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SKIN CONTACT IN AROMATIC WHITE GRAPE VARIETIES

What is Skin Contact?

- White wines are typically made by extracting the juice from the grapes as quickly as possible after harvest
- In some cases, a pre-fermentation maceration period of 3-24 hours can help enhance aroma, flavor, structure, and color in white wines
  - Typically done at cool temperatures (10-15°C)
  - Grapes can be destemmed or not
  - Can be crushed or not
    - Usually at least a minimal amount of SO_2 and CO_2 protection

Pre-fermentation Maceration

- After harvest, the white grapes are treated as you would a red grape
- Grapes can be destemmed
  - If stems are green, they should be removed
  - Brown stems won't add vegetal character
    - May add tannins, reduce acidity, reduce pH
- Grapes can be crushed or left whole
- Tank is filled with berries, and chilled
  - Shorter macerations can be done inside press cage
- After desired maceration period, free run juice is drained into a separate tank, solids are pressed to extract remaining juice
- Juice is racked and fermented like a normal white wine

To crush or not to crush…

Advantages of Crushing

- More space in the tank
- Shorter maceration time
- Can homogenize the must
  - SO_2, enzymes easily distributed
- Can use a must pump to transfer must to press
- Frees more juice
  - 70% of juice is free run

Disadvantages of Crushing

- Tearing and mechanical action on the grapes
  - Releases a higher proportion of suspended solids into the juice
    - Can result in more vegetal aromas, bitter compounds, higher pH, tannin extraction
- Free run juice is of lower quality due to higher suspended solids

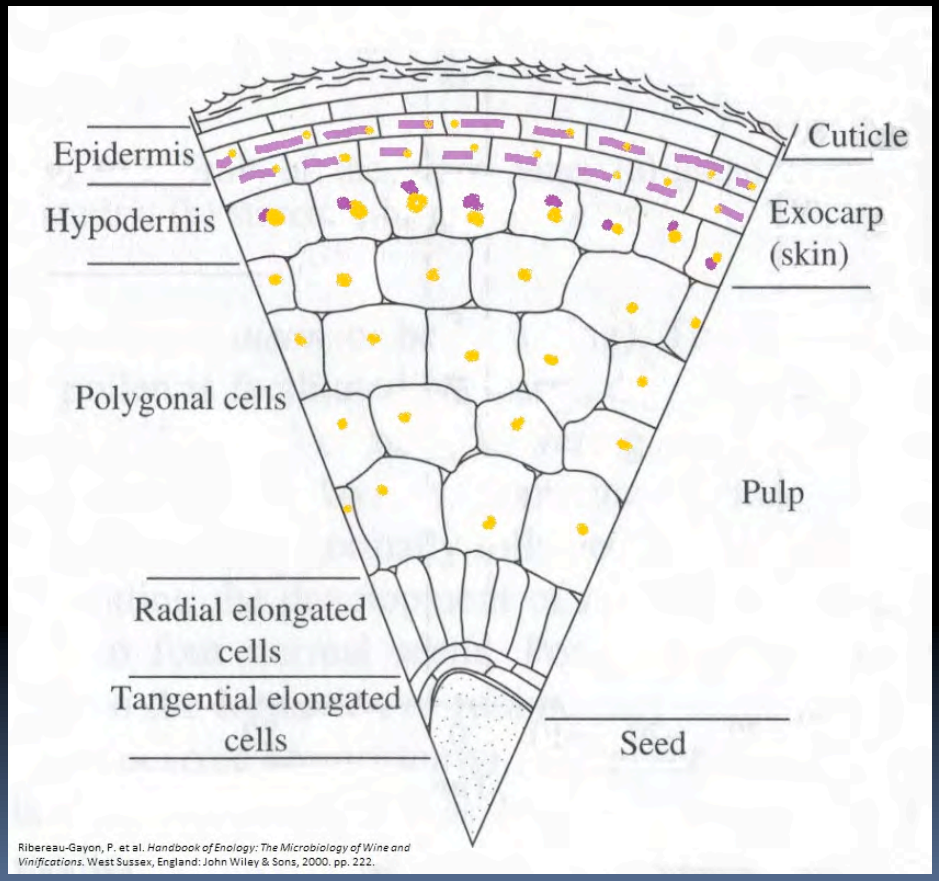
Traditional Riesling processing in the Mosel

- In the past, crushers were placed on top of open-wooden vats carried on horse- or ox-drawn wagons at the foot hillside vineyards
- Grapes were crushed at the vineyard to fit as many grapes as possible into the vat, so fewer trips were needed back and forth from the vineyard to the winery
- The grapes often macerated an entire day or even longer on their skins, pips, and juice.
- Today, some wineries mimic this process by practicing pre-fermentation maceration with must-oxidation

Maceration Considerations

- Many factors to consider:
  - Wine style
  - Grape ripeness
  - Grape variety
  - Acidity
  - Climate…
- In general, maceration can make wine with more complexity, but it may lose some of it's elegance
  - Should only be considered with high-quality perfectly-ripe fruit

Grape Morphology



Ribereau-Gayon, P. et al. *Handbook of Enology: The Microbiology of Wine and Vinifications*. West Sussex, England: John Wiley & Sons, 2000. pp. 222.

- Each grape contains a group of tissues surrounding the seeds
- Cuticle varies in thickness and is covered by a waxy "bloom"
- Grape skin can be divided into two layers:
  - Epidermis: clear single layer of cells
  - Hypodermis: more or less 6 layers of cells containing various polphenols
- Hydroxycinnimates
  - 3rd most abundant class of polyphenols
  - Located in skin and pulp cells
  - Most abundant polyphenol in white wines

The exocarp layers (skin) of grapes contains certain compounds that don't exist in the pulp, or exist in smaller quantities in the pulp

Compounds in skin that will impact wine flavor

- Aromatic Compounds
  - Monoterpenoids, methoxypyrazines
- Aroma Precursors
  - Carotenoids, Cysteine Conjugates, Glycoconjugates, Unsaturated Lipids
- Phenols
- Nitrogen
  - Higher concentration in skin than in juice
- Potassium
  - Will increase the buffer capacity (pH) of higher acid wines

Origin of Wine Aroma

- Hundreds of aromatic compounds have been identified in wine, often in micro-concentrations
- Classified into 4 main groups:
  - Originating from the grape
  - Produced during the crushing of the grapes by action of certain enzymes
  - Produced during fermentation
  - Produced during maturation

Cultivar Bouquet

- Aromas found in the wine that are associated with a particular grape variety (cultivar)
- The cultivar bouquet is caused by:
  - Aromatic compounds that are typical of the grape variety, and transferred unchanged from the grape to the wine without being affected by the fermentative process
  - Compounds equally typical to the cultivar, but are formed from a grape aroma precursor(s) during the process of fermentation

Aromatic Compounds in Grapes

- Most *V. vinifera* grape varieties contain no characteristic aroma molecules
- Exceptions:
  - Monoterpenoids
    - Aromatic molecules found in Muscat varieties, Gewurztraminer, Riesling, Viognier…
    - Rose aroma – linalool
    - Rose-like, or citrus aroma - geraniol
    - "fresh" green aromas – nerol
  - Methoxypyrazines
    - Found in Cabernet Sauvignon and related varieties
    - "green," vegetal, and herbaceous aromas

Monoterpenes in Grapes

- Over 50 have been identified in V. vinifera cultivars
- Exist in Free, and glycosidically-bound forms
  - Free monoterpenes are aromatic, bound are potentially aromatic

- Aromatic white grapes should be harvested based on their PVT concentration
- The terpene concentration may continue to increase even as sugar levels remain the same

Content of free (FVT) and potentially volatile monoterpene (PVT) in grape juice from different grape varieties

Grape variety	FVT (mg/l)	PVT (mg/l)	PVT/FVT
Italian Riesling	0.288	0.625	2.200
Chardonnay	0.181	0.307	1.700
Vranec	0.172	0.164	0.953
Cabernet Sauvignon	0.321	0.135	0.421
Muscat Italia	0.780	2.330	2.900
Muscat Hamburg	0.563	2.190	3.900

(Doneva-Sapeska, et al. 2005)

Monoterpene distribution

- Majority of FVT and PVT is located in the skins of grapes
- Extended skin contact allows for more free and bound monoterpenes to be passed from the skins to the juice
  - Possible to enhance Varietal flavor

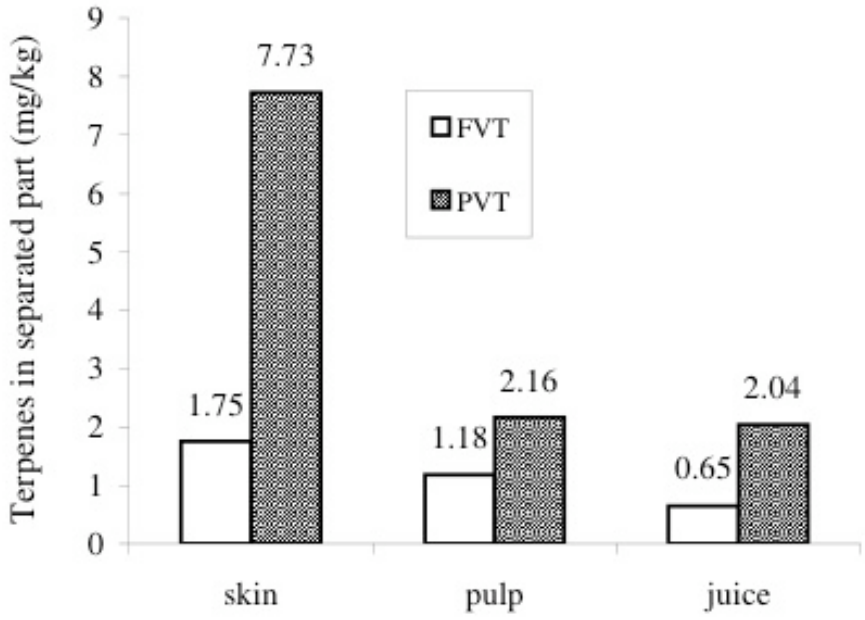
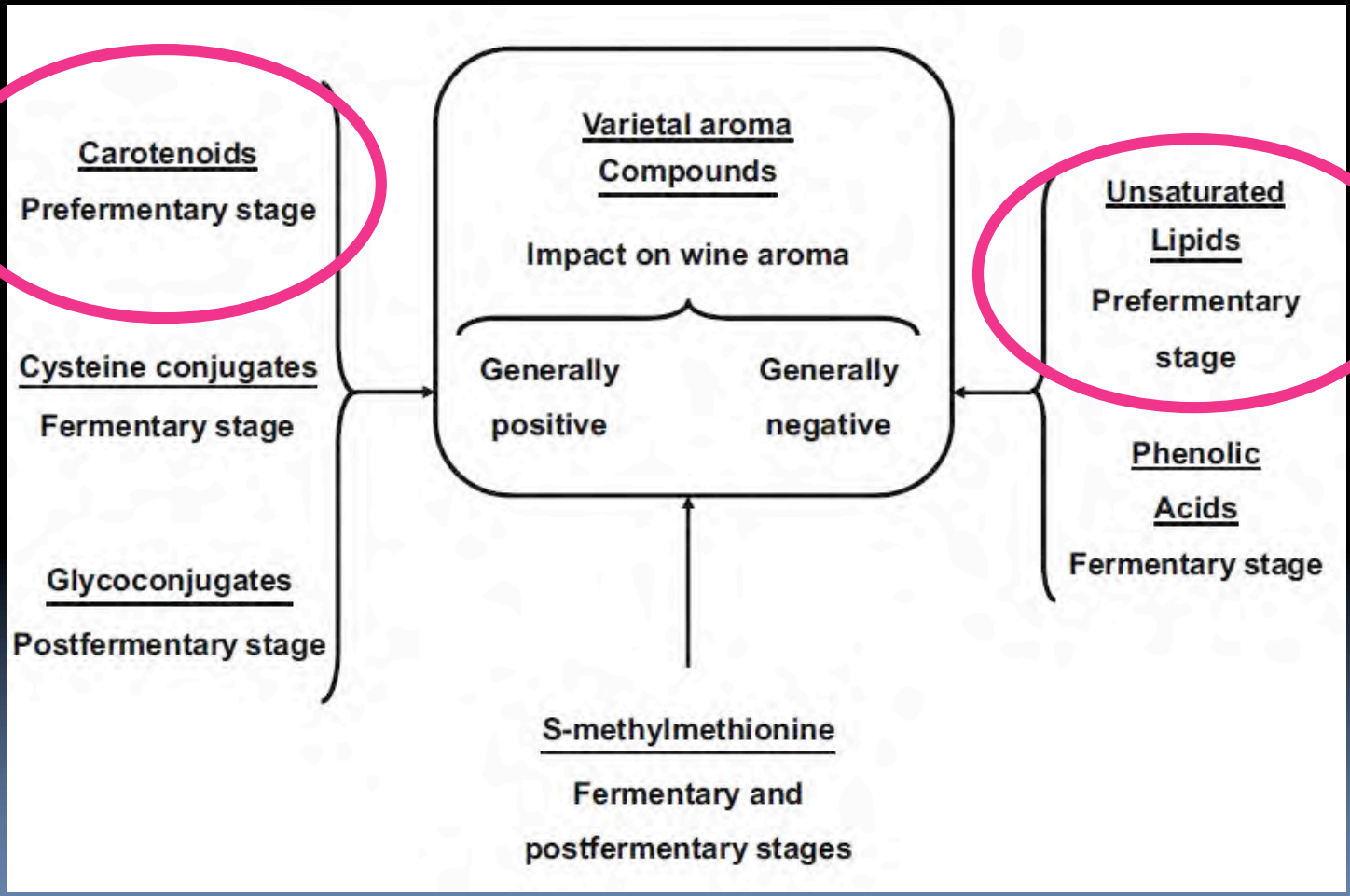


Fig. 1. Content of free and potentially volatile terpenes in grape variety Muscat Italia

(Doneva-Sapeska, et al. 2005)

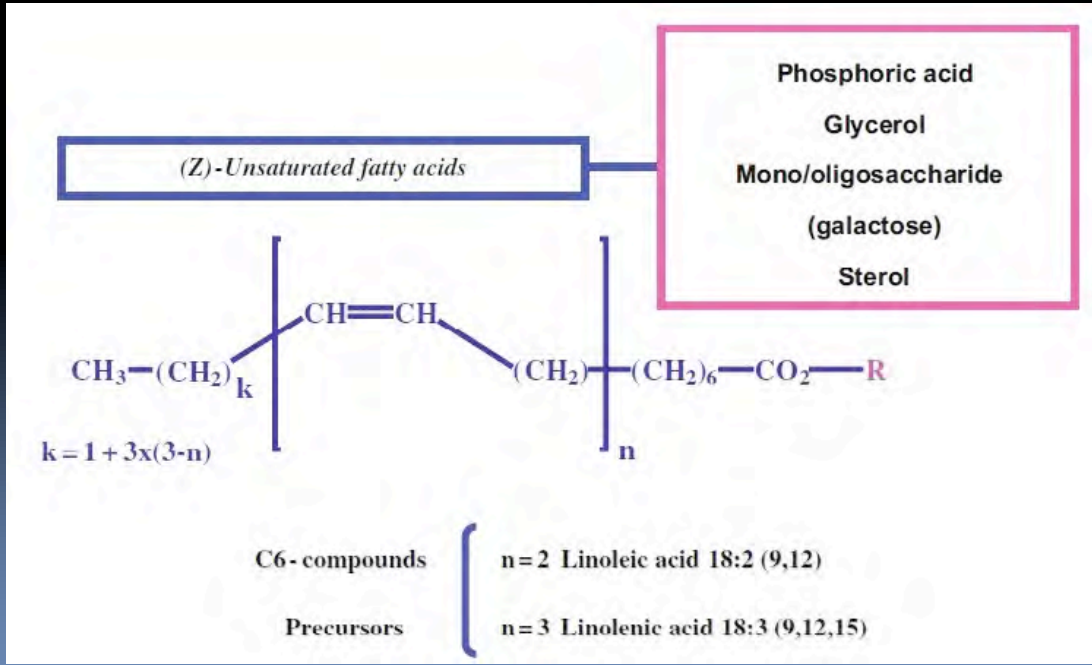
Aroma Precursors



Unsaturated Fatty Acids (lipids)

- Mainly linoleic and linolenic acid esters
- Not cultivar dependant
  - Their concentration decreases during berry ripening
- Primarily located in the skins, stems, and seeds)

- Converted to C6 compounds by grape enzymes during pre-fermentative treatments
  - Hexanal, 2-hexenal, hexanol, and hex-2- and 3-en-1-ols



Lipids can produce off-odors

- Formation of off-aromas (C6 Compounds) depends on:
  - initial concentration of lipids
  - enzyme activity in the presence of oxygen
- The off-aromas are almost always stronger in the juice than in the wine
  - some C6 compounds are changed to non-odorous compoundsduring fermentation to

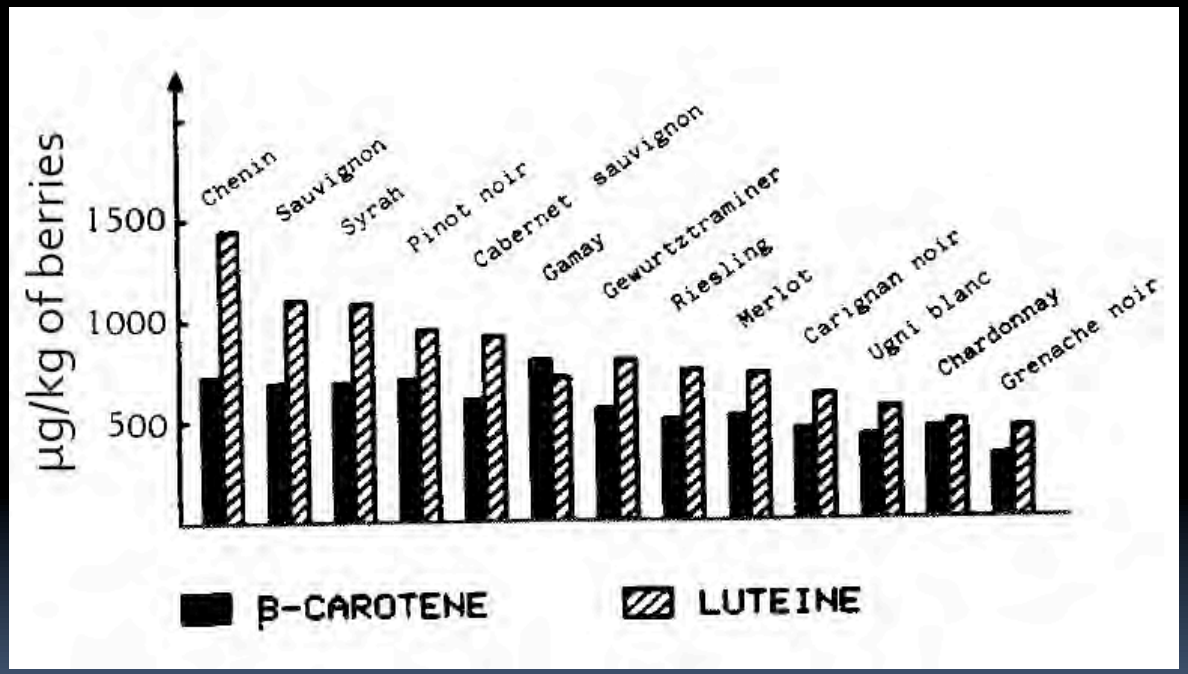
Conclusion: unripe grapes should not be used for skin maceration

Carotenoids

- Found in the skin at levels 2-3 times higher than in the pulp
- Concentration is dependant on grape cultivar and growing conditions
- Considered part of the aromatic potential of a grape
  - Precursor of the class of some of the most powerful odorants in wine (C13-norisoprenoids)
    - TDN, Vitispirine, damascenone…
- Sunshine favors formation of Carotenoids pre-*veraison;* post-*veraison* sunshine helps degrade them to C13-norisoprenoids
- In wine, Carotenoids are likely precursors to another class of aromas - Ionones

Carotenoids

- It is proposed that carotenoids are degraded to Ionones - floral aromas - during winemaking
  - Occurs only during skin-contact with the juice



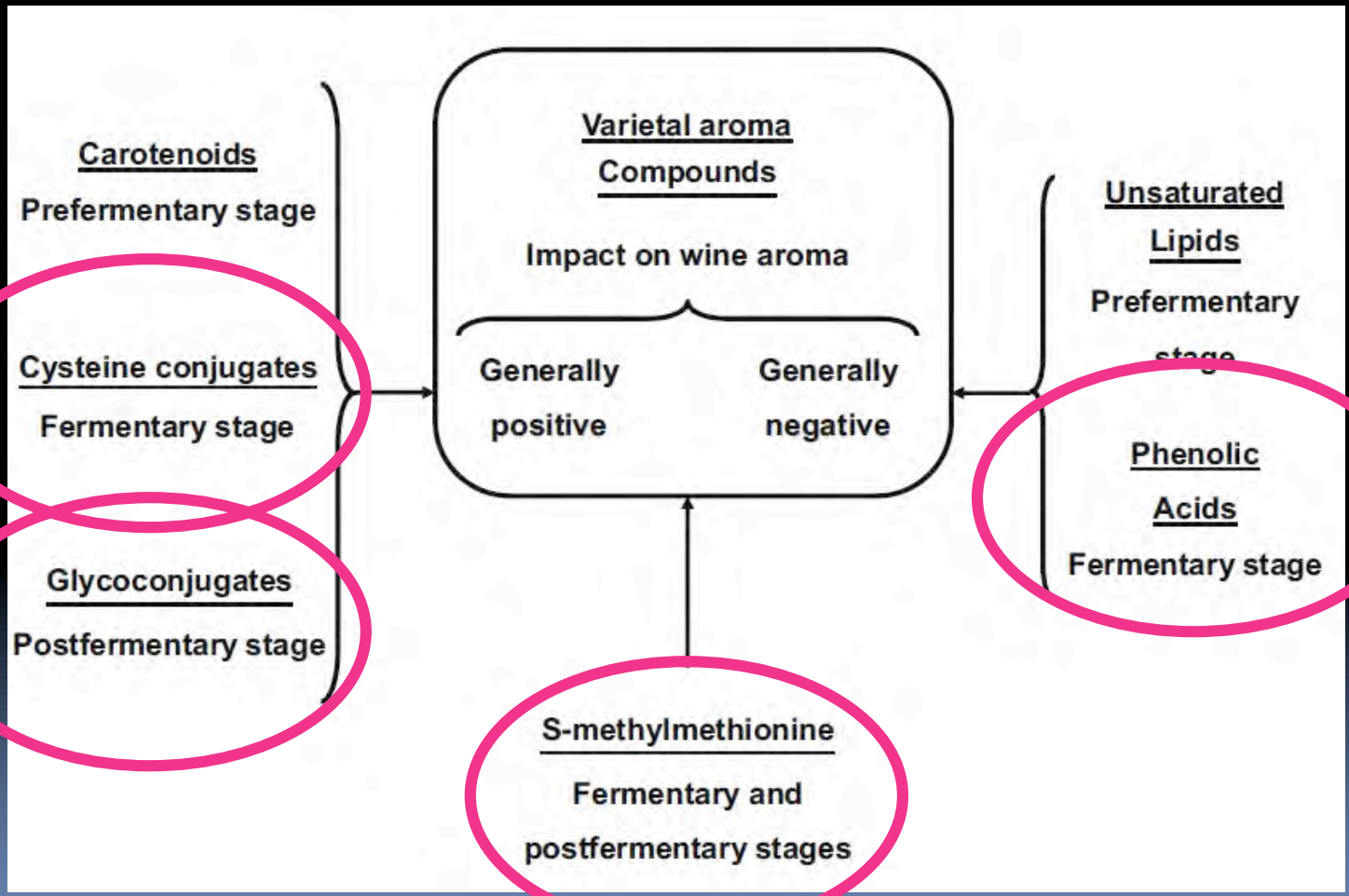
Razungles, A. *et. al* (1987). Etude des carotenoides du raisin a maturite. *Vitis, 26, 183–191*

- Certain aromatic varieties that have characteristic odors of violets are high in carotenoids
  - This mechanism for formation of ionones in wines haven't been proven, but it is seen in other species of plants

Carotenoids

- Conclusions:
  - They are precursors to important aromatic compounds in Riesling, and other aromatic varieties (TDN, Vitispirines, damascenones…)
    - These compounds, like their carotenoid precursors, are often found in higher concentrations in the skins
  - Carotenoids may act as an important precursor to the development of Ionones (floral aromas)
  - Grape Ripeness is an important factor in Carotenoid and Norisoprenoid content of grapes

Aroma Precursors



Phenolic Acids

- primarily located in the solid parts of the berry, and their concentration decrease with maturation
  - Caftaric acid, ester of caffeic acid, coutaric acid, ester of coumaric acid, fertaric acid, ester of ferulic acid
- In contrast to lipids, their concentration differs between grape cultivars
- Precursors to Volatile Phenols in wine

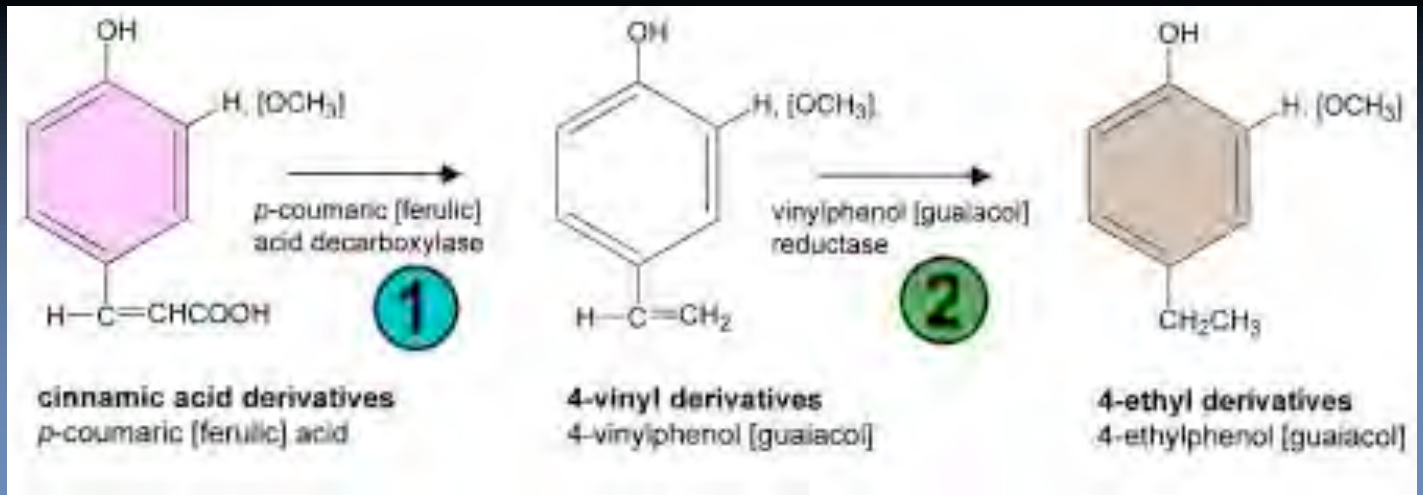
Volatile Phenols

- Two volatile phenols (4-vinyl-phenol and 4-vinyl-guaiacol) are formed during alcoholic fermentation by decarboxylation of the free cinnamic acids
- Tannins in red wines (catechins) prevent this reaction from happening by inhibiting the yeast enzyme
  - The enzyme produced by *Brettanomyces* is not inhibited by catechins
- Vinylphenols will negatively impact white and rosé wines by masking fruity notes

Volatile Phenols

- volatile phenols play a minor role in the aroma of most wines, and when their influence is significant in certain wines, they have mostly a negative effect

- the corresponding precursors in grape, phenolic acids, are hardly taken into account to capture an essential characteristic of the varietal aroma, but to avoid their transformation into off-flavors



Glycoconjugates

- In grape berries, most volatile phenols, monoterpenoids and C13 norisoprenoids occur as glycoconjugates

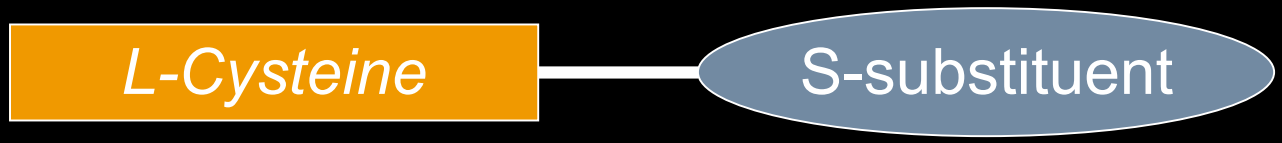
- Many of these aglycons are odorants or precursors of odorants, their odorless glycoconjugates make up a reserve of grape flavor, which is generally more abundant than the free one

Glycoconjugates

- In neutral grape varieties, the total amount of glyconjugates is not much more than a few mg/kg,
  - Can be up to 10x higher in aromatic varieties
- Generally the skin contains ≥50% of their total content
- This potential of aroma precursors, as well as the typical free aroma, can be enhanced by processes such as skin contact or carbonic maceration

S-Cysteine Conjugates

- Discovered relatively recently
- Odourless nonvolatile cysteinylated precursors of very odorous volatile thiols



- Volatile Thiols can have pleasant aromas such as passionfruit, grapefruit, boxtree…

  or unpleasant aromas such as cabbage, skunk, garlic, burnt rubber…

S-Cysteine Conjugates

- Little research available; mostly is centered on Sauvignon Blanc
- The changes in their levels during ripening were shown to be dependant on environmental conditions, soil and climate parameters, and vineyard management techniques.
- One precursor (P3MH) was found in higher levels in the skin than in the juice for Sauv. Blanc
  - Suggests that skin contact has a higher impact on that particular volatile precursor than with others.

Nitrogen impact on aromas

- Nitrogen accumulation is important from a Fermentation standpoint
  - Very important yeast nutrient
- Nitrogen transport to the grape exists in two forms
  - Ammonium cations and Amino Acids
  - Nitrogen accumulation increases after véraison and reaches a maximum value around mid-maturity

Nitrogen accumulation

- Nitrogen is supplied to the vine, which is in turn deposited in the grape
- Viticultural conditions which limit Nitrogen supply include:
  - Superficial root systems of young vines
  - Winter root asphyxiation in poorly-drained soils
  - Light soils with insufficient water reserve
  - Ground cover strongly limiting water and nitrogen supplies
- Juice with less than 160 ppm of assimilable nitrogen should be supplemented with Ammonium sulfate

Nitrogen Impact

- Juice from mature grapes contains 20% of the total berry nitrogen
  - The remainder is in the skins and seeds
  - Juice in white and rosé winemaking should be systematically tested for "Yeast Available Nitrogen" (YAN)
- Skin contact will increase the nitrogen content in the must

Effect of Nitrogen Content of the must on fermentation aromas in wine

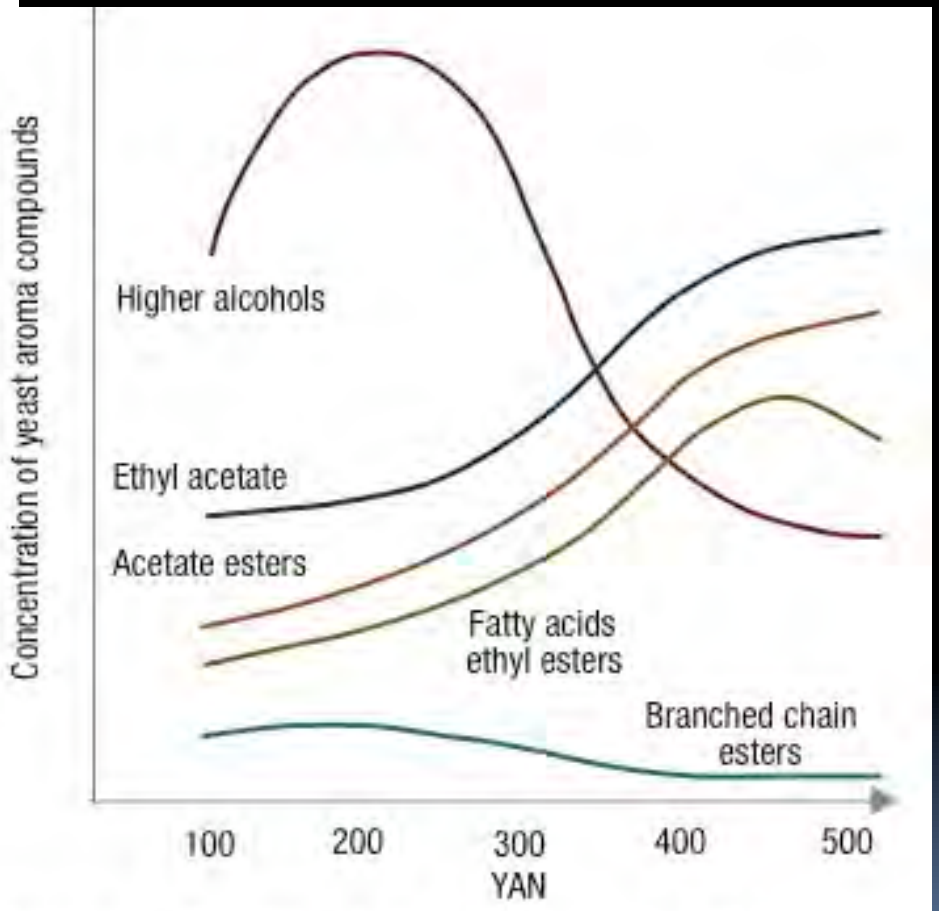


Figure 3. Relationship between initial YAN concentration and final concentration of volatile compounds after fermentation.

- Over-addition of Nitrogen can have undesirable consequences
  - Production of ethyl acetate (nail polish/solvent aroma)
  - Overproduction of Higher Alcohols (can mask fruity aromas at high concentrations)
  - Inhibit Malolactic fermentation

Source: Australian wine Research Institute

Skin contact and Acidity

- Skins contain more potassium than the juice
  - Skin contact will raise a wine's pH
- Skins and stems have the ability to adsorb certain compounds, like tartaric acid
  - Certain winemakers in the Mosel have observed a decrease in TA of 0.1 g/L for each hour of skin contact
- In a high-acid vintage, and for progressively higher ripeness levels, longer macerations can be beneficial
- Shorter maceration in Riper Vintages
  - Risk the pH rising too high

Conclusions

- Ripeness of the fruit is the most important consideration when deciding whether or not to implement pre-fermentation maceration
  - Unripe grapes contain higher amounts of lipids and phenolic acids
  - Unripe Grapes contain fewer grape aromas and positive grape aroma precursors
- Aromatic white grape varieties will benefit the most from prefermentation maceration

Conclusions

- Skin maceration in whites can be done to:
  - Reduce acidity while increasing mineral content
  - Increase wine aromatics
  - Increase extraction of tannins
  - Extract more flavor and volume
- Skin maceration should be done at cooler temperatures
- When stems are ripe, maceration can be done with the stems
- Grapes can be crushed or left whole
- Very Ripe Fruit, which will already produce an opulent wine, is not a good candidate for skin maceration
  - Damaged and/or rotten fruit should also be directly pressed

Thank you For your Time!

Questions or Comments?