Driving Chardonnay Wine Style

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Outline

- Chardonnay History and Current Relevance
- Vinification and Processing Strategies
- Chardonnay Aroma and Wine Style
  - Yeast Strains and Varietal Aroma
- Chardonnay Wine Styles and Malolactic Fermentation
- Winemaking Protocols and Recommended Chardonnay Strain Characteristics

Chardonnay History and Current Relevance

Origins

- Likely from the Mâcon Village in Mâconnais region of France
  - Earliest recorded reference in 1330
  - Medieval Latin, Cardonnacum "*A place of thistles*"
  - The most famous wines are from the "Golden Triangle of Burgundy"
    - Meursault, Puligny-Montrachet, and Chassagne-Montrachet
- White Burgundy:
  - Barrel fermentation on lees aging
    - 13% ABV, TA 6-7 g/L, pH 3.1-3.3
    - Ageing potential and reduction bouquet

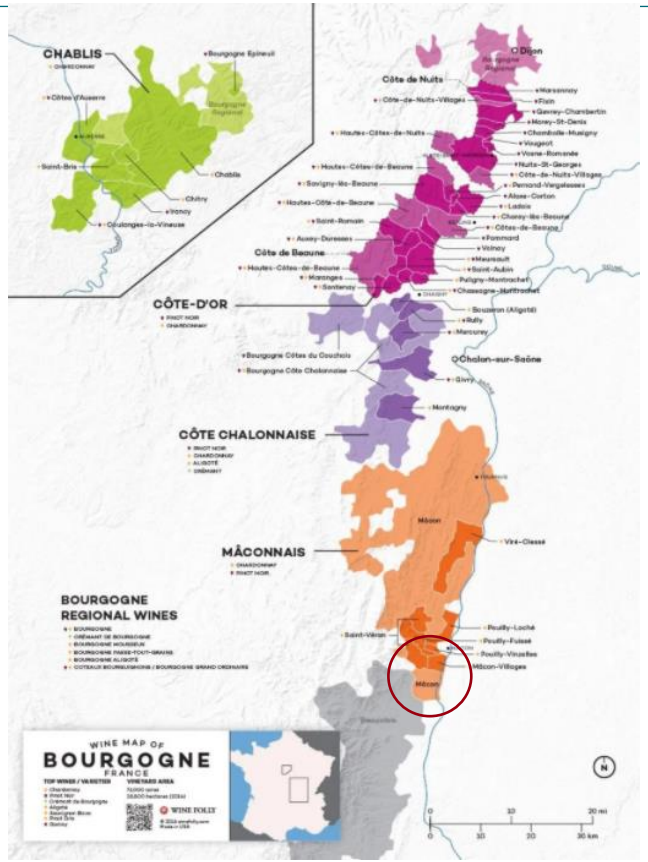


Image from Wine Folly

(Nancy Sweet, 2007; Ribéreau-Gayon et al, 2006)

Chardonnay in the New World

- In California there are references of Chardonnay being grown in the late 1800's
- Budwood imported by Charles Wetmore in 1[illegible] Meursault, Burgundy
  - Integral[illegible]
- [illegible]ce of California Chardonnay is budwood from the Wente vineyard in Livermore and the Paul Masson Vineyard in the Santa Cruz Mountains
  - Today there are over 100 Chardonnay clones listed in the FPS directory.
- The 1976 Judgment of Paris
  - 1st Chateau Montelena
  - 3rd Chalone Vineyard
  - 4th Spring Mountain Vineyard
  - 6th Freemark Abbey Winery

For more history on California Chardonnay check out Jancis Robinsons 4-part article on "The Story of California Chardonnay"

Pinot Blanc

Gouais Blanc

Stephen Spurrier

(Nancy Sweet, 2007)

Vinification and Processing Strategies

Preventing Oxidation and Spoilage

- Protect grapes as soon as liquid is extracted

- Keep temperatures low
  - 50-55°F

Phenols & polyphenol → browning & loss of color

Lipids → bitterness & veggie hint

Aromatic compounds → loss of varietal aromas

- Antioxidant protection SO_2
  - Winy (Non-clumping KMBS)
  - Effergran (Effervescent KMBS)
  - AST (Ascorbic acid)
  - EnartisTan Blanc (Tannins)

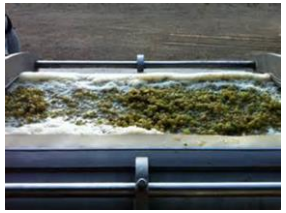
Whole Cluster or Crushed Grapes

- Whole Cluster Advantages:
  - Stems create channels to facilitate de-juicing
  - Limited extraction of phenols

  - Disadvantages:
    - Reduces press capacity by 50%

- Crushed Grapes Advantages:
  - Allows skin contact and the use of enzymes

  - Disadvantages:
    - Increased extraction of phenols
    - Longer press cycle
    - Press aids



Extracting, Settling and Clarification

- **Skin contact →** 6-24 hours
  - Glucosidase enzyme application
  - Limit flavonoid extraction by lowering temperature < 55 °F/13°C
- **Low Pressing PSI**
  - Low pressing
  - Limit suspended solids and dissolution of phenolic compounds
  - voltammetry as a tool for benchmarking press fractions
- **Settling** *(Static, flotation)*
  - Pectolytic enzyme
  - Phenolic fining
  - Target turbidity <200 NTU
- **Reductive Winemaking**
  - Limiting juice oxidation
  - Preservation of varietal aroma
- **Passive-oxidation (Barrel fermentation)**

Preventing oxidation

- Removes metals-catalyzers of oxidation reactions
- Removes bitter and herbaceous compounds
- Enhances primary aromas (PRO FT)
- Provides yeast polysaccharides that enhance mouthfeel

Chardonnay Aroma and Wine Style

Chardonnay Varietal Aroma

Glycosylated precursors

1.) YEAST SELECTION
2.) EXOGENOUS ENZYMES
3.) S-CONTAINING AMINO NITROGEN

INCREASED VOLATILE VARIETAL AROMA

- **Terpenes and C_{13} norisoprenoid**
  - β-damascenone
    - Lemon balm-Rose
  - 3-oxo-a-ionol
    - Fruity-Spicy
  - 1,2-dihydronaphthalene (TDN)

β-lyase

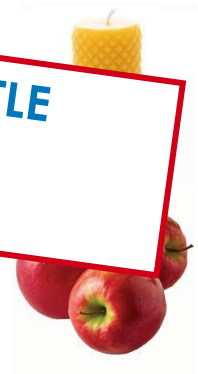
Cysteinylated & glutathionylated precursors

- **Thiols**
  - 3-sulfanylhexyl acetate (3-SHA)
    - Grapefruit
  - 4-methyl-4-sulfanylpropan-2-one (4-MSP)
    - Black current-fruity
  - 3-sulfanylhexan-1-ol (3-SH)
    - Fruity
  - Benzenemethanethiol (BM)
    - Boxwood
  - 2-furanemethanethiol (FFT)
    - Roast coffee, gun powder

Esters and Acetates

- nd most significant volatile chemical group in Chardonnay
  - er alcohols

ESTERS ARE RAPIDLY HYDROLYZED DURING THE FIRST YEAR IN BOTTLE AND HAVE NO LONG-TERM INFLUENCE ON THE AROMATIC CHARACTERISTICS OF WHITE WINES



- Conce
  - Yeast strain
  - Enzyme expression
  - Unsaturated fatty acids
  - Fermentation temperature
  - Exogenous carbon sources
  - Nitrogen

- Main esters for unwooded Chardonnay
  - Ethyl hexanoate, ethyl octanoate, ethyl decanoate, ethyl 2-methylpropanoate, ethyl 2-methylbutanoate, ethyl 3-methylbutanoate, hexyl acetate, 2-methylbutyl acetate and 3-methylbutyl acetate.

Yeast Strains and Varietal Aroma

	MAIN ENZYMATIC ACTIVITIES	MAIN ENOLOGICAL EFFECT	MAIN SENSORY EFFECT	Temperature (°C)
AROMA WHITE	**Alcohol acetyl-transferase** **β-lyases**	Reveals thiols and high ester production	Tropical and fruit aroma	15-17 thiols 18-21 esters
ES 181	**Alcohol acetyl-transferase** **β-lyases** **Glucosidase**	Reveals thiols, terpens & nor-isoprenoids, production of esters	Tropical and fruit aroma	13-15
VINTAGE WHITE	**Glucosidase**	Reveals terpenes and nor-isopernoids	Fruit aroma	14-24 barrel ferment
Q CITRUS	**Alcohol acetyl-transferase** **Glucosidase**	Production of esters, reveals terpens and nor-isopernoids	Fruit aroma	12-13 Grapefruit 14-15 Citrus-Tropical 16-18 Tropical

- Alcohol acetyl-transferase→ INCREASED ACETATE ESTERS
- Glycosidase→ GLYCO-CONJUGATED NOR-ISOPRENOIDS & TERPENES
- β-lyase → CYSTEINE-CONJUGATED THIOLS

Chardonnay Aroma and Wine Style

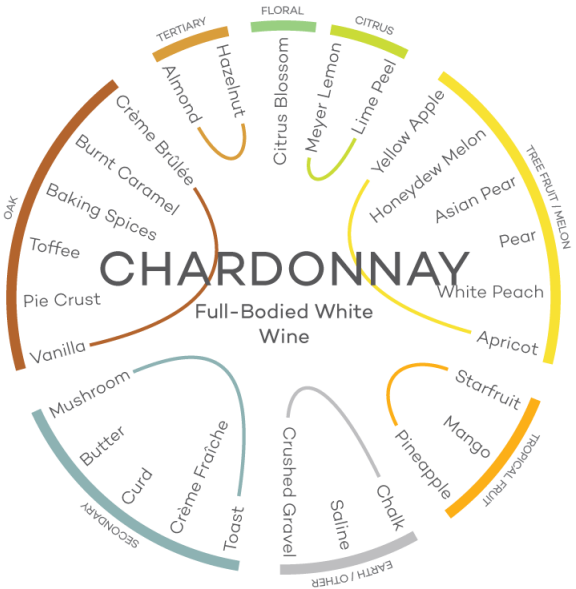
Concentrations (mg/L) and Comparison of Volatile Compounds In Two Styles of Chardonnay *Fruity* and *Oaky*

- Increase in higher alcohols, ethyl acetate, and total esters (x4 increase) compared to stainless steel tanks
- Barrel fermentation favors extraction of oak related volatiles
  - Furfural reduction→ Benzenemethanethiol & 2-furanemethanethiol

	Buettner et al.[87]			Lee and Noble[40]		
	Fruity	Oaky	Factor of difference	Fruity	Oaky	Factor of difference
Ethyl isobutyrate	72.2	99.9	**1.4**	31	-	
Ethyl butanoate	263	341.5	**1.3**	844	1040	**1.2**
Ethyl isovalerate	9.2	19.9	**2.2**	42	41	**1.0**
3-methylbutyl acetate	943.7	163.5	**0.2**	519	349	**0.7**
Ethyl hexanoate	757.2	737.5	**1.0**	843	600	**0.7**
Linalool	-	-	**-**	50	31	**0.6**
2-Phenylethanol	12415	24971	**2.0**	153840	116850	**0.8**
Acetic acid	434232	489370	**1.1**	10000	11290	**1.1**
Butanoic acid	1839	1611	**0.9**	1824	1505	**0.8**
trans-Oak lactone	7.1	131.1	**18.5**	173	996	**5.8**
cis-Oak lactone	17	214.8	**12.6**	33	382	**11.6**
2-Methoxyphenol	2.7	9.9	**3.7**	25	284	**11.4**
Ethyl cinnamate	1.5	3.1	**2.1**	3	6	**2.0**
Eugenol	1.6	8.9	**5.6**	21	362	**17.2**
4-Vinylguaiacol	50.5	49.3	**1.0**	1356	380	**0.3**
Vanillin	48.5	241.6	**5.0**	107	1223	**11.4**

(Buettner et al, 2004; Gambetta et al, 2014; González-Marco et al, 2008; Lee and Noble, 2003)

Still Chardonnay Wines



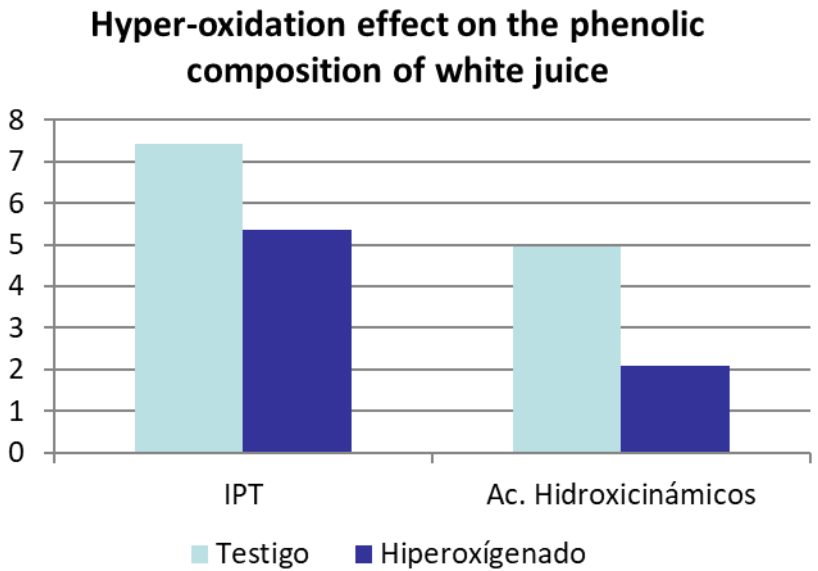
Excerpt from: *Wine Folly: The Essential Guide to Wine*

- **Oak Fermented and Aged Chardonnay**
- **Mineral, Citrus Driven Chardonnay**
- **Buttery, Toasty, Creamy Chardonnay**

Oak Fermented and Aged Chardonnay

Barrel fermentation and Passive Oxidation

- Requires no SO_2 additions prior to fermentation
- Use of inert gases Nitrogen, Argon or CO_2 to prevent oxidation during crushing and pressing
- The goal is to oxidize phenols that will drop to the bottom during settling
- Early elimination of oxidizable compounds that could cause browning and loss of fruit aromas at racking



Oak Fermented and Aged Chardonnay

- Pressed and settled Chardonnay juice is racked into barrel with headspace
- ff after primary before
- Chardonnay stays in contact with li for several months were batonnage (stirring of lees) is typically practiced
  - Reducing power of the lees protects wine from oxidation
  - Yeast autolysis releases mannoproteins and polysaccharides over 12-month period

Enological Enzymes and Yeast derivatives can mimic the effect of Sur Lie aging, saving time and mitigating negative volatile Sulphur aroma

Optimizing Sur Lies Aging

- **Surli One**
  - Inactivated yeasts meant to complement natural lees in the sure lies phase
  - Very fast in release mannoproteins compared to endogenous lees → 3-4 weeks of treatment with daily homogenization

- **Surli Elevage**
  - Inactivated yeast rich in free mannoproteins
  - 24-48 hours contact with daily homogenization

- **EnartisZym Elevage**
  - Micro-granulated pectolytic enzyme preparation with significant ß-glucanase activity, developed to enhance wine sensory characteristics during lees ageing and improve wine filterability
  - 2-5 g/hL dosage with 4-6 weeks of treatment

- **EnartisZym EZ Filter**
  - Liquid enzyme preparation with pectolytic activity (polygalacturonase, pectinesterase, pectin lyase and betaglucanase activity.
  - 2-5 g/hL dosage with 4-6 weeks of treatment

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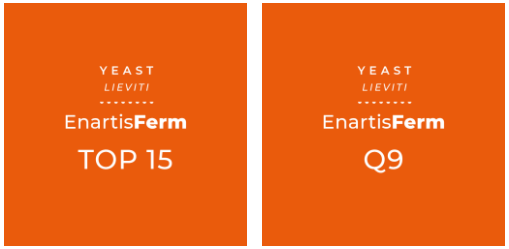
Mineral, Citrus Driven Chardonnay

Mineral, Citrus Driven Chardonnay

- **Minerality Associated Compounds**
  - Methanethiol (MeSH) has been positively correlated with perceived minerality along with ethyl esters.
  - Increasing succinic acid is correlated with the perception of minerality.

- **Winemaking practices for increasing succinic acid:**
  - Higher solids
  - Moderate SO_2 addition
  - Fermentation temperature < 68ºF (20ºC)
  - Target nitrogen supplementation to at least 300 mg/L YAN (limit amino nitrogen)
  - Aeration during fermentation (2 mg/L during early stages)

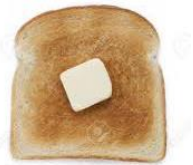


(Maltman et al, 2013; Rodrigues et al., 2017)

Buttery, Toasty, Creamy Chardonnay

Buttery, Toasty, Creamy Chardonnay

- **Malolactic Strain Selection and Diacetyl Production→** chemical compound responsible for driving this style
  - Homolactic/heterolactic sugar metabolism pathways as well as by the utilization of citric acid
  - 1-3 mg/L *Nutty*
  - 5-7 mg/L *Buttery*

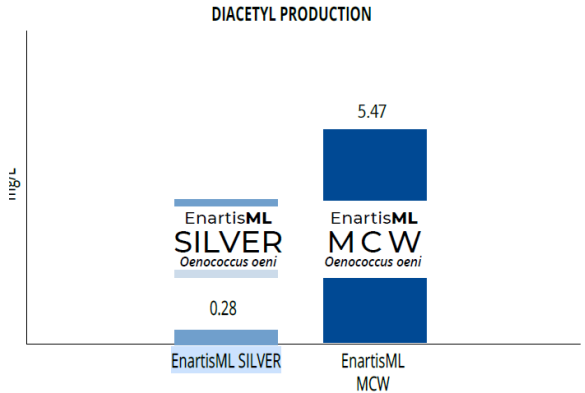




- **Increasing Mouthfeel and Diacetyl**
  - Choice of yeast strain and lower Inoculation rate (10^4-10^5 CFU/mL)
  - Temperature above 64°F (18°C)
  - Mitigate contact with lees → Absorption
  - Semi-aerobic environments
  - Redox 300mV and 2-4 mg/L O_2 (Nielsen and Richelieu,1999)
  - Sulfite wines once desired level of character is reached
    - SO_2 reacts with diacetyl in a reversible manner → re-releasing during maturation

Malolactic Bacteria

- **Deacidification and Biological stability**

- **Aroma enhancement**
  - Glycosidase activity can release terpenes, C13-norisoprenoids and other glycoconjugates in model wine, even when MLF does not take place (Hernandez-Orte et al, 2009)



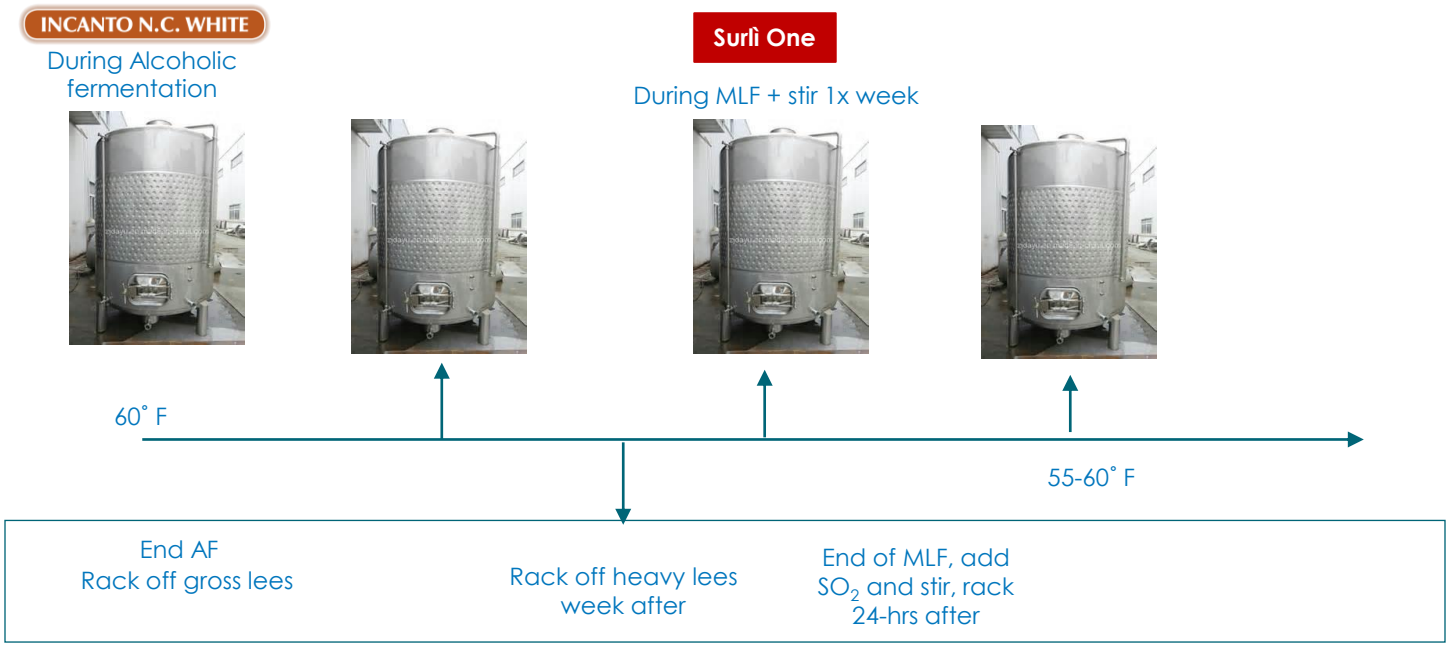
EnartisML MCW produces high amounts of diacetyl which contributes to buttery, creamy notes in wine.

MCW *Oenococcus oeni* SILVER *Oenococcus oeni* UNO *Oenococcus oeni*

ENARTIS STRAINS	EnartisML MCW	EnartisML SILVER	EnartisML UNO
SPECIES	*Oenococcus oeni*		
pH TOLERANCE	>3.1	>3.1	>3.3
TOTAL SO_2 RESISTANCE (mg/L)	<40	<45	<40
FREE SO_2 RESISTANCE (mg/L)	<10	<10	<10
ALCOHOL TOLERANCE (%v/v)	>15	>15	<15
CONVERSION SPEED	Moderate/High	High	Moderate
AROMATIC CHARACTERISTICS	Buttery, "Sweet"	Fruity, Floral	Fruity, Varietal

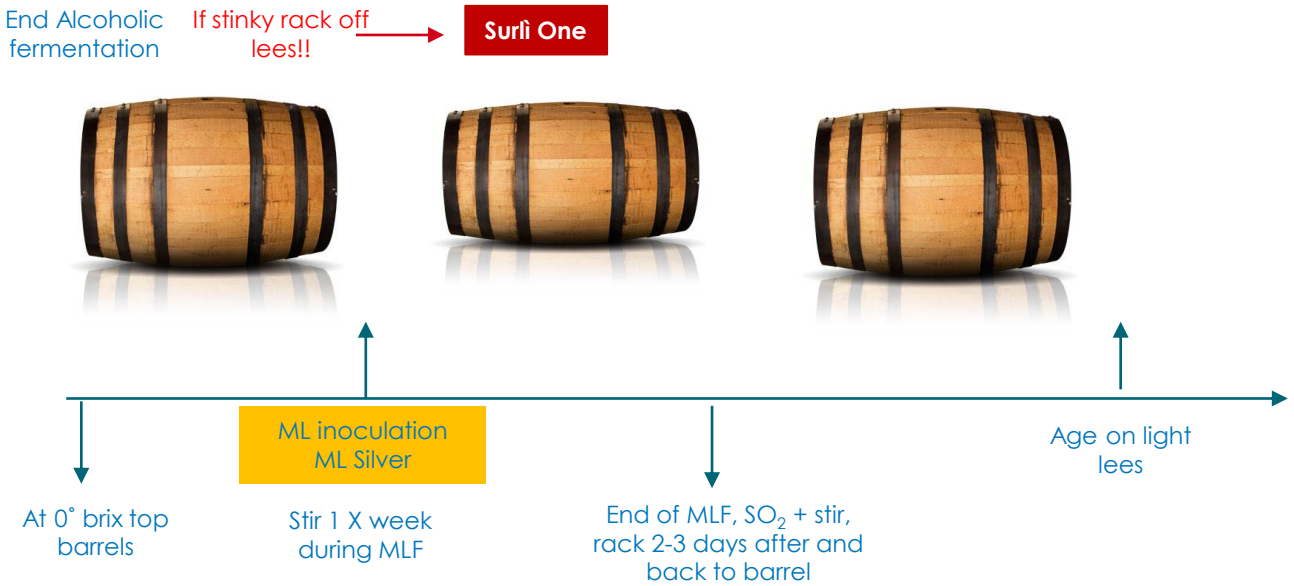
Malolactic Fermentation in Tank

- Rack-off gross lees after AF and inoculate with ML Silver + Nutriferm Osmobacti
- Rack after 1 week if heavy lees are formed, then stir once per week during MLF
- After ML is completed, add SO_2 stir and rack 24-hrs after



Malolactic Fermentation in Barrel

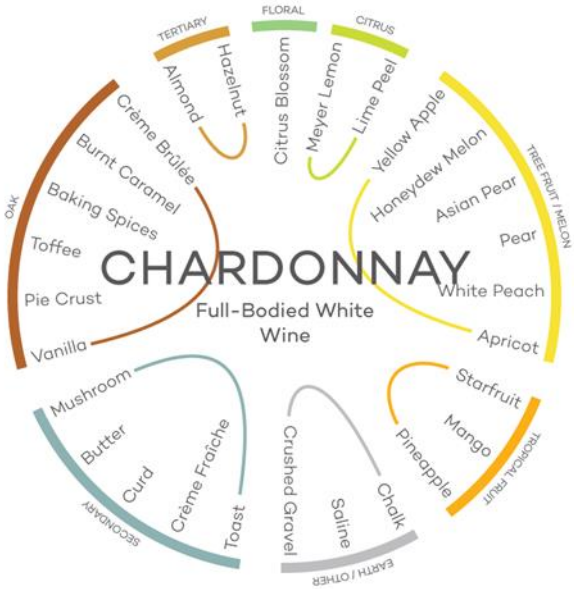
- Keep temperature between 60-65ºF
- Top Barrel at 0˚Brix and Inoculate with ML Silver + Nutriferm Osmobacti
- Stir once a week during MLF
- Once complete add SO_2 and rack off lees 2-3 days after→ return to barrel for aging on light lees



Winemaking Protocols

Full Winemaking Protocols are in Sending Documents

- Available in downloadable material and online
  - Classic California Chardonnay
  - Increasing Minerality



Excerpt from: *Wine Folly: The Essential Guide to Wine*

Chardonnay Strain Characteristics

YEAST SELECTION	OPTIMAL TEMPERATURE RANGE (°C)	LAG PHASE	FERMENTATION SPEED	ALCOHOL TOLERANCE	NITROGEN NEEDS	OXYGEN NEEDS	VA PRODUCTION	H2S PRODUCTION	SO2 PRODUCTION	COMPATIBILITY MLF	RESISTANCE TO SO2
EnartisFerm Q CITRUS	10-22	Short	High	15	Med	Med	Med	Low	Med	Low	High
EnartisFerm AROMA WHITE	14-24	Med	Med	15	Med	Med	Low	Low	Low	N	Med
EnartisFerm VINTAGE WHITE	14-24	Short	Med	15.5	High	Med	Low	Low	Low	High	Med
EnartisFerm ES181	10-20	Short	High	16.5	Low	Low	Low	Low	Low	Low	High

Thank you!

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Citations

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