MAKING WINE WITH HIGH AND LOW PH JUICE

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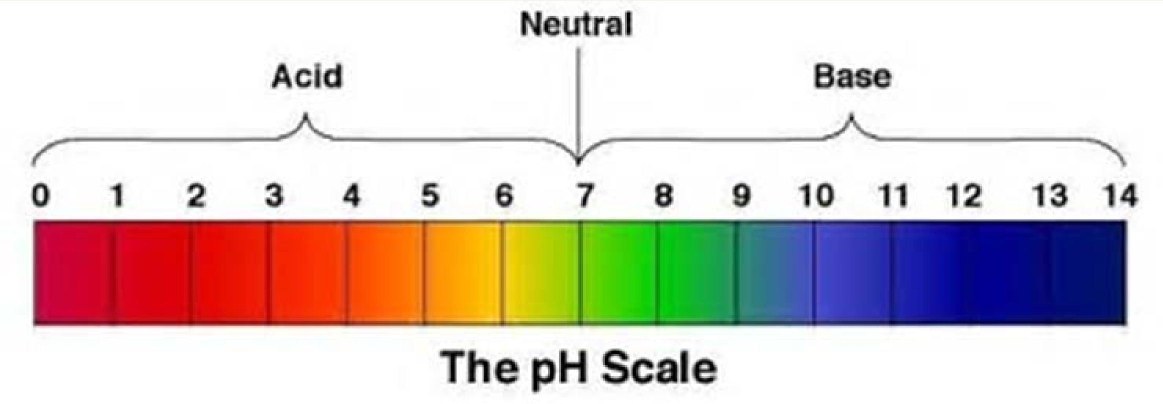
Overview

- How pH changes during winemaking
- Reds→ To adjust for high pH and how
- Whites → Early harvest due to poor conditions
  - Low pH
  - Low varietal character
- Deacidification of White wine juice

pH in Wine

- pH is the MOST important number in winemaking!
  - *Microbial stability*
  - *Indirect stylistic effects*



- White wine range 3.20-3.50
- Red wine range 3.40-3.70

What Changes pH in the Winery

- Skin Contact
  - *With reds skin contact can ↑ pH.*
  - *How much can depend on contact time*
- Acids produced during fermentation
  - *Weak organic acid will actually ↑ pH*
- Malolactic Fermentation
  - *↑ pH due to malic to lactic conversion (increase by 0.2 typical)*
- Bitrartrate stabilization
  - *↑ pH if above 3.65 (3.5 -3.8)*
  - *↓ if pH is below 3.65 (3.5-3.8)*

Titratable Acidity

- With strong acids pH and TA are about the same
- Grapes have weak organic acids, thus pH and TA differ.
- TA in relation to pH relates to perceivable acidity
  - *Same TA will taste more sour at lower pH values*
- Is TA a useful harvest parameter?

What happens to pH and TA during:				
		pH	TA	Comments *
VINEYARD	**Acid synthesis in the berry**		↑	
VINEYARD	**Acid degradation** (malate respiration or gluconeogenesis)	-- or ↑	↓	pH can remain constant if the ratio tartaric:malic rises; or it can rise if there is mineral uptake
VINEYARD	**Uptake of K or Na**	↑	↓	TA falls while extent of exchange increases
VINEYARD	**Post-veraison rainfall**	--	↓	TA falls as acidity is diluted in swollen berries, no change in pH
WINERY	**Wine dilution with water**	--	↓	pH does not change because K and Na are diluted at the same degree as TA
WINERY	**Yeast fermentation (by itself)**	↑		Weaker acids (e.g. succinic) are formed at the expense of stronger ones
WINERY	**Malolactic fermentation**	↑	↓	
WINERY	**Precipitation of potassium bitartrate**	--, ↑ or ↓	↓	Interesting case in which effect on pH depends entirely on original wine pH: if original pH<3.8, then pH drops; if original pH>3.8, then pH increases; and if original pH=3.8, then there is no change in pH
WINERY	**Extended skin contact**	↑	↓	Skin is rich in K+, and there is more extent of exchange
WINERY	**Actual fermentation** (weak acid formation and bitartrate precipitation combined)	↑ or ↓	↓	Depending on the extent of two opposing forces: weak acid formation dominates, which raises pH, or bitartrate precipitation dominates, which lowers pH
WINERY	**Wine contamination**	--	↑	TA due to formation of acetic and other acids, but impact on pH is negligible due to wine buffering capacity

* Please read discussion in original text for further explanation

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In General

- pH will increase after fermentation
- Excess skin contact will increase pH
- pH will decrease after cold stabilization (assuming adjustment)

- Expectedly, TA will decrease and pH will increase during the winemaking process

Acidity Index

- Acid perception depends on TA > pH and buffering capacity
- Combined use of total acidity and pH

- Acidity Index = Total Acidity(g/L) – pH

- Only valid
  - *TA → (3.8-7.5)*
  - *pH → (2.6-4.0)*

- Estimated "balanced" wine
  - *Red: AI = 2.6*
  - *White: AI = 3.9*

Only a very rough guideline

Plane, R.M., "An acidity index for the taste of wines," *Am. J. Enol. Vit. 31 (1980) 265.*

Red Wines Harvest Parameters

- Maturity with moderate pH is the goal

"Maturity"

- Mature
  - Soft tannins
  - Smooth tannic structure
  - Round mouthfeel
  - Full bodied
  - Deep color

- Immature
  - Rough
  - Bitter
  - Herbaceous
  - Astringent

The Red Grape Harvest Decision

- With warm and wet viticulture environments harvest is not easy

- Two main harvest parameters
  - *pH*
  - *"grape quality in the field"*

- We worry about
  - *Increasing pH*
  - *Onset of rot*
  - *Dilution of berries due to water*

High pH Happens

- Often a high pH > 3.6 is inevitable in reds

- The decision then is what route to take
  - *Low pH winemaking*
  - *High pH winemaking*

- The implications are…
  - *Stability*
  - *Stylistic choice of high pH wine*

Low pH Red Winemaking

- Always make major adjustments pre-fermentation
- Tartaric Acid
  - *Most prominent acid in grapes*
  - *Most common acid to acidify juice/wine*
  - *Strongest of the acids found in grape juice…less needed*
- Malic Acid
  - *Will not precipitate like tartaric will*
  - *Will contribute to malolactic fermentation*
  - *Only L-malic will ferment*
- Citric Acid
  - *Never add before primary fermentation – bacterial metabolism*
  - *Good for final acid adjustment to finished wine*

Low pH Red Winemaking

- 1 g/L of tartaric will lower pH 0.1 units
- Keep in mind how pH will change through winemaking
  - *Fermentation*  *(0.1 unit)*
  - *Skin contact*  *(0.05-0.2 units) Due to K in the grape skins*
  - *ML fermentation*  *(0.1 – 0.3)*
  - *Cold stabilization* 
- Adjustment down to pH 3.35 of juice = finished wine pH of 3.2-3.9!

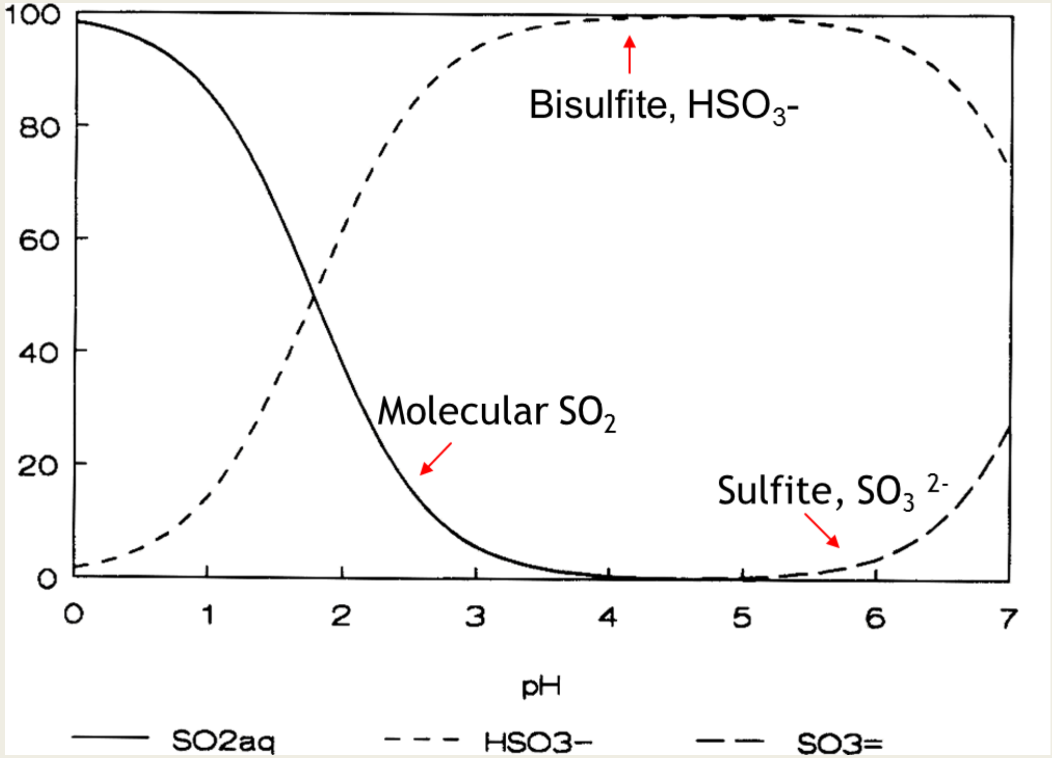
Low pH Considerations

- SO_2 has antimicrobial effect at lower pH values due to molecular SO_2
- Overall stability and aging…longer life span
- Fresh for the “modern” wine drinker
  - *Vibrant color*
  - *More fruit forward = less oxidation*
- New world style is fresh…and maybe tart (variety dependent?)
- Goes well with fruit forward stylistic techniques
  - *(co-inoculation, tannin additions, shorter aging time)*

High pH Red Winemaking

- Why?!?
- Stylistic approach is key
- Acidic “fresh” wines may be popular but “traditional” reds are desirable
- Effects of high pH reds
  - *Less microbial stability*
  - *Less color stability*
  - *More round, soft mouthfeel*

SO_2 has three main forms in wine



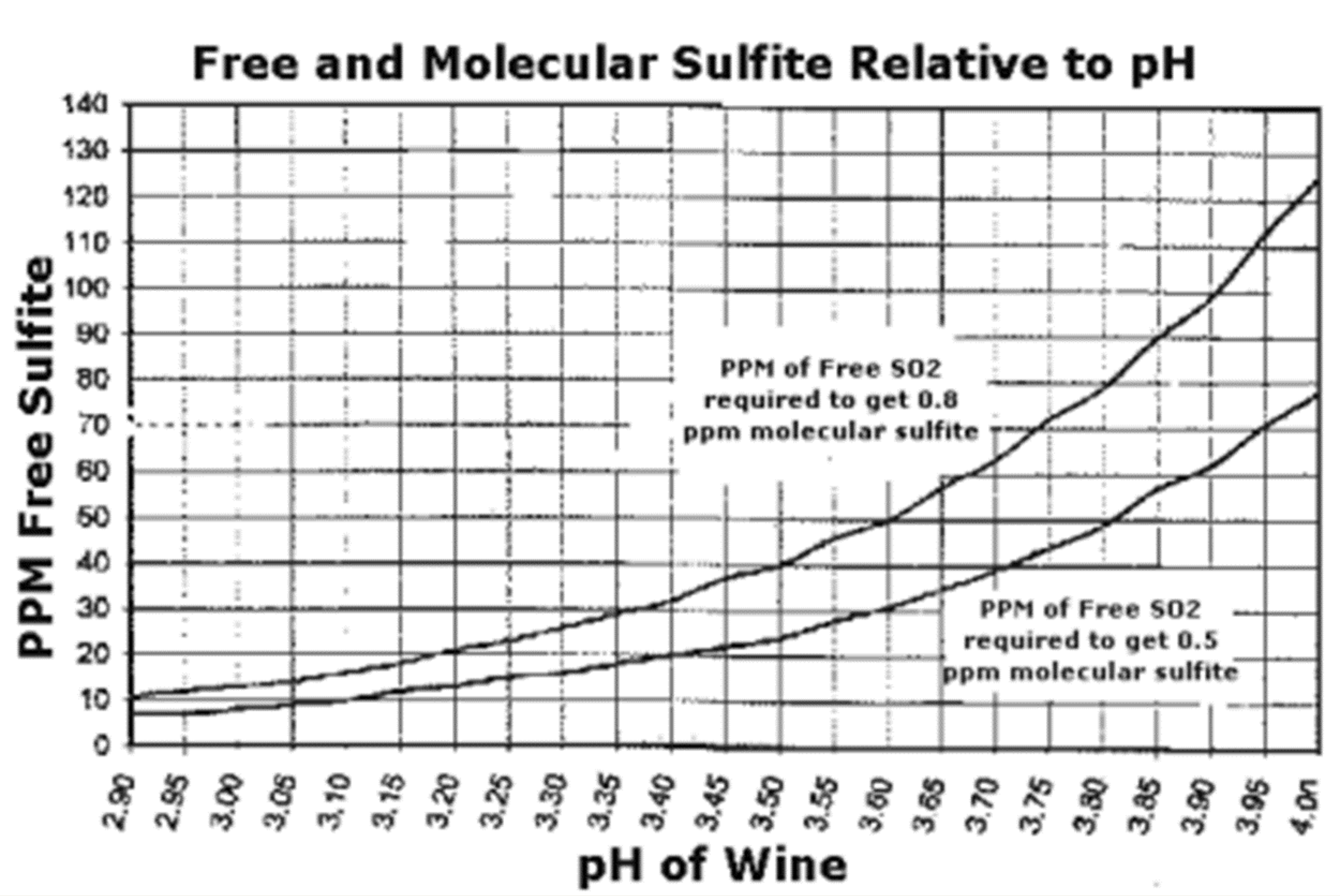
Stability through SO_2

- The molecular form inhibits microbes

- Loss of cell viability and inhibition of growth
- Rules of thumb
  - *0.5 ppm molecular SO_2 is sufficient if pH is not too high*
  - *0.8 ppm molecular SO_2 is preferrable in unhealthy wine*

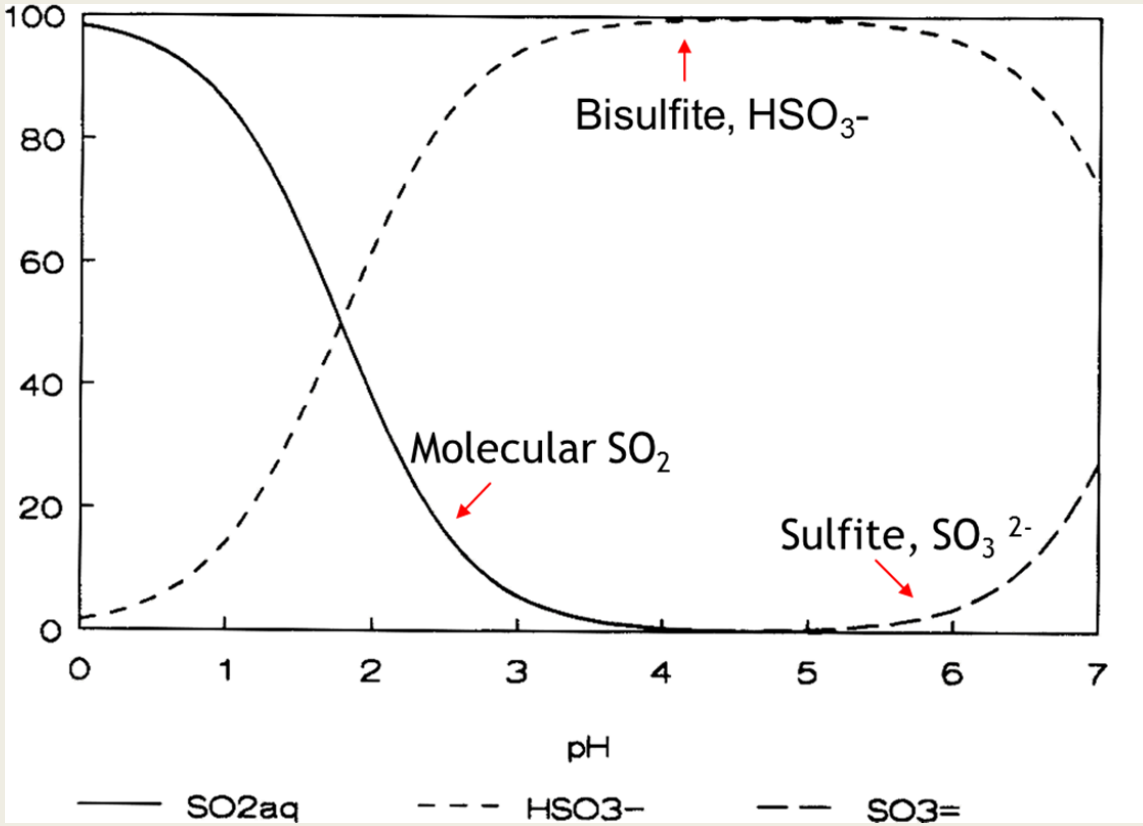
Stability through SO_2

- Microbial stability is the largest factor
  - *Sulfur dioxide is pH dependent*
  - *Molecular (free) sulfur dioxide*



At High pH Free SO_2 is not the goal

- Above pH 3.6 we will not reach a good level of free molecular SO_2
- Oxidation is a large factor though!
- Oxidation of phenolics generates H_2O_2 leading to further oxidation
- Bisulfite is the largest scavenger of peroxide
- Bisulfite also inhibits enzymatic oxidation
- Add 15-20 ppm “free” to keep oxidation down

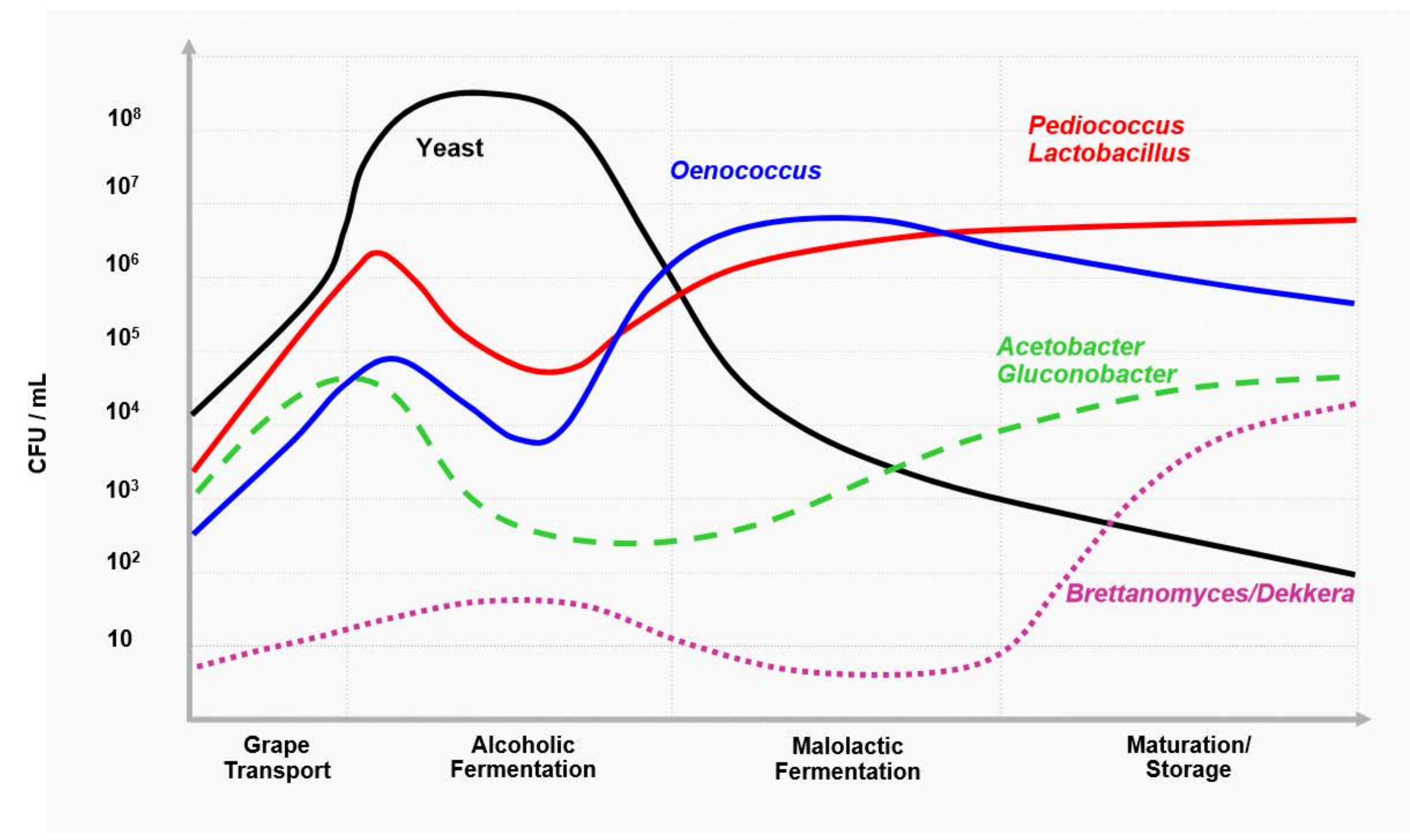


Living with Microbes

- We must consider all factors to allow microbes to flourish

- What do they need?

    - *Nitrogen content*
    - *Temperature*
    - *Oxygen*
    - *Control agents?*



Living with Microbes - Nitrogen

- Without sufficient molecular SO_2 microbial stability must be gained in different ways
- Always run YANs to determine perfect nutrient amount
  - *Never make a general addition for fear of excess nutrients*

Nitrogen Requirements

- Depends on…
  - *Yeast strain needs and Brix*

- Low N Strains: Sugar (g/L) x 0.75
- Medium N Strains: Sugar (g/L) x 0.90
- High N Strains : Sugar (g/L) x 1.25

- 1º Brix ≈ 10 (g/L)

- Rule of Thumb
  - 150 mg/L = 21 degrees Brix
  - 200mg/L = 23 degrees Brix
  - 250mg/L = 25 degrees Brix

Living with Microbes - Temperature

- Careful of cool fermentations due to competition
- Fear the cold soak
- Tank fermentation is better for temp control
- Lower barrel room temps between 55-60
  - *Always sterile filter if kept at cool temps*

Living with Microbes - Oxygen

- High pH wines require less oxygen
  - *Possible browning*
  - *Growth of unwanted organisms*
- Very mindful barrel topping
- Gas reds in tank more regularly

Living With Microbes – Cellar Procedures

- Strong “fast” yeast strain selection
- Co-inoculation vs. sequential of ML bacteria
- How much SO_2 to add and when
  - *Don’t be afraid of high initial additions (depending on color)*
  - *Stay on top of barrel maintenance*
- Tannin addition to make up for intensity

- Sterile filtration

Living With Microbes – Control Agents

- Scott Labs:
  - *Lysozyme – LAB*
  - *Bactiless – AAB and LAB*
  - *No Brett Inside*
  - *Velcorin*
    - Kills yeast, bacteria and molds
    - Requires $74,000 dosing machine

- None of these replace SO_2
- Check on legalities if exporting
- All depend on microbial load and dosing

Extremely High pH…over 4.0

- “Plastering”
  - *Calcium sulfate (gypsum) in combination with Tartaric Acid*
  - *Calcium sulfate removes H+ from tartaric acid*
  - *Thus lowers pH without affecting TA*
  - *1 g/L of gypsum lowers pH 0.09 units (approximately)*
  - *Legal limit of sulfate = no more than 2.0g/L*

  - *Trial:*
    - Add gypsum up to approximately 1.5g/L …Test
    - Add Tartaric Acid for further adjustment

  - *Not common b/c slow precipitation and some bitter aftertaste*

Bringing it all together!

- Techniques of low and high pH winemaking can both be used for the end goal
- The important point:
  - *pH of reds ready for bottling should be 3.6-3.7*
  - *TA of reds ready for bottling should be 5-7 g/L*
- Difference is style is about the pH at and after primary fermentation

Questions?

Whites With Low pH

- Harvesting early can result in low pH and immature fruit

- Results:
  - *Great for sparkling wine production*
  - *Increased acidity may result in deacidification*

Deacidification

- Not a common adjustment to wine but has serious implications

- pH range 3.19-3.29 = upwards pH adjustment

  - *Malolactic Fermentation = associated flavor changes*

  - *Calcium Carbonate ($CaCO_3$) – will remove tartaric acid in the form of calcium tartrate. Acceptable in small additions.*

  - *Can cause calcium tartrate instability – will result in precipitation of fine crystals over long periods of time…months after bottling!*

Deacidification

- Potassium carbonate (K_2CO_3) or potassium bicarbonate ($KHCO_3$)
- Potassium bicarbonate is more commonly used
  - *Slightly weaker than potassium carbonate*
  - *Produces less CO_2*

- Double Salt Method:
  - *Reduction of both tartaric and malic acids*
  - *Deacidify a portion of the juice with all of the addition and add back to main lot. Treat 20%-30% of total. Has to be above pH 4.5*

Double Salt Deacidification

- Name comes from the double salt – calcium tartrate malate

- Formed at a pH > 4.5, Maximum at 5.1, thus, only a portion of wine can be treated

- Take 20%-30% of wine and treat with calculated amount of calcium carbonate for entire batch.
  - *Allow precipitation of salt crystals and then filter before blending back*
  - *Advantages:*
    - Better sensory results and uniform acid removal
    - Can be used with high pH and high TA b/c it removes both malic and tartaric acids

Calculate Deacidification

TA Reduction

Lower	Add	Salt	
– *1.0 g/L TA*	*0.9 g/L*	$KHCO_3$	*potassium bicarbonate*
– *1.0 g/L TA*	*0.6 g/L*	K_2CO_3	*potassium carbonate*
– *1.0 g/L TA*	*0.67 g/L*	$CaCO_3$	*calcium carbonate*

Calculate Deacidification

pH Increase

The wine solution is buffered, thus, pH increase may not directly change with TA

Always run test trials when deacidifying

Deacidification

- Perceivable acidity is the most important thing.
- Consider both TA and pH values in this case.
- Actual pH and TA change depends on the juice buffering capacity
  - *Calculations are approximations*
- Consider acidity changes throughout the winemaking process.

Method of Addition

- Always conduct lab trials!!
- Too much of any salt may contribute to a salty taste.
- Conduct the trials below and up to calculated addition of salt.

Potassium Bicarbonate Trial

Rate of addition of $KHCO_3$ (g/L)	pH	Titratable acidity (g/L)
0 (Control)	2.94	10.2
1	3,15	9.4
2	3.29	8.3
3	3.50	7.0
4	3.76	5.7

Low pH Summary

- Early harvest may force low pH issues
- Potassium bicarbonate is the best agent to add
- Always run trials to see affect on TA and pH

High pH Summary

- Can adjust pH with risk of increasing tartness
  - *Adjust downward of 3.5 with tartaric acid*

- Can maintain high pH with improved microbial control
  - *Alternative…a combined approach*
- SO_2 will always be beneficial even at a high pH
- We have microbial control agents if needed

Questions?