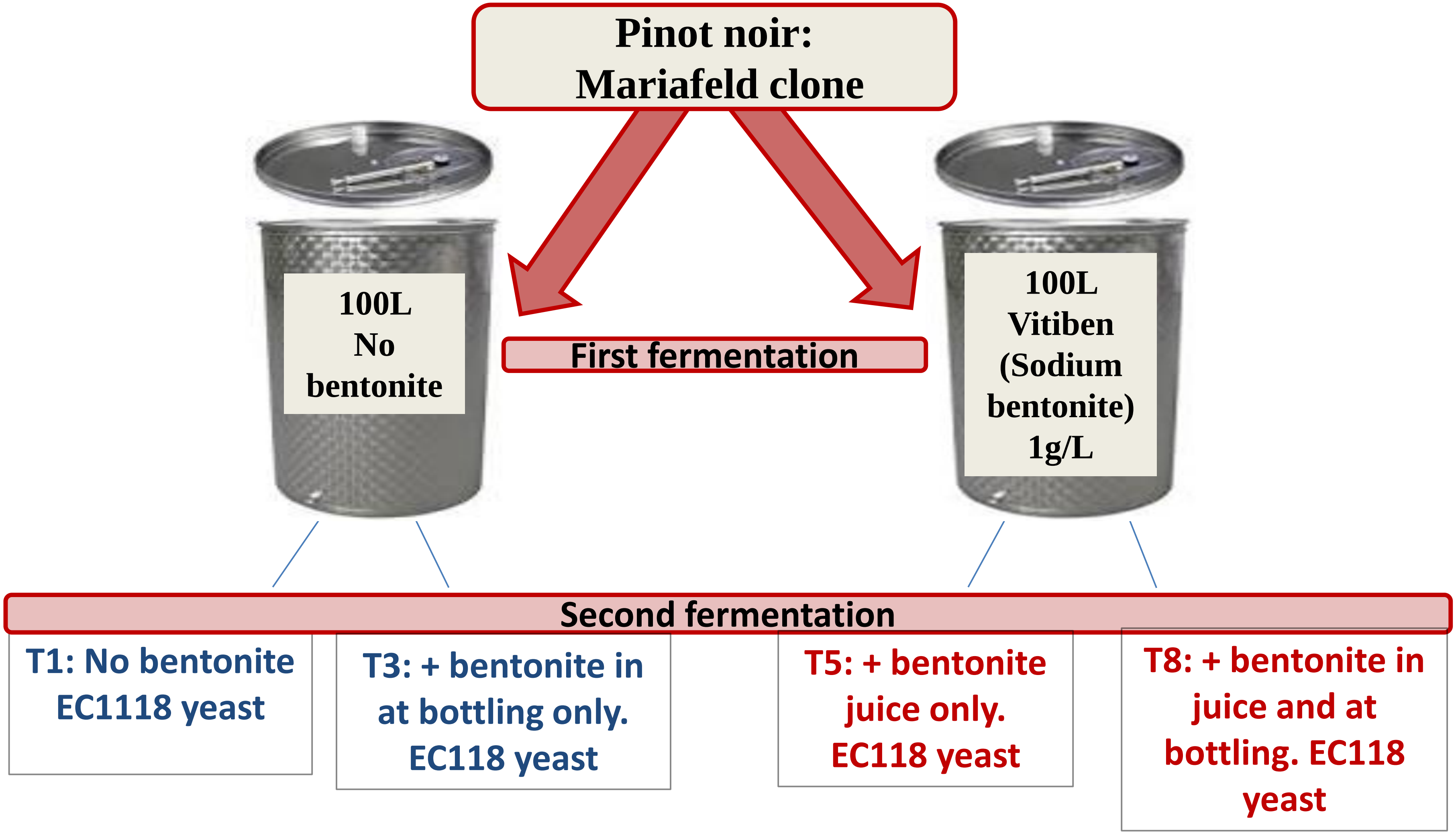
Considerations

- ✓ Press type
- ✓ Press size
- ✓ Press cycles
- ✓ Pressing level per fraction
- ✓ Grape variety
- ✓ Health of grapes
- ✓ Mechanical or manual harvesting
- ✓ SO_2 addition level at press
- ✓ Initial grape ripeness
- ✓ Whole bunch pressing
- ✓ Grape temperature at picking & pressing

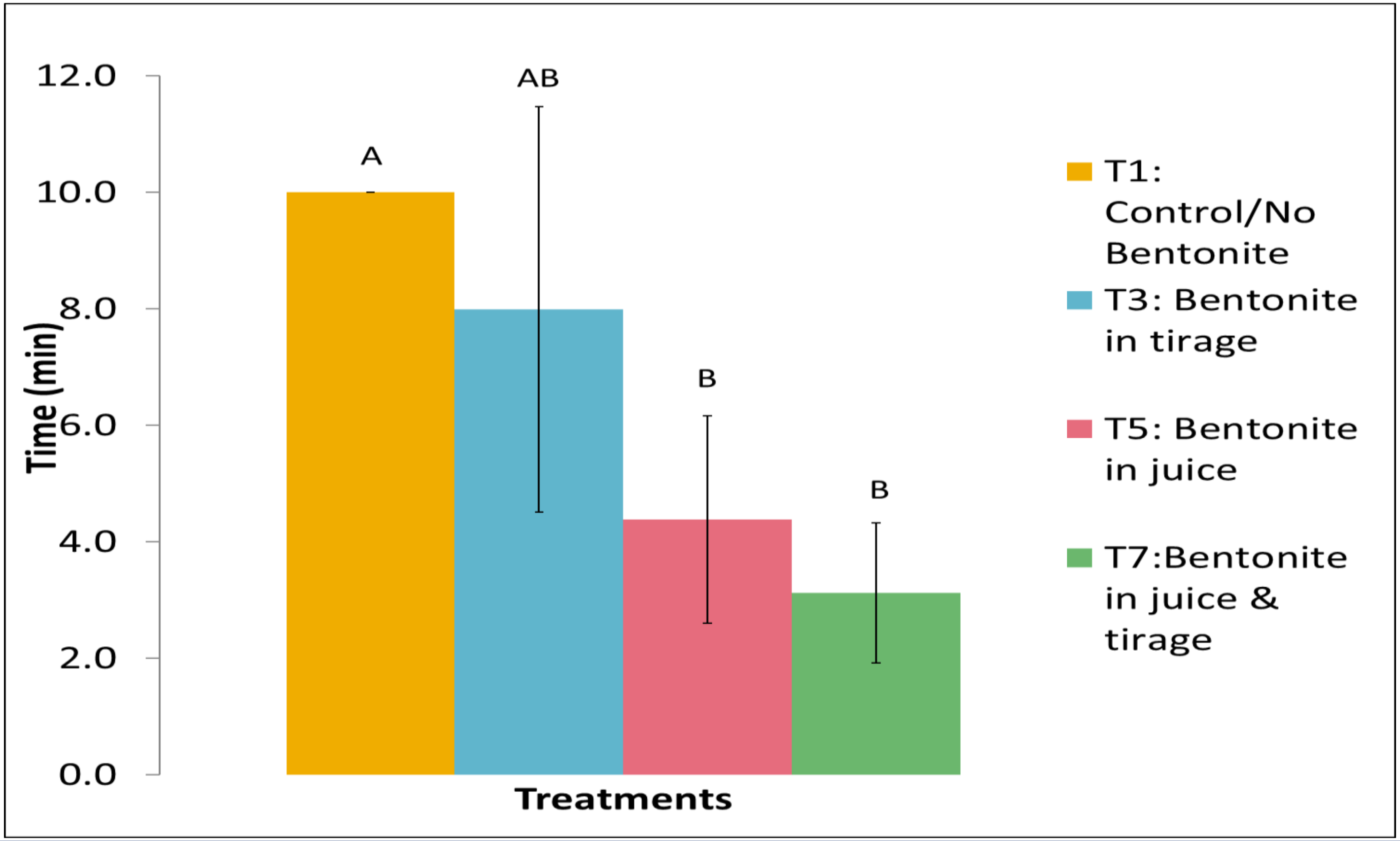
Bentonite and proteins at bottling impacts foam stability



* *Bentonite used: Vitiben pre-fermentation and Inoclair 2 at tirage*

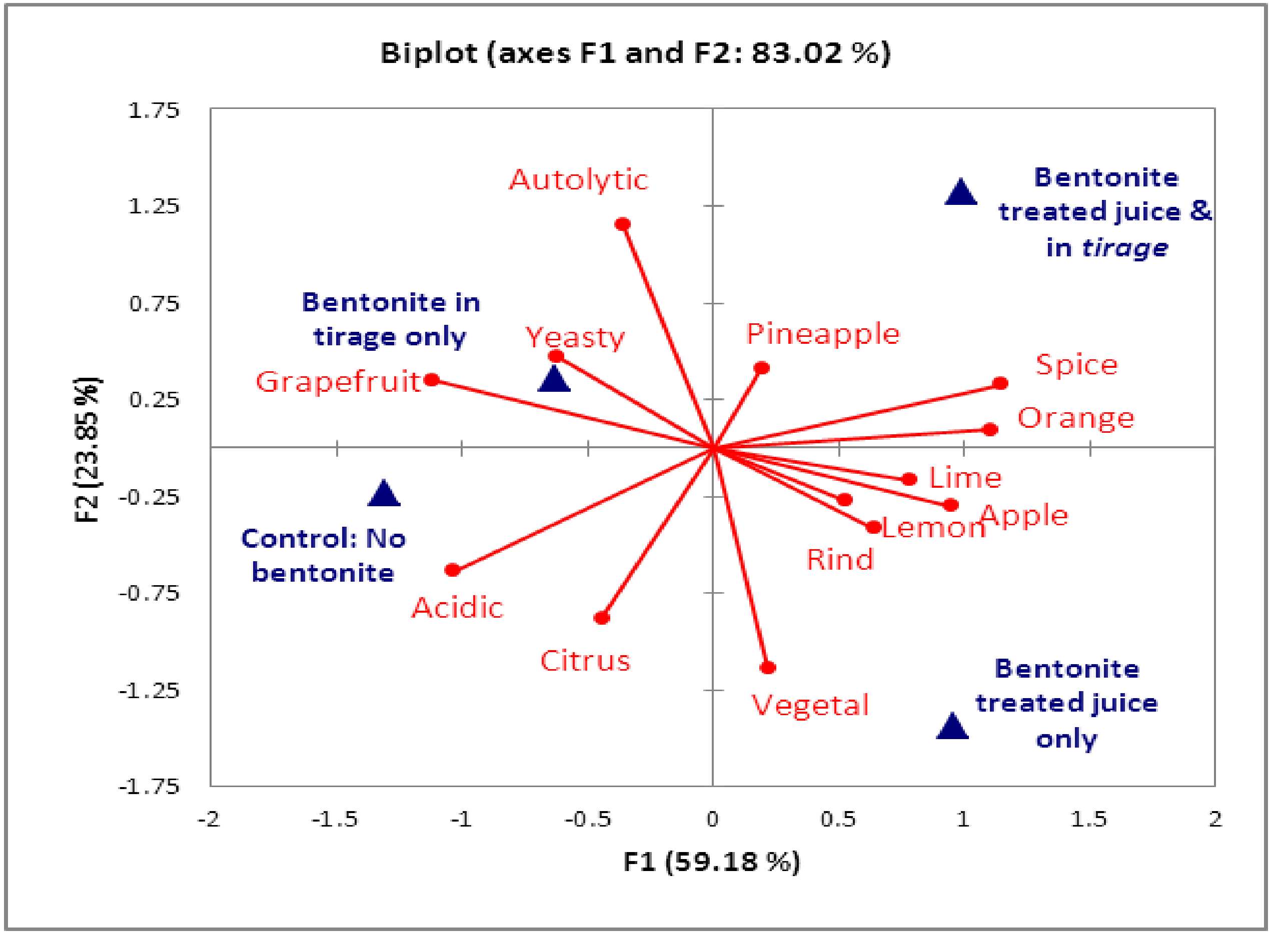
Trius WINERY AT HILLEBRAND

Bentonite impacts foam



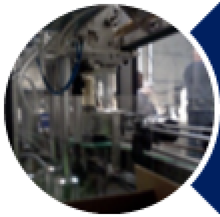
Time elapsed for dissipation of foam. Analysis of variance (ANOVA) with mean separation by Tukey's Post Hoc ($p<0.05$). Uppercase letters indicate differences between treatments. Error bars represent standard deviation.
(*Onguta, Kemp, Van der Merwe & Inglis. 2016).*

Bentonite use in sparkling wine
Sensory analysis of sparkling



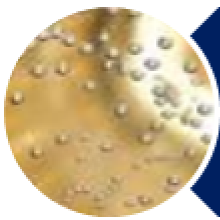
The effect on sensory characteristics of sparkling wines from bentonite use at different stages of production.

Issues at disgorging: GUSHING



Bottle handling & disgorging environment

- Light (UV)
- Ambient temperature
- Seasonal timing of disgorging
- Rough handling before disgorging
- Angle of the bottle
- Neck freezing too fast
- Rapid movement of wine from cold room to warm room



Wine composition

- Grape variety
- Vintage variation
- Protein instability — **Botrytis associated proteins**
- Wine temperature and *dosage* temperature
- High bottle pressure
- Tartrate crystals
- Calcium crystals
- Inconsistent mixing during *tirage*
- Undissolved sugar in the *dosage* after addition
- Yeast (from inadequate riddling/disgorging)
- High phenolic concentration
- Turbidity
- Malolactic fermentation in bottle

Packaging materials

- Cork dust
- Glass imperfections in the bottle
- Dust in the bottle

Kemp et al. (2015)

Dosage project

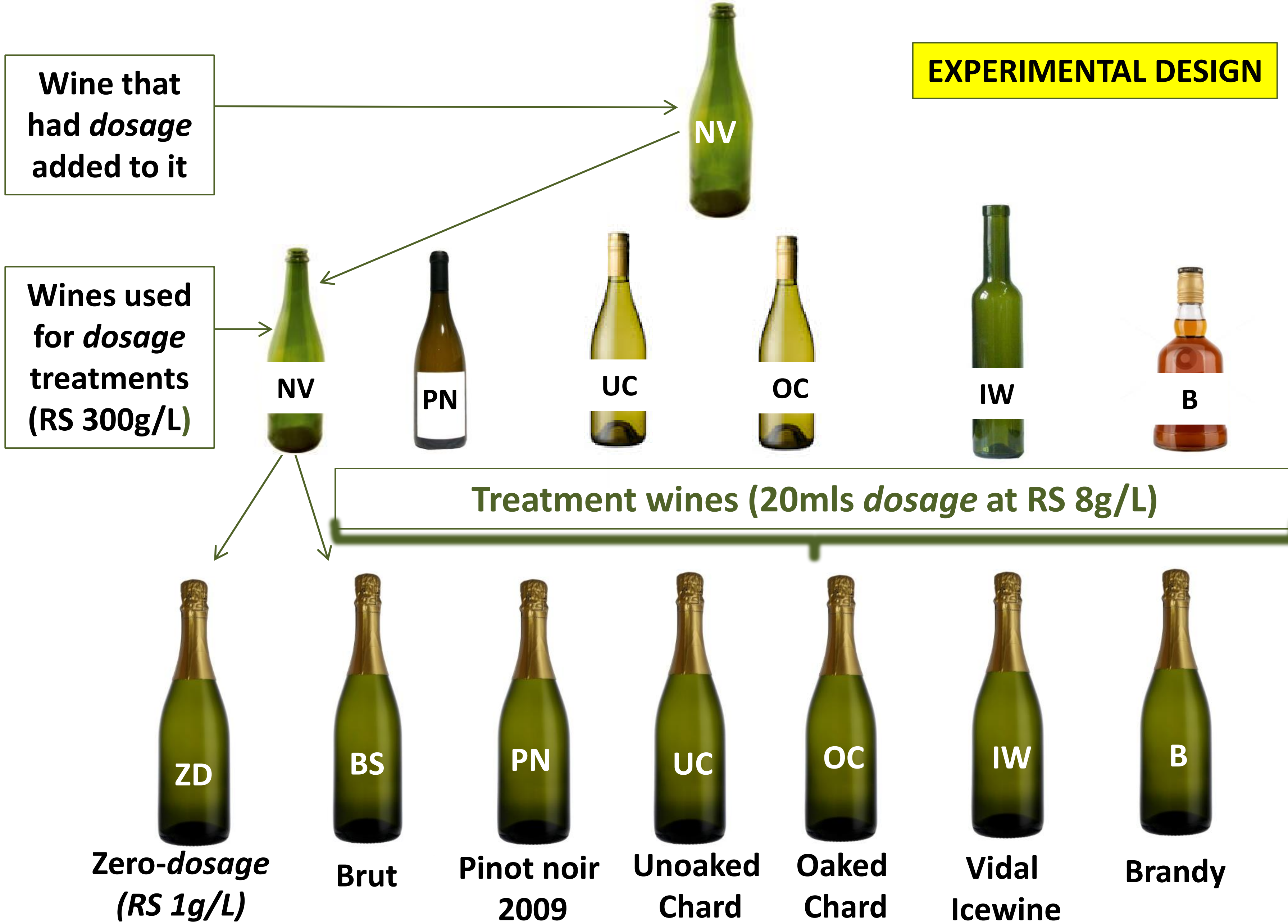
Aims & objectives

- Effect of wine used to make the addition influences wine flavor and foam
- Impact of sugar on foam and flavor

Dosage calculation

Millilitres of *dosage* required = …mL

$$\frac{\text{(Bottle volume mL) (Desired sugar level g/L)}}{\text{(Sugar concentration of stock solution)}}$$


EXPERIMENTAL DESIGN
Wine that had *dosage* added to it
NV
Wines used for *dosage* treatments (RS 300g/L)
NV
PN
UC
OC
IW
B
Treatment wines (20mls *dosage* at RS 8g/L)
ZD
BS
PN
UC
OC
IW
B
Zero-*dosage* *(RS 1g/L)*
Brut
Pinot noir 2009
Unoaked Chard
Oaked Chard
Vidal Icewine
Brandy

Standard chemical parameters at 5-15 weeks after disgorging

- **pH range: 3.08 (UC) - 3.3 (ZD)**

{higher pH in wines with sparkling wine dosages}

- **TA (g/L): 7.9 - 8.2**

- **Residual sugar (g/L): 1.1 - 8**
- **Alcohol (% v/v): 12.3 (ZD, UC) - 12.9 (B)**

- **Free SO_2: 3 - 5ppm**
- **Total SO_2: 53 - 59ppm**
- **Dissolved oxygen (DO mg/L): 3.1 (IW) - 6.6 (ZD)**

<u>Cork MUST be at least 24mm inside the bottle!</u>

Wines 15 weeks after *dosage* addition in wines with RS 8g/L

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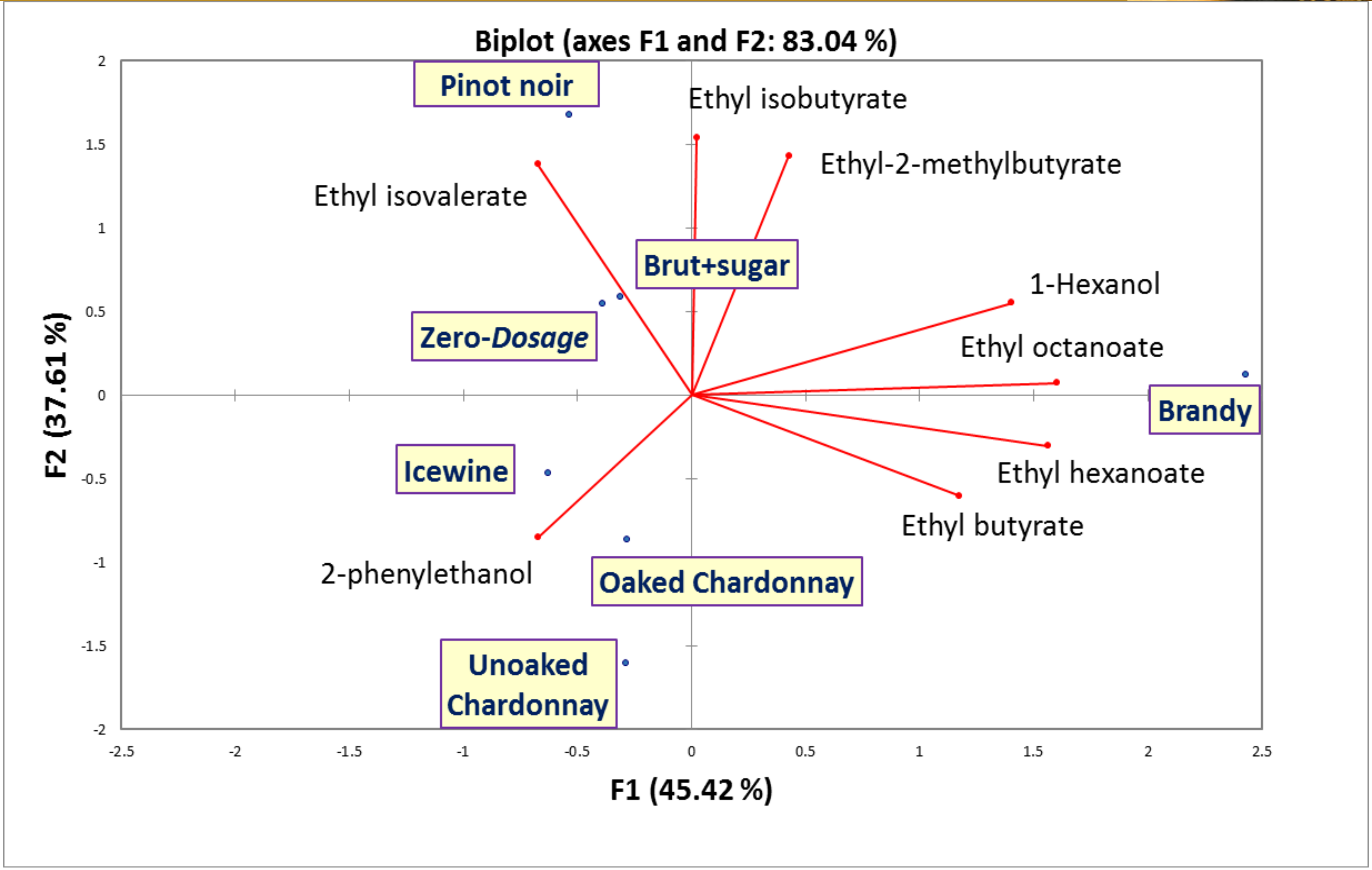


PCA biplot of sparkling wines with different dosages at 15 weeks after disgorging

Influence of *dosage* on foam stability

Treatment	Time for foam to elapse (sec)
Brut Zero-*dosage* wines	168
Pinot noir 2009	76
Unoaked Chardonnay	64
Brut + sugar	50
Brandy	49
Vidal Icewine	43
Oaked Chardonnay	42

Highest foam height & stability in zero-*dosage* wines

Dosage trial sensory results

- **A-Not A test** (Bi 2006, Kim et al. 2012)
- **Difference between each wine and the control/ Brut with oaked Chardonnay *dosage***

(ZD not included)

- **63 correct answers from a total of 80 = 74% correct answers**

Sureness rating (R index value)		Very sure	Sure	Unsure	Very unsure	Total	R-index (%)
	A	2	8	6	0	16	
	Not A	27	28	6	3	64	
						80	73

- ➢ **An *R* index of 50% = identical samples**
- ➢ **An *R* index of 100% are completely different**

Sparkling wine *dosage*

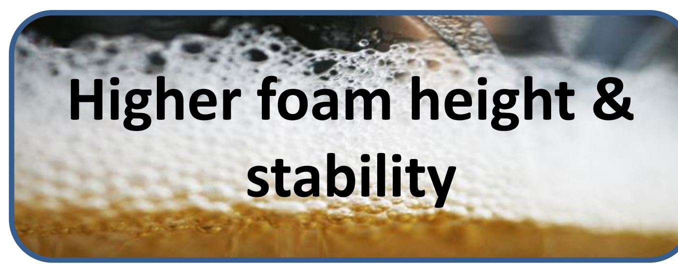
Sugar {8g/L (+/-2)}

Zero-*dosage* {0g/L}

5 weeks later….
Lower levels of aromatic alcohols

5 weeks later….
Higher levels of some ethyl esters

15 weeks later….
No difference in aroma compounds



Tempranillo for sparkling wine?

Chemical composition considerations: Acidity, pH, phenolics etc..

- Different anthocyanin-to-flavanol ratio in Tempranillo *(Monagas et al. 2005)*
- High pH values in Spain *(Monagas et al. 2005)*
- Polysaccharides, oligosaccharides and nitrogenous compound were found to be higher in Tempranillo sparkling wines *(Martínez-Lapuente et al. 2017)*

Future studies

- Final year of leaf removal study
- Final year of clone study
- + yeasts, YAN (mg N/L) source for 2nd fermentation, specific flavours, aging projects

Different viticulture for sparkling grapes!

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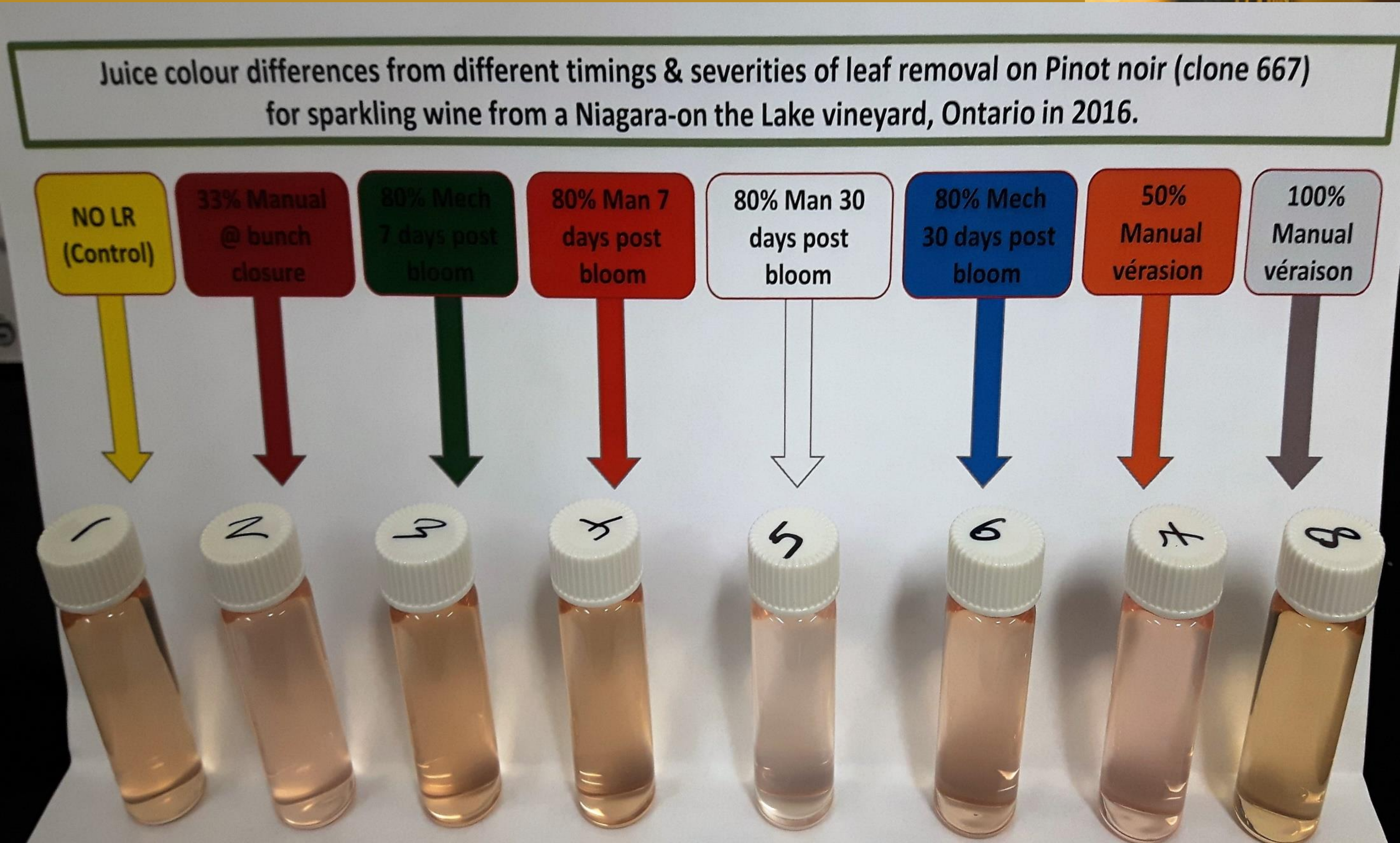

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- Fielding Winery - Bottling & Millesime - disgorging
- All grape pickers: Stephanie Van Dyke, Jim Willwerth, Mary Jasinski, Jen Kelly, Andréanne Hebert-Hache, Thomas Willwerth, Tom Willwerth.

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Thank you for your attention.
Any questions?