Paving The Way to Great Wine

Viticulture and Pre-Fermentation Winemaking

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Agenda

- Tasting: Grape / Wine flavor
- Grape ripening / Flavor development
- What are the varietal flavor impact players?
- How environment and viticultural practices impact varietal flavor?
- When is a grape ready for harvest?
- Tasting
- How does grape handling affect wine color and flavor?

Berry Ripening

Phase 1: Green Berry Growth

- # of cells in the berry increase
- Seed starts to form
- Tannins and organic acids increase
- Increase in “unripe” flavor compounds
- Aromas are vegetative and herbaceous
- Taste is bitter, acidic, no sweetness

Berry Ripening

Phase 2: Lag phase

- # of cells in berry stop forming
- Seed becomes fully formed
- Tannins and acids stop increasing
- “Unripe” flavor compounds continue to increase
- Aroma remains herbaceous
- Flavor remains bitter and acidic

Berry Ripening

Phase 3: Veraison

- Onset is marked by a change in the appearance and hardness of the berry
- Berry size increase
- Color changes (translucent yellowish/red)
- Sugar increases
- Acids decrease (malic)
- Tannins remain constant but change

Verasion Cont'd

- "Unripe" flavor compounds decrease
- "Ripe" flavor compounds increase
- Aromas: red fruits, floral, black fruits, jammy
- Taste: sweeter, less acidic, softer tannins
- At some point sugar stops accumulating and dehydration / raisining begins
- At this point, varietal flavor compounds begin to decrease

Evolution of Berry Flavors - White

Vegetative / Herbaceous

↓

Unripe Fruit

↓

Citrus, floral, melon, fresh stone fruit, apple

↓

Dried fruit, honey, waxy

Color: Bright green → translucent yellow / golden

Evolution of Berry Flavors - Red

Vegetative / Herbaceous

↓

Unripe fruit

↓

Red fruits

↓

Black / Blue fruit, jam, cooked fruits, raisin

Color: Bright green → medium / dark red

Grapes with Strong Varietal Character

Traminer

Muscat

Rieslings

Crosses with the above

Albariño

Other whites

Few red varieties

Wines with Strong Varietal Character

White Wines

Traminer
Muscat
Riesling
Albariño
Viognier
Semillon
Chardonnay
Sauvignon blanc
Others

Red Wines

Cabernets
Syrah
Pinot noir
Nebbiolo
Zinfandel
Merlot
Pinotage
Others

Why the difference?

Total amount of flavor compounds in grapes

Compound form? (free or bound)

Free = aroma or taste

Bound = no aroma or taste

Fermentation is the main way the bound form is converted to the free form

What are the Flavor Compounds?

Basic Tastes	Varietal Aromas
Sugars	Terpenes
Acids	Norisoprenoids
Tannins	Pyrazines
	Polyfunctional Thiols

Many of the varietal flavor differences come from the different combination of these in the grape and wine

Terpenes

- > 60 identified
- Mostly found in the grape skin
- Increase mid – late ripening

- **Monoterpenes** (~20) : geraniol, linalool, α-terpinol, nerol, cis-rose oxide, citronellol, others
  - Aromas: Floral, fruity, lychees
  - Varieties: *Traminers, Muscats, Rieslings*, others

- **Sesquiterpenes** (~40) : rotundone, others
  - Aromas: white/black pepper, spicy
  - Varieties: *Syrah, Mouvedre, Durif, Vespolina*

Terpenes Cont'd

- Both monoterpenes and sesquiterpenes can be detected at ppb levels
- **Free volatile terpenes** (FVT's) are aromatic (~10%)
- **Potentially volatile terpenes** (PVT's) are bound to sugars and have no flavor (~90%)

Norisoprenoids

- β-damascenone, β-damascone, β-ionone

  Aromas: flowery, fruity, honey
- TDN

  Aromas: kerosene, petrol
- Vitispirane

  Aromas: chrysanthemum, flowery, earthy, woody
- Important variety: *Rieslings* and crosses
- Located in the skin
- Develop mid – late ripening
- Detected at ppb

Pyrazines

- Methoxypyrazines: IBMP / SBMP
- Aromas: herbaceous, bell pepper, asparagus
- Located in the skin
- Varieties: *S. blanc, Merlot, C. sauv, C. franc*, others
- Decrease from lag phase through ripening
- Detected at ppt

Polyfunctional Thiols "Good Thiols" (GT)

- 3MH, 3MHA, 4MMP, 4MMPOH
- Aromas: grapefruit, citrus, boxwood, herbaceous, passion fruit, guava, cat urine, sweaty
- Varieties: *S. blanc, P. grigio, Chardonnay, C. sauv, C. franc, Merlot,* others

Polyfunctional Thiols "Good Thiols" (GT)

- Found as bound form (cysteine or glutathione) in grapes and is odorless
- Located mainly in skin
- Increase from verasion – ripening
- Detected at ppt

Aroma Compound Summary

- All aroma compounds are found in all vinifera grapes at some level
- Specific varietal aromas come from a complex mixture of these compounds
- Most of the compounds are found in grapes in a bound (no flavor) form
- Most compounds are located in the skin

Compound Group & Aromas

- **Terpenes**: Floral, fruity, tropical fruit, lychees,
  : white / black pepper, spicy
- **Nor-Isoprenoids**: Floral, fruity, honey, petrol, kerosene
  : chrysanthemum, earthy, woody
- **Methoxypyrazines (MP):** Herbaceous, bell pepper,
  : asparagus
- **Polyfunctional Thiols:** Grapefruit, passionfruit,
  : citrus, box tree, herbaceous,
  : guava, cat urine, sweaty

Where does Viticulture Come in?

Assume that the correct planting decisions were made

- Grape variety was chosen based on climate and market

- Assume also that soil, water and topography were used to determine: rootstock, clone, vine spacing and training method

These can be 20+ year decisions

Viticulture

- Grapes are climbing plants
- Given “comfortable” conditions, grapes will grow very large canopies
- Some level of stress forces it to produce fruit and limit vegetative growth
- Stress = limiting water, nutrients and disease pressure while managing sunlight in a given environment
- Managing “stress” is what a grower does

Tools to Manage Stress

- Pruning
- Canopy, water, nutrient and crop management
- Disease management

- These are the tools that growers use to manage yearly environmental variations

Pruning

Vine balance is critical to fruit ripening / flavor development and winter pruning is the first step

- Timing of winter pruning is important
- Early pruning risks disease/infection
- Late pruning delays bud break
- Winter pruning depends on weather and labor availability
- Winter pruning has no direct effect on flavor but it sets the stage for optimum flavor development

Canopy Management

- Temperature and sunlight are the most important factors in ripening / flavor development
- Canopy management optimizes sunlight exposure to leaves and fruit
- This includes shoot thinning, shoot positioning and fruit zone leaf removal
- Fruit zone leaf removal is most effective way to control flavor compounds and color
- Leaf removal is best pre-verasion and can be done to modify timing of sun exposure on fruit

Canopy Management

- Increased temp: increases sugar accumulation rate, tannins, mono-terpenes but decreases MP, rotundone, GT and acids

- Increased sunlight on fruit: increases most terpenes, nor-isoprenoids and GT but decreases MP and rotundone

Example

Cool Weather *Sauvignon blanc*

Without Fruit Zone Leaf Thinning

Increased: bell pepper / vegetative aroma
Decreased: grapefruit, box tree, floral aromas and color

With Fruit Zone Leaf Thinning

Decreased: bell pepper / vegetative aromas

Increased: grapefruit, box tree, floral aromas

Water / Nutrients

- Vine water availability affects grape maturation (affects vine vigor)
- Water stress increases nor-isoprenoids and GT but reduces MP
- Water stress between berry set and verasion increases citrus and fruit aromas but decreases bell pepper, vegetative aromas
- Water stress is achieved through irrigation type, timing and cover crops
- Nutrient addition method and timing affect GT
- Foliar nitrogen spray greatly increases GT

Disease Pressure

- Vine stress caused by insects increases terpene levels
- Botrytis infection can increase GT by 50X (sauternes)
- Open canopies and cover crops
- Fungicides, pesticides

Not a recommended method of flavor control!

Crop Thinning

- Reducing the number of bunches per vine by dropping the least desirable ones
- Increases terpene levels
- No effect on nor-isoprenoid and GT levels
- Can increase MP levels
- Increases sugar and color accumulation
- Minor impact on aroma but favorable impact on color and maturation rate
- Major impact on vine yield

Viticulture Summary

- The grower has a large effect on the style of wine that will be produced
- Matching grape variety with the local and regional conditions is most important
- Viticultural practices that manage canopy size and environmental stress can yield high quality fruit in terms of color and flavor potential
- Grape maturity and harvest timing are determined by wine style

Harvest Decisions

Grape Maturity

Non-grape factors

Grape Maturity

Grapes should be harvested at the ideal time for the style of wine

Character of the finished wine will be largely dictated by the composition of the fruit at harvest

Goal: Have the ideal grape composition at the time of harvest for the style of wine

Measures of Grape Maturity

Berry Composition

Sugar Level (°Brix)

TA / pH

Sugar / acid balance

Malic / Tartaric balance

Tannins

Color

Varietal flavors may develop at a different rate than those listed above

Multiple harvests?

Measures of Grape Maturity

Berry Physical Characteristics

Berry Firmness

Skin Thickness / Pliability

Seed Color

Seed Friability

Stem color

Non-Grape Factors

Weather: Rain, temperature, humidity

Labor availability

Winery equipment restrictions

Winemaker Focus at Harvest time

- Juice: sugar, water, acids, 3MH
- Skin: terpenes, norisoprenoids, MP, most GT, color, other tannins, variety of microbes
- Seeds / Stems: variety of tannins
- Focus is always on the amount of interaction among these different components and exposure to air

Fruit Handling Post harvest

Harvesting options

Sorting

De-stemming / Crushing

Cold soak

Press: Style / Timing

Must adjustments

Enzymes additions

Cold Soak

- Holding grapes at low temperatures (40-50°F) for an extended period of time (hrs -10+days) prior to fermentation
- Can be as: must, whole berry, whole bunch
- Can develop flavors from ambient yeast / bacteria
- Can help extract color and flavor without adding harsh tannins (water extraction)
- Can increase varietal aroma
- Popular in Pinot noir winemaking
- Debatable long term benefits

Enzyme Additions

- Prepared enzymes can be added to juice or must
- Can increase wine varietal character
- Can have downsides through unintended reactions (increase volatile phenols or loss of color)
- Not legal everywhere and a debated practice